SUPREME COURT VOLUME-2

ANNEXURES

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WORLD HEALTH ORGANIZATION
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IARC Monographs on the Evaluation of Carcinogenic Risks to Humans

VOLUME 85

Betel-quid and Areca-nut Chewing and Some Areca-nut-derived Nitrosamines

LYON, FRANCE
2004

Table 3. Production of areca nut by country since 1961 (in millions of tonnes)

Country	1961	1971	1981	1991	2001
Bangladesh	62 995	23 369	25 051	24 120	47 000
India	120 000	141 000	195 900	238 500	330 000
Indonesia	13 000	15 000	18 000	22 812	36 200
Kenya	NA	NA	NA	100	90
Malaysia	6 500	3000	2 500	4000	2500
Maldives	1	1	5	16	37
Myanmar	8000	19 203	25 807	32 270	51 463
Taiwan, China[a]	3718	10 075	24 358	111 090	165 076
Thailand	NA	NA	NA	13 250	20 500
World	428 428	423 296	583 242	892 316	1 305 732

From FAO (2003)
NA, not available
[a] From Council of Agriculture, ROC (2003)

graphical cultivation in South and South-East Asia and in the Pacific basin was given by Furatado (1933). Areca nut for chewing is obtained exclusively from *Areca catechu*, which is believed to be native to Sri Lanka, West Malaysia and Melanesia (IARC, 1985a). This tropical palm tree bears fruit all year, which are ovoid or oblong with a pointed apex, measuring 3–5 cm in length and 2–4 cm in diameter. The outer surface is green when unripe and orange-yellow when ripe. The seed (endosperm) is separated from a fibrous pericarp, is rounded with a truncated base and is opaque and buff-coloured with dark wavy lines. It has a characteristic astringent and slightly bitter taste and is consumed at different stages of maturity according to preference. An individual may consume the whole nut or thin slices of the nut, in its natural state or after processing in many forms.

The nut may be used fresh or it may be dried and cured before use, by sun-drying, baking or roasting (Table 2). Areca fruit may also be boiled and fermented (in eastern parts of India, Sri Lanka) by covering it with mud to soften the nut for consumption. These treatments change the flavour of the nut and its astringency. In Taiwan, China, areca nut is most often used in the unripe stage when it is green, like a small olive.

Areca nut is known colloquially in Hindi and other languages in India as *supari*; it is called *puwak* in Sri Lanka, *gua* in Sylheti (Bangladesh), *mak* in Thailand, *pinang* in Malaysia, *daka* in Papua New Guinea, *pugua* in Guam and *Kun-ywet* in Myanmar (IARC, 1985a).

Chemical constituents

Comprehensive analyses of the chemical composition of areca nut have been reported and reviewed (Raghavan & Baruah, 1958; Shivashankar *et al.*, 1969; Arjungi, 1976; Jayalakshmi & Mathew, 1982). The major constituents of the nut are carbohydrates, fats,

170

proteins, crude fibre, polyphenols (flavonols and tannins), alkaloids and mineral matter. The ranges in concentration of the chemical constituents of areca nut are given in Tables 4 and 5. Variations in the concentrations of the various constituents may occur in nuts from different geographical locations and according to the degree of maturity of the nut. Of the chemical ingredients, tannins, alkaloids and some minerals that may have biological activity and adverse effects on tissues have been subjected to detailed study.

Polyphenols (flavonols, tannins) constitute a large proportion of the dry weight of the nut. The ranges in concentration of polyphenols in unprocessed and processed nuts are shown in Tables 4 and 5. The polyphenol content of a nut may vary depending on the region where *Areca catechu* is grown, its degree of maturity and its processing method. The tannin content is highest in unripe areca nuts and decreases substantially with increasing maturity (Raghavan & Baruah, 1958). The roasted nut possesses the highest average content of tannins, ranging from 5 to 41% (mean, 21.4%); the average tannin content of sun-dried nuts is 25%; and the lowest levels are seen in boiled nuts, which contain 17% (Awang, 1987).

Polyphenols are responsible for the astringent taste of the nut (Raghavan & Baruah, 1958).

Alkaloids: Among the chemical constituents, alkaloids are the most important biologically. The nut has been shown to contain at least six related alkaloids, of which four (arecoline, arecaidine, guvacine and guvacoline) (Figure 1) have been conclusively identified in biochemical studies (Raghavan & Baruah, 1958; Huang & McLeish, 1989; Lord *et al.*, 2002). Arecoline is generally the main alkaloid. The ranges in concentration of arecoline in unprocessed and processed nuts are given in Tables 4 and 5.

The contents in the four major alkaloids of fresh areca nuts obtained from Darwin, Australia, have been determined by high-performance liquid chromatography (Table 6).

Table 4. Ranges in concentration[a] of the chemical constituents of a variety of unprocessed green and ripe areca nuts

Constituents	Green (unripe) nut	Ripe nut
Moisture content	69.4–74.1	38.9–56.7
Total polysaccharides	17.3–23.0	17.8–25.7
Crude protein	6.7–9.4	6.2–7.5
Fat	8.1–12.0	9.5–15.1
Crude fibre	8.2–9.8	11.4–15.4
Polyphenols	17.2–29.8	11.1–17.8
Arecoline	0.11–0.14	0.12–0.24
Ash	1.2–2.5	1.1–1.5

From Jayalakshmi & Mathew (1982)

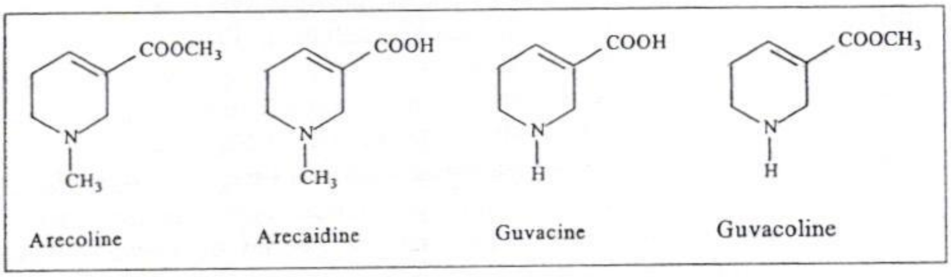
[a] Percentage based on dry weight (except moisture)

Table 5. Ranges in concentration[a] of some chemical constituents of a variety of processed areca nuts in India

Type/trade name	No. of samples analysed	Poly-phenols (%)	Arecoline (%)	Fat (%)	Crude fibre (%)	Total poly-saccharides (%)
Chali	65	7.3–34.9	0.1–0.7	4.9–24.4	7.1–17.4	14.3–26.3
Parcha	18	11.7–25.0	0.1–0.5	12.3–18.1	8.0–14.3	13.0–27.3
Lyon	25	19.6–45.9	0.1–0.7	6.8–18.1	5.4–13.3	13.5–28.2
Api	54	15.2–41.3	0.2–0.9	5.3–18.5	5.4–18.5	9.2–28.2
Batlu	31	22.4–55.2	0.1–0.9	4.3–17.9	3.1–12.3	14.2–27.0
Choor	33	24.9–43.7	0.1–0.9	5.9–17.8	5.1–15.2	11.1–28.1
Erazel	9	16.9–38.0	0.2–0.8	5.5–12.3	5.9–8.7	13.1–26.6
Chalakudi	3	32.0–39.3	0.4–0.9	7.1–10.5	5.3–14.9	22.1–26.9
Nuli	6	39.0–47.9	0.6–0.9	3.7–13.8	3.8–6.0	16.4–22.7

From Shivashankar *et al.* (1969)
[a] Percentages based on dry weight

Figure 1. Chemical structure of areca alkaloids



From Mujumdar *et al.* (1982)

Table 6. Alkaloid content of fresh areca nuts from Darwin, Australia

Alkaloid	% Nut[a]
Arecoline	0.30–0.63
Arecaidine	0.31–0.66
Guvacoline	0.03–0.06
Guvacine	0.19–0.72

From Huang & McLeish (1989)
[a] [Percentage not specified, probably based on dry weight]

172

The levels were slightly higher than those observed for Indian and Papua New Guinean nuts. The authors concluded that this difference may result from seasonal and geographical variations (Huang & McLeish, 1989).

In an aqueous extract of Taiwanese betel quid composed of fresh areca nut, betel inflorescence and red lime paste (80.5:12.5:7 by weight), arecaidine was the most abundant alkaloid (7.53 mg/g dry wt) and guvacoline the least abundant (0.26 mg/g dry wt). No change in the levels of alkaloids was observed during cold storage or during the process of freeze-drying (Wang *et al.*, 1999).

Examining volatile alkaloids in areca nut [source unspecified] by gas chromatography–mass spectrometry, Holdsworth *et al.* (1998) and Self *et al.* (1999) described the presence of at least six other related alkaloids in addition to arecoline and guvacoline. These were identified as nicotine (~0.02%), methyl nicotinate, ethyl nicotinate, methyl- and ethyl-*N*-methyl piperidine-3-carboxylate and ethyl-*N*-methyl-1,2,5,6-tetrahydro-pyridine-3-carboxylate.

Wide variations in the arecoline content of areca nut have been demonstrated in commercially available nuts, ranging between 0 and 1.4% (Table 5; Awang, 1986; Canniff *et al.*, 1986). Arecoline content is reduced following processing of the nut (Awang, 1988). The content is reduced from 1.4% to 1.35% by sun-drying, to 1.29% by roasting, to 0.7% by soaking in water and to 0.1% by boiling in water (Awang, 1988). The practice of boiling the nut in a liquor obtained from the previous year's boiling is designed to increase the alkaloid content of treated nuts (Canniff *et al.*, 1986).

Elemental composition: Concentrations of sodium, magnesium, chlorine calcium, vanadium, manganese, copper and bromine were measured in areca nut, *pan masala* and other chewing materials available in the United Kingdom (Ridge *et al.*, 2001). The values obtained for areca nut were lower than those reported in areca nut from Taiwan, China (Wei & Chung, 1997), but generally showed good consistency. Mean concentrations of 36 elements in areca nut, betel leaf, slaked lime and catechu are shown in Table 7 and Figure 2 (Zaidi *et al.*, 2002).

In view of possible fibrogenic, mutagenic and toxic effects of areca nut, the copper content in samples of raw and processed areca nut was analysed and reported to be much higher than that found most frequently in other nuts consumed by humans (Trivedy *et al.*, 1997). The mean concentration of copper in samples of processed, commercially available areca nut was 18 ± 8.7 μg/g (Trivedy *et al.*, 1999). In an Indian Food Report, the copper content of processed areca nut was found to be 2.5 times that of the raw nut (Gopalan *et al.*, 1989).

Areca-nut-derived nitrosamines: No study has been undertaken to determine areca-nut-derived nitrosamines in any variety of areca nut (J. Nair, personal communication).

Table 7. Concentration[a] of trace elements in betel-quid ingredients

Element[b]	Areca nut	Betel leaf	Slaked lime	Catechu
Cr (μg/g)	0.50 ± 0.06	0.46 ± 0.06	19.2 ± 2.9	7.3 ± 1.2
Mn (μg/g)	47 ± 6	380 ± 38	57.1 ± 8.6	170 ± 20
Fe (μg/g)	75 ± 8	171 ± 21	190 ± 29	5156 ± 774
Co	27 ± 4	132 ± 16	66 ± 9	2250 ± 360
Zn (μg/g)	5 ± 1	16.6 ± 2.2	1.24 ± 0.19	1.77 ± 0.27
Mg (μg/g)	2.8 ± 0.4	6.2 ± 0.9	1.30 ± 0.06	19.4 ± 2.9
Na (μg/g)	127 ± 14	793 ± 95	67 ± 7	6424 ± 964
K (% wt)	0.43 ± 0.04	4.42 ± 0.44	0.013 ± 0.002	0.46 ± 0.07
Ba (μg/g)	1.7 ± 0.3	15.4 ± 1.8	16.0 ± 2.4	7.7 ± 1.2
Ca (μg/g)	1.2 ± 0.2	4.8 ± 0.7	NA	12.6 ± 1.2
Ga	9 ± 1	16 ± 3	5 ± 1	58 ± 9
Al (μg/g)	2.9 ± 0.5	5.7 ± 0.8	7.2 ± 1.2	18.4 ± 0.2
V	12 ± 2	26 ± 4	15 ± 2	67 ± 10
Ti	14 ± 2	36 ± 6	48 ± 7	73 ± 12
In	18 ± 3	26 ± 4	31 ± 5	89 ± 13
Sn (μg/g)	1.4 ± 0.2	7.2 ± 1.1	9.4 ± 1.4	23.1 ± 3.4
Sb	13 ± 2	46 ± 5	404 ± 60	1100 ± 200
As (μg/g)	0.34 ± 0.04	18.3 ± 2.2	0.28 ± 0.04	5.96 ± 0.89
Se	120 ± 20	38 ± 5	70 ± 8	1045 ± 158
Hg	6 ± 1	9 ± 1	8 ± 1	12 ± 2
Cl (% wt)	0.15 ± 0.02	0.55 ± 0.1	ND	0.064 ± 0.01
Br (μg/g)	7.2 ± 0.9	7.1 ± 0.9	0.46 ± 0.07	0.61 ± 0.01
Cs	250 ± 40	7 ± 1	6 ± 1	14 100 ± 2100
Sc	18 ± 2	33 ± 4	274 ± 41	2490 ± 398
Rb (μg/g)	57 ± 7	225 ± 27	20.2 ± 2.8	232 ± 37
Ta	7 ± 1	9 ± 2	38 ± 6	1100 ± 180
La	44 ± 4	37 ± 4	2958 ± 473	7300 ± 1022
Ce (μg/g)	0.24 ± 0.04	1.14 ± 0.20	8.5 ± 1.3	20.6 ± 3.1
Nd	10 ± 2	18 ± 2	16 ± 2	21 ± 3
Sm	23 ± 4	35 ± 5	19 ± 3	51 ± 8
Eu	5 ± 1	7 ± 1	120 ± 20	296 ± 44
Gd	21 ± 5	12 ± 2	38 ± 6	49 ± 7
Tb	10 ± 2	9 ± 1	90 ± 10	121 ± 18
Dy	12 ± 2	10 ± 2	26 ± 3	38 ± 4
Yb	8 ± 1	78 ± 13	347 ± 56	2142 ± 343
Hf	18 ± 2	98 ± 12	78 ± 12	1200 ± 200

From Zaidi *et al.* (2002)

NA, not applicable; ND, not detected

[a] Mean ± standard deviation of five determinations

[b] Values expressed in ng/g dry weight, unless otherwise specified

Figure 2. Trace elements found in the main ingredients of betel quid

	Groups																		
	1	2	3		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	IA	IIA	IIIA		IVA	VA	VIA	VIIA	VIIIA			IB	IIB	IIIB	IVB	VB	VIB	VIIB	VIII
	IA	IIA	IIIB		IVB	VB	VIB	VIIB	VIII			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1	H 1																		He 2
2	Li 3	Be 4												B 5	C 6	N 7	O 8	F 9	Ne 10
3	**Na 11**	**Mg 12**												**Al 13**	Si 14	P 15	S 16	**Cl 17**	Ar 18
4	**K 19**	**Ca 20**	**Sc 21**		**Ti 22**	**V 23**	**Cr 24**	**Mn 25**	**Fe 26**	**Co 27**	Ni 28	Cu 29	**Zn 30**	**Ga 31**	Ge 32	**As 33**	**Se 34**	**Br 35**	Kr 36
5	**Rb 37**	Sr 38	Y 39		Zr 40	Nb 41	Mo 42	Tc 43	Ru 44	Rh 45	Pd 46	Ag 47	Cd 48	**In 49**	**Sn 50**	**Sb 51**	Te 52	I 53	Xe 54
6	**Cs 55**	**Ba 56**	**La 57**	1	**Hf 72**	**Ta 73**	W 74	Re 75	Os 76	Ir 77	Pt 78	Au 79	**Hg 80**	Tl 81	Pb 82	Bi 83	Po 84	At 85	Rn 86
7	Fr 87	Ra 88	Ac 89	2	Rf 104	Db 105	Sg 106	Bh 107	Hs 108	Mt 109	Uun 110	Uuu 111	Uub 112		Uuq 114		Uuh 116		Uuo 118

6	1	**Ce 58**	Pr 59	**Nd 60**	Pm 61	**Sm 62**	**Eu 63**	**Gd 64**	**Tb 65**	**Dy 66**	Ho 67	Er 68	Tm 69	**Yb 70**	Lu 71
7	2	Th 90	Pa 91	U 92	Np 93	Pu 94	Am 95	Cm 96	Bk 97	Cf 98	Es 99	Fm 100	Md 101	No 102	Lr 103

1.1.3 *Betel leaf*

The most common accompaniment for chewing areca nut globally is the leaf of *Piper betle*. This has led to areca nut being labelled 'betel nut' in the English literature, but the Working Group does recommend this nomenclature.

Betel leaves contain betel oil, a volatile liquid, which contains several phenols including hydroxychavicol, eugenol, betel phenol and chavicol. Vitamin C (1.9 mg/g) and a large amount of carotenes (80.5 mg/g) have also been reported (Wang & Wu, 1996).

Mean concentrations of 36 trace elements in betel leaf are listed in Table 7 and Figure 2 (Zaidi *et al.*, 2002).

1.1.4 *Betel inflorescence*

Apart from the leaf, other parts of the vine such as the stem, inflorescence (also called flower or pods) or catkins are also consumed with areca nut (Tables 1 and 2). Consumption of the inflorescence is common in Melanesia and in parts of Taiwan, China, and it is mostly added to the quid for its aromatic flavour.

Betel inflorescence contains a high concentration of phenolic compounds including hydroxychavicol, eugenol, isoeugenol, eugenol methyl ester and safrole (Hwang *et al.*, 1992; Wang & Hwang, 1993). Concentrations of phenolic compounds in fresh *Piper betle* flower, determined by high-performance liquid chromatographic analysis, are listed in Table 8. Safrole, the major phenolic compound, is a possible human carcinogen (IARC, 1976).

Table 8. Concentrations of phenolic compounds in fresh *Piper betle* flower by high-performance liquid chromatographic analysis

Phenolic compound	Molecular weight (g)	Concentration (mg/g fresh wt)
Safrole	162	15.35
Hydroxychavicol	151	9.74
Eugenol	164	2.51
Eugenol methyl ester	178	1.81
Isoeugenol	164	1.81
Quercetin	338	1.11

From Hwang *et al.* (1992)

1.1.5 *Slaked lime*

Slaked lime (calcium hydroxide) is often combined with areca nut (Table 1). In coastal areas, it is obtained by heating the covering of shell fish (sea shells) or is harvested from corals. In central parts of a country, it is quarried from limestone (Table 2). In the

176

Asian markets, slaked lime is sold as a paste mixed with water, which is white or pink. In Papua New Guinea, slaked lime is available in the powdered form and stored in air-tight containers.

Free calcium hydroxide, iron(II) and magnesium(II) were measured in 25 samples of slaked lime from Papua New Guinea, and large variations in their concentrations were found (Nair *et al.*, 1990). Mean concentrations of 35 trace elements measured in slaked lime are listed in Table 7 and Figure 2 (Zaidi *et al.*, 2002).

1.1.6 *Catechu*

Catechu is an astringent, reddish-brown substance which is often smeared on the betel leaf used to wrap the ingredients of betel quid. Two main types of catechu may be used depending on the tree or shrub from which the catechu has been extracted (Table 2). One type of catechu is prepared by decoction and extraction from the heartwood of *Acacia catechu*, Willd. (N.O. Leguminosae), a tree indigenous to India and Myanmar. It is sometimes referred to as black catechu or cutch. The main constituents are catechu-tannic acid (25–35%), acacatechin (2–10%), quercetin and catechu red. Another type of catechu is an aqueous extract prepared from the leaves and young shoots of *Uncaria Gambier*, Roxb. (N.O. Rubiaceae), a climbing shrub indigenous to the Malay Archipelago. It is sometimes referred to as pale catechu or *gambir*. The main constituents are catechin (7–33%), catechu-tannic acid (22–50%), quercetin and catechu red (Council of the Pharmaceutical Society of Great Britain, 1911). In addition, in Northern Thailand, catechu may be derived from the sun-dried pounded bark of *Lithocarpus polystachya*. It is referred to as *nang ko* (Mougne *et al.*, 1982).

Mean concentrations of 35 trace elements measured in catechu are listed in Table 7 and Figure 2 (Zaidi *et al.*, 2002).

1.1.7 *Tobacco*

Tobacco is often added to the quid mixture. Chewing tobacco in the Indian subcontinent is prepared from sun-dried and partly fermented, coarsely cut leaves of *Nicotiana rustica* and *Nicotiana tabacum* without further processing. Sometimes tobacco is powdered and combined with molasses or boiled before use (Table 2).

1.1.8 *Miscellaneous additives and contaminants*

Some of the most common additives are listed in Table 2.

Sago palm nut is sometimes used as an adulterant in packages of sun-dried or processed areca nut. Sweet potato and tapioca are other adulterants (Jayalakshmi & Mathew, 1982).

Areca nut can be contaminated with fungi such as *Aspergillus flavus*, *A. niger* and *Rhizopus sp.* (Borle & Gupta, 1987). Almost 40% (12/32) of samples of areca nut from India analysed using thin-layer chromatography contained aflatoxins (IARC, 2002). The mean concentration of aflatoxin B_1 in the analysed samples was 94 μg/kg (range,

177

18–208 μg/kg), largely exceeding the commonly accepted food limit of 5 μg/kg. Nine samples contained concentrations of aflatoxin B_1 higher than 50 μg/kg (Raisuddin & Misra, 1991). All 10 samples of raw areca nut analysed in a South African study contained aflatoxin B_1, with a mean concentration of 5 μg/kg (range, 2.1–10.2 μg/kg) (Van der Bijl *et al.*, 1996).

1.2 Areca nut-based industrial packaged products

A variety of packaged areca products are now available in several countries. Based on labelling, these packaged products may fall into any one of the four categories described in Section 1.1.1, depending on the substances included (see Table 1).

Two main products are *gutka* and *pan masala*. *Gutka* is a dry, relatively non-perishable commercial preparation containing areca nut, slaked lime, catechu, condiments and powdered tobacco. The same mixture without tobacco is called *pan masala*. The products arrived on the market in the late 1960s and early 1970s. Both *gutka* and *pan masala* come in attractive foil packets (sachets) and tins which can be stored and carried conveniently. Aggressive advertising, targeted at the middle class and adolescents since the early 1980s, has enhanced the sales of these products. In advertisements, *pan masala* is depicted as implying hospitality and equality, as is betel quid. *Pan masala* and *gutka* are very popular in urban areas of India and Pakistan, especially among adolescents, and their popularity is growing fast in rural areas (Gupta & Ray, 2002). Although the actual prevalence of this habit is unknown, its popularity can be gauged by current commercial estimates valuing the Indian market for *pan masala* and *gutka* at several hundred million US dollars. These products are exported to all countries where Asian migrants live (see Section 1.3.20).

1.3 Consumption by geographical region

Global estimates report up to 600 million chewers (Gupta & Warnakulasuriya, 2002). This section reviews patterns and prevalence of consumption in different countries. For the sake of clarity, the nomenclature has been made uniform throughout the section (see Glossary A for definitions).

1.3.1 *India*

Countrywide surveys on the use of areca nut have not been conducted, nor have any other surveys been conducted to investigate specifically the use of areca nut. Surveys of habits have been conducted on the use of tobacco and other chewing habits, especially betel-quid chewing, in limited populations. Studies of adults are presented first, followed by those of children and adolescents. Within these categories, rural studies are presented first, followed by available urban studies.

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180

The tobacco included in betel quid varies from region to region. In Uttar Pradesh, *mainpuri* tobacco, which is a mixture of tobacco with slaked lime, finely cut areca nut and powdered cloves or camphor, is commonly used (Wahi, 1968).

(*a*) *Adults*

(i) *Rural studies*

Several studies have investigated the prevalence of betel-quid chewing in limited population samples.

The prevalence of all chewing habits, with and without areca nut and with and without tobacco, was recorded in house-to-house surveys among villagers in various parts of India (Mehta *et al.*, 1971, 1972). There were marked differences between localities and some differences between sexes (Table 9).

In Ernakulam District, Kerala, information on smoking and chewing habits was collected during a survey of oral lesions in a sample of 5099 persons aged 15 years and older (Daftary *et al.*, 1980). Betel-quid chewing, mostly with tobacco, was practiced by 23.7%, smoking by 21.5% and both habits by 9.8% (Table 10). Overall, 34.7% of men and 32.4% of women indulged in the habit, and only about 0.7% chewed betel quid without consuming any form of tobacco.

In another house-to-house survey during 1977–78 in Ernakulam District, 12 212 tobacco users aged 15 years or older were identified in a rural population of about 48 000 (Gupta *et al.*, 1986, 1989). Of these, 11 412 were interviewed. Among tobacco users, 37.7% were chewers only, mostly of betel quid, and 14.3% both chewed and smoked (Table 11). Thus, approximately 50% of tobacco users chewed betel quid. Among tobacco users, 95.5% of women and 33.6% of men (of whom more than half also smoked) chewed. Betel-quid chewing was most common in the group aged 35 years and above.

Table 9. Prevalence of chewing habits (with and without smoking) in house-to-house surveys among villagers in India[a]

Location (state)	Sample size	Prevalence of chewing habits (%)	
		With tobacco	Without tobacco
Andhra Pradesh	10 169	2.3	0.5
Bihar, Darbhanga	10 340	15	1.3
Bihar, Singhbhum	10 048	13	0.4
Gujarat	10 071	3	1.5
Kerala	10 287	26	0.4
Maharashtra	101 761[b]	28	0.6

[a] From Mehta *et al.* (1971), unless otherwise specified
[b] From Mehta *et al.* (1972)

181

Table 10. Prevalence of tobacco and areca-nut habits in a population ≥ 15 years old in Ernakulam District, Kerala, India

Habit	Men		Women		All	
	No.	%	No.	%	No.	%
No habit	467	19.6	1828	67.2	2295	45.0
Smoking only	1087	45.6	11	0.4	1098	21.5
Chewing only	338	14.2	868	31.9	1206	23.7
With tobacco					1170	23.0
Without tobacco					36	0.7
Both habits	487	20.5	13	0.5	500	9.8
Total	2379	100.0	2720	100.0	5099	100.0

From Daftary *et al.* (1980)

Table 11. Prevalence of tobacco and areca-nut habits among tobacco users ≥ 15 years old in Ernakulam District, Kerala, India

Tobacco habit	Men		Women		All	
	No.	%	No.	%	No.	%
Smoking only	5330	66.5	150	4.4	5480	48.0
Chewing only[a]	1137	14.2	3162	93.2	4299	37.7
Both habits	1554	19.4	79	2.3	1633	14.3
Total	8021	100.0	3391	100.0	11 412	100.0

From Gupta *et al.* (1986)
[a] Tobacco was chewed mostly in the form of betel quid.

In 1986, a house-to-house survey of tobacco habits was conducted among 30 544 villagers of all ages in 373 villages in three areas of Kolar District, Karnataka, to gather baseline information for an intervention study (Anantha *et al.*, 1995). About 8–16% of men and 29–39% of women had chewing habits (Table 12). While the content of the substances chewed was not defined in this study, a case–control study carried out in Karnataka by one of the authors identified the chewing habits of women as including tobacco, betel leaf, areca nut and slaked lime and as being the only tobacco habit of women (Carley *et al.*, 1994).

Mawa is popular in Gujarat, India, especially among the young. The prevalence of this habit increased tremendously in the 1970s and 1980s (Sinor *et al.*, 1990).

182

Table 12. Prevalence of tobacco and areca-nut habits among villagers in Kolar District, Karnataka, India

Habit	Dibbur	Malur	Gudiband
Men			
No.	5464	5369	4893
Tobacco smoking	17.7%	21.0%	21.7%
Tobacco chewing	16.4%	7.7%	8.4%
Women			
No.	5236	4905	4677
Tobacco smoking	0%	0%	0%
Tobacco chewing[a]	38.5%	28.7%	30.4%

From Anantha *et al.* (1995)
[a] Inferred as betel quid with tobacco from Carley *et al.* (1994)

The distribution of areca-nut use and tobacco smoking and chewing habits was assessed through a house-to-house survey in Bhavnagar District, Gujarat. Of 21 842 villagers aged 15 years and above (Gupta *et al.*, 1998), 2298 men (20.4% of all men) were chewing only and used areca nut in the form of *mawa* or betel quid with tobacco (Table 13).

Table 13. Prevalence of tobacco and areca-nut habits among villagers in Bhavnagar District, Gujarat, India

Habit	Men		Women	
	No.	%	No.	%
No habit	3 648	32.4	9 325	88.1
Smoking only (any)	3 942	35.0	16	0.2
Chewing only (any)	3 124	27.7	1 242	11.7
Mawa	2 127	18.9	7	0.1
Betel quid with tobacco	171	1.5	2	–
Tobacco	799	7.1	2	–
Bajar[a]	27	0.2	1 231	11.6
Mixed habits	544	4.8	1	–
Total	11 258	100.00	10 584	100.0

From Gupta *et al.* (1998)
[a] Dry snuff

183

In West Bengal, 1990 women aged 16–60 years attending rural cancer detection clinics attached to a Calcutta-based cancer institute were interviewed about their tobacco and areca-nut habits (Chakrabarti *et al.*, 1990). The habit usually consisted of chewing betel leaf, areca nut, slaked lime, catechu and a few flavouring agents. Sometimes women added *zarda*. A total of 23.3% reported chewing betel quid, half of whom used tobacco in the quid (Table 14).

Table 14. Prevalence of tobacco and areca-nut habits in women attending rural cancer detection clinics in West Bengal, India

Habit	No.	%
No habit	1502	75.5
Betel quid without tobacco	226	11.4
Betel quid with tobacco	236	11.9
Other habits[a]	26	1.3
Total	1990	100.0

From Chakrabarti *et al.* (1990)
[a] Other habits included drinking and chewing of anise seeds and cloves.

A study of chewing and smoking habits among 259 rural school teachers (230 men and 29 women) aged 28–63 years was conducted in Hoogly District, West Bengal (Pandey *et al.*, 2001). In this population, 51% were current tobacco users and 16.2% were former users. Among the current users, 72% were predominantly smokers, while 28% preferred smokeless forms of tobacco. Some 12% of all teachers chewed betel leaves with tobacco (Table 15). A small fraction used manufactured areca-nut products such as *gutka* and *pan masala*.

(ii) *Urban studies*

The most detailed account of chewing habits was reported among 10 000 persons admitted to the clinic of the dental school in Lucknow, Uttar Pradesh. No less than 22 different betel-chewing habits were reported (Pindborg *et al.*, 1967).

Dayal *et al.* (1978) presented a detailed report on chewing habits without a simultaneous smoking habit among 57 518 textile-mill workers aged 35 years and above in Ahmedabad, Gujarat (Table 16). Of all workers, 8710 (15.2%) had no oral habit, 2212 (3.8%) had a current chewing habit and 475 (0.8%) had a past chewing habit, all of them without a simultaneous smoking habit. The data show that the practice of a single chewing habit is rare.

A survey on issues pertaining to the control of oral cancer was conducted among 120 health professionals in the field of oncology from all over India, 85% of whom were men

Table 15. Prevalence of smoking and chewing habits in rural school teachers of Hoogly District, West Bengal, India

Habit	No.	%[a]
No habit	127	49.0
Smoking		
Filter-tipped cigarettes	82	[31.7]
Untipped cigarettes	75	[29.0]
Chewing		
Betel leaves with tobacco	32	[12.4]
Others[b]	17	[6.6]

From Pandey *et al.* (2001)

[a] Percentages do not add up because 66 respondents used more than one form of tobacco.

[b] Including tobacco quid (*khaini*), snuff, tobacco paste (*gudaku*), *pan masala* and *gutka*

Table 16. Prevalence of current chewing habits among 57 518 textile-mill workers in Ahmedabad, Gujarat, India

Chewing habit	No.	%
Betel quid with slaked lime, catechu, areca nut and tobacco	1335	[2.3]
Betel quid with slaked lime, catechu and areca nut	737	[1.3]
Betel quid with slaked lime	2	[0.003]
Betel quid with areca nut	3	[0.005]
Areca nut	113	[0.2]
Others	22	[0.04]

From Dayal *et al.* (1978)

and 28% of whom were under 35 years of age (Stanley & Stjernsward, 1986). Among those surveyed, 8% currently chewed betel quid with tobacco, 4% were previous regular chewers and 22% reported occasional chewing (Table 17). The prevalence of chewing was similar among men and women.

In 1992–94, a baseline survey on tobacco and areca-nut habits was conducted among 99 598 permanent residents of Mumbai, aged 35 years and above, belonging to the lower socioeconomic strata (Gupta, 1996). The prevalence of smokeless habits was high among both women and men (Table 18). Overall, areca nut in all forms was used by 29.7% of women and 37.8% of men, and betel quid without tobacco by 0.4% of men and 0.5% of women. Ten per cent of men practised both smokeless (including areca-nut habits) and smoking habits.

Table 17. Prevalence of tobacco and areca-nut habits of 120 health professionals in the field of oncology in India

Habit	Prevalence (%)				
	Current	Occasional	Past[a]	Never	Total
Cigarette	10	9	14	66	100
Bidi	0	1	1	97	100
Betel quid with tobacco	8	22	4	66	100

From Stanley & Stjernsward (1986)
[a] Past habit was defined as those having quit for at least 1 month.

Table 18. Prevalence of tobacco and areca-nut habits among permanent residents of Mumbai, India, of lower socioeconomic status

Habit	Men		Women		All	
	No.	%	No.	%	No.	%
No current habit[a]	[12 280]	[30.7]	[25 268]	[42.5]	[37 548]	[37.7]
Smokeless tobacco	18 322	45.7	34 019	57.1	52 341	52.5
Smoking	5 494	13.7	146	0.2	5 640	5.7
Smokeless tobacco and smoking	3 975	9.9	94	0.2	4 069	4.1
Total	40 071	100.0	59 527	100.0	99 598	100.0
Use of smokeless tobacco						
Mishri	[4 140]	10.3	15 740	26.5	19 880	20.0
Mishri + betel quid with tobacco	4 976	12.4	10 687	18.0	15 663	15.7
Betel quid with tobacco	5 871	14.7	3 527	5.9	9 398	9.4
Tobacco + slaked lime	2 997	7.5	640	1.1	3 637	3.7
Others with tobacco	1 144	2.9	1 200	2.0	2 344	2.4
Multiple practices	2 993	7.4	2 013	3.3	5 006	5.0
Areca nut[b]	176	0.4	306	0.5	482	0.5
No smokeless tobacco use (no habit + smoking only)	17 774	44.4	25 414	42.7	43 188	43.4
Total	40 071	100.0	59 527	100.0	99 598	100.0

From Gupta (1996)
[a] Includes about [14%] of men and [5%] of women who were former users of tobacco, mostly in the form of smokeless tobacco.
[b] Areca-nut chewing, most often as betel quid without tobacco

186

In a northern suburb of Trivandrum City, Kerala, two groups of men and women, 35 years of age or older, mostly of lower socioeconomic status, were interviewed in 1995–98 (Sankaranarayanan *et al.*, 2000). Chewing habits, consisting mainly of betel quid with tobacco, were practised by 26.8% of men and 26.4% of women in one group and 20.5% of men and 17.6% of women in the other group (Table 19). Chewing habits were more common in low-income, low-education participants and in individuals with a manual occupation or retirees (Hashibe *et al.*, 2003). Among those for whom information was available, 89% chewed betel quid with tobacco, 11% chewed betel quid without tobacco and 0.4% chewed tobacco only (Thomas *et al.*, 2003).

Table 19. Prevalence[a] of tobacco and areca-nut habits among urban residents in Trivandrum, Kerala, India

Habit	Men (%)		Women (%)	
	Group I	Group II	Group I	Group II
No.	25 453	23 356	34 441	31 351
No habit	31.4	44.1	72.3	81.8
Chewing[b]	26.8	20.5	26.4	17.6
Smoking	55.8	43.9	2.4	1.0

From Sankaranarayanan *et al.* (2000)
[a] Percentages do not add up to 100% possibly because some residents reported multiple habits.
[b] Mostly betel quid with tobacco

(*b*) *Children and adolescents*

In 1992, a survey of 146 children and teenagers (84 boys and 62 girls) between the ages of 5 and 20 years was conducted in the coastal fishing community of Mariyanad, Kerala (George *et al.*, 1994). Chewing of betel quid with tobacco was by far the most prevalent habit in both boys and girls, and was inversely related to level of education (Table 20). Two boys both chewed betel quid with tobacco and drank alcohol. One boy, 17 years of age, chewed betel quid with tobacco and smoked.

A survey conducted in 1998 among 400 male medical students revealed that about 12.5% were regular users of *gutka* (Table 21) and 27.5% were occasional users of areca-nut products without tobacco (Sinha & Gupta, 2001). Among those with a regular habit, about half had smokeless habits, consisting of chewing *gutka* and *khaini*. Occasional users mainly chewed areca-nut products not containing tobacco, e.g. *pan masala*.

A number of surveys conducted in households in India have shown that *pan masala* and *gutka* are commonly chewed by children and adolescents, especially in Gujarat, Maharashtra and Bihar. In a survey of 1200 students from junior and degree colleges of Maharastra, 9.9% chewed *pan masala* and 9.6% chewed *gutka*. In a survey of 95 boys and girls in the 8th and 9th grades (13–14 years old) of a small-town private school in Anand, Gujarat, 16% used *gutka*. In a village community of Kheda District, Gujarat, 72% of men and 50% of women under 26 years of age used tobacco products. Men favoured bidis and *gutka* while women preferred *gutka* and tobacco toothpaste. Among high school students in classes 10–12 (15–17 years old) in Patna, Bihar, approximately 12% used *pan masala* (Gupta & Ray, 2002).

Table 20. Prevalence of tobacco and areca-nut habits of children and teenagers aged 5–20 years in a coastal fishing village in Kerala, India

Habit	Boys		Girls		All	
	No.	%	No.	%	No.	%
No habit	[44]	[52.3]	[52]	[83.9]	[96]	[65.8]
Betel quid with tobacco chewing						
Occasionally	12	14.3	7	11.3	19	13.0
Regularly	23	27.4	1	1.6	24	16.4
Bidi smoking						
Occasionally	–	–	2	3.2	2	1.4
Regularly	1	1.2	–	–	1	0.7
Alcohol drinking						
Occasionally	4	4.8	–	–	4	2.7
Regularly	–		–	–	–	–
Total	84	100.0	62	100.0	146	100.0

From George *et al.* (1994)

Table 21. Prevalence of tobacco and areca-nut habits of medical students in Patna, Bihar, India

Habit	No.	%
No habit	[78]	18.8
Tobacco (smoking and chewing)		
Regular	172	43.0
Smoking		20.7
Chewing		20.2
Gutka		12.5
Occasional	37	9.3
Areca-nut products without tobacco		
Regular	3	0.8
Occasional	110	27.5
Total	400	100.0

From Sinha & Gupta (2001)

188

1.3.2 *Pakistan*

In a study on dietary and chewing/smoking habits, data on 10 749 persons of low and middle socioeconomic status, aged 20 years and over, were collected from various districts of Karachi (Mahmood *et al.*, 1974). Overall, 27.9% of men and 37.8% of women chewed areca nut in the form of betel quid (Table 22). Of this group, 47.5% of men and 31.9% of women chewed betel quid without tobacco (Table 23).

Table 22. Prevalence of tobacco and areca-nut habits in a population sample in Karachi, Pakistan, 1967–72

Habit	Men (%)	Women (%)	Total (%)
No.	5802	4947	10 749
No habit	36.9	56.8	46.0
Pan	4.2	11.5	7.6
Tobacco chewing	2.6	1.9	2.2
Smoking	30.3	2.2	17.4
Pan + tobacco chewing	6.1	25.0	14.8
Pan + smoking	8.9	0.4	5.0
Tobacco chewing + smoking	0.7	0.1	0.5
All three habits	8.7	0.9	5.1
Unknown	1.6	1.2	1.4
Total	100	100	100

From Mahmood *et al.* (1974)

Table 23. Prevalence of *pan*-chewing habits in a population sample in Karachi, Pakistan, 1967–72

Habit	Men (%)	Women (%)	Total (%)
No *pan* habit	70.9	61.2	66.5
Without tobacco	13.3	12.0	12.7
With tobacco *qiwam*[a]	2.1	2.6	2.3
With tobacco leaf	12.3	22.5	17.0
With tobacco leaf + *qiwam*[a]	0.3	0.6	0.5
Other types	0.2	0.3	0.3
Unknown	0.9	0.9	0.9
Total	100.0	100.0	100.0

From Mahmood *et al.* (1974)

[a] *Qiwam* (also spelt *kiwam*): paste prepared from processed tobacco leaves, from which the stalks and stems have been removed, that are soaked and boiled in water with flavourings and spices, macerated and strained. The paste is chewed.

A survey was conducted in a sample of 160 primary school students aged 4–16 years (98% were < 12 years) in a fishing community on Baba Island of Karachi, Pakistan (Shah *et al.*, 2002). Of the 159 respondents, 118 (74.2%) used areca-nut products in the form of sweetened areca nut or betel quid (Table 24).

Table 24. Prevalence of areca-nut habits among primary school children (4–16 years of age) on Baba Island, Karachi Harbor, Pakistan

Habit	No.	%
No habit	41	25.8
Sweetened areca nut only	63	39.6
Betel quid only	4	2.5
Sweetened areca nut and betel quid	51	32.1
Betel quid[a] with tobacco	10	[6.2]
Betel quid without tobacco	46	[28.9]
Total	159	100.0

From Shah *et al.* (2002)
[a] Alone or in conjunction with sweetened areca nut
[The Working Group noted small inconsistencies between the text and table in the percentage of users of sweetened areca nut and the number of betel-quid users.]

1.3.3 *Bangladesh*

Prevalence patterns of use of tobacco and areca nut by Bangladeshi populations have not been published in the English language literature. Extrapolating from migrant populations originating from Bangladesh and living in the United Kingdom, it is clear that the habit of chewing areca nut with and without tobacco is very prevalent in this population (see Section 1.3.6) and may therefore be taken as evidence for the existence of the habit in the home country.

1.3.4 *Sri Lanka*

In Sri Lanka, the quid consists of fresh areca nut, slaked lime from seashells, fresh betel leaf and slightly dried (or processed) tobacco (Chiba *et al.*, 1998). Studies in the early 1970s (Senewiratne & Uragoda, 1973) indicated that, among a group of healthy people, 55.6% of the men and 42.7% of the women added tobacco to the quid.

In rural Sri Lanka, the habit of betel-quid chewing is widely practised. Stephen and Uragoda (1970) reported that 30.1% of 1088 persons (men, 27.9%; women, 32.3 %) chewed betel quid with tobacco. In a large-scale study in rural Sri Lanka, it was shown that [57%] of men and women were chewers, about half of whom included tobacco in

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under the age of 16 were able to purchase *gutka* easily (National Centre for Transcultural Oral Health, 2001). Only a few areca products give specific health warnings on the dangers of chewing areca nut, although most carry the statutory health warning regarding added tobacco. In 20 commercially processed and packaged areca-nut products on sale in the the United Kingdom, only three carried a health warning related to oral cancer; none warned about submucous fibrosis or potential addiction (Trivedy, 2001).

(*d*) *Limited bans in other countries*

In the late 1970s, the Public Services of Papua New Guinea issued a ban on betel-quid chewing in government offices (Burton-Bradley, 1978). Possession of areca nut in the California public school system is grounds for suspension (Croucher & Islam, 2002). In Singapore, spitting in public places can lead to a fine, indirectly discouraging the practice of betel-quid and areca-nut chewing (Cheong, 1984).

2. Studies of Cancer in Humans

2.1 Oral cancer

2.1.1 *India, Pakistan and Sri Lanka*

(*a*) *Descriptive studies and case series*

In this section, the subsites included in oral cancer were rarely specified, but mostly included lip, tongue and mouth. The reports summarized in the previous monograph on betel-quid and areca-nut chewing (IARC, 1985a) are given in Table 33, which shows that the percentage of oral cancer among all cancers diagnosed in hospitals or groups of hospitals in Asia was always much higher than that usually found in western countries (3–5%; Parkin *et al.*, 2003), where the habit of chewing betel quid, with or without tobacco, is virtually unknown.

In many descriptive studies, investigators have obtained histories of chewing betel quid with tobacco from series of patients with oral cancer (Table 34). In most of these studies, the percentage of patients who practise chewing habits is extremely large. Several authors also commented that the cancer generally develops at the place where the quid is kept.

A high incidence of oral, oro- and hypopharyngeal cancer is observed in regions of the world where a high proportion of the population practises betel-quid chewing (Parkin *et al.*, 2003). Of the 267 000 new oral cancers estimated to occur around the year 2000 throughout the world, 128 000 (48%) occur in South and South-East Asia; of the 123 000 cases of oro- and hypopharyngeal cancer estimated to occur globally annually, 63 000 (51.2%) are accounted for in South and South-Easts Asia (Figures 3 and 4).

In India, the age-standardized incidence rates (ASR) of oral cancer (ICD 9: 140–145) per 100 000 population are 12.8 in men and 7.5 in women (Ferlay *et al.*, 2001).

192

Table 33. Chewing habit and percentage of oral cancer among all cancers

Location	Habit	All cancers (years)	Oral cancer	Reference
Papua New Guinea	Betel quid without tobacco	1175 (1958–63)	209 (17.8%)	Atkinson *et al.* (1964)
Papua New Guinea	Betel quid without tobacco	2300 (1958–65)	(17.1%); 29 (9%) oral cancers were verrucous carcinoma	Cooke (1969)
Papua New Guinea	Betel quid without tobacco	6186 (1958–73)	890 (14.4%)	Henderson & Aiken (1979)
Travancore, South India	Betel quid with tobacco	1700 (5 years)	989 (58%)[a]	Bentall (1908)
Neyoor, South India	Betel quid with tobacco	377 epithelial cancers (2 years)	346 (91.5%)[b]	Fells (1908)
Mumbai, India	Betel quid with tobacco	2880 carcinomas (1941–43)	1000 (34.7%)[c]	Khanolkar (1944)
Mumbai, India (Parsees)	Betel-quid chewing very rare	1705 (1941–65)	160 (9.4%)[d]	Paymaster & Gangadharan (1970)
Sri Lanka	Betel quid	2344 (1928–48)	1130 (48.2%)[e]	Balendra (1949)
Thailand	Betel quid	1100	155 (14.1%)[f]	Piyaratn (1959)
Malaysia (Indians)	Betel quid with tobacco	–	219[g]	Marsden (1960)
Singapore	Betel quid with tobacco	7131	(8%)[h]	Muir (1962)
Philippines	Betel leaf, tobacco chewing, reverse cigarette smoking	– (1957–61)	186	Tolentino *et al.* (1963)
Malaysia	Betel quid with and without tobacco	4369 (1961–63)	476 (10.9%)[i]	Ahluwalia & Duguid (1966)
Indians	Betel quid with tobacco	912	306 (33.6%)	
Malays	Betel quid without tobacco	777	74 (9.5%)	
Bangladesh	Betel quid	3650	672 (18.4%)[j]	Huq (1965)
Pakistan	Betel quid with tobacco, cigarette smoking	14 350 (1960–71)	2608 (18.2%)	Zaidi *et al.* (1974)

[a] Lip, tongue, buccal mucosa
[b] Epithelial cancers of the buccal cavity
[c] Lip, buccal mucosa, alveolus, tongue, palate
[d] Lip, tongue, alveolus, floor of mouth, buccal mucosa, palate
[e] Cheek, tongue, palate and tonsil, jaw, floor of mouth, pahrynx and larynx, lip
[f] Lip, tongue, oral cavity
[g] 'Betel cancers'
[h] Buccal cavity and pharynx
[i] Lip, tongue, floor of mouth, cheek, palate
[j] Buccal cavity

Table 34. Case series of oral cancer and chewing habits

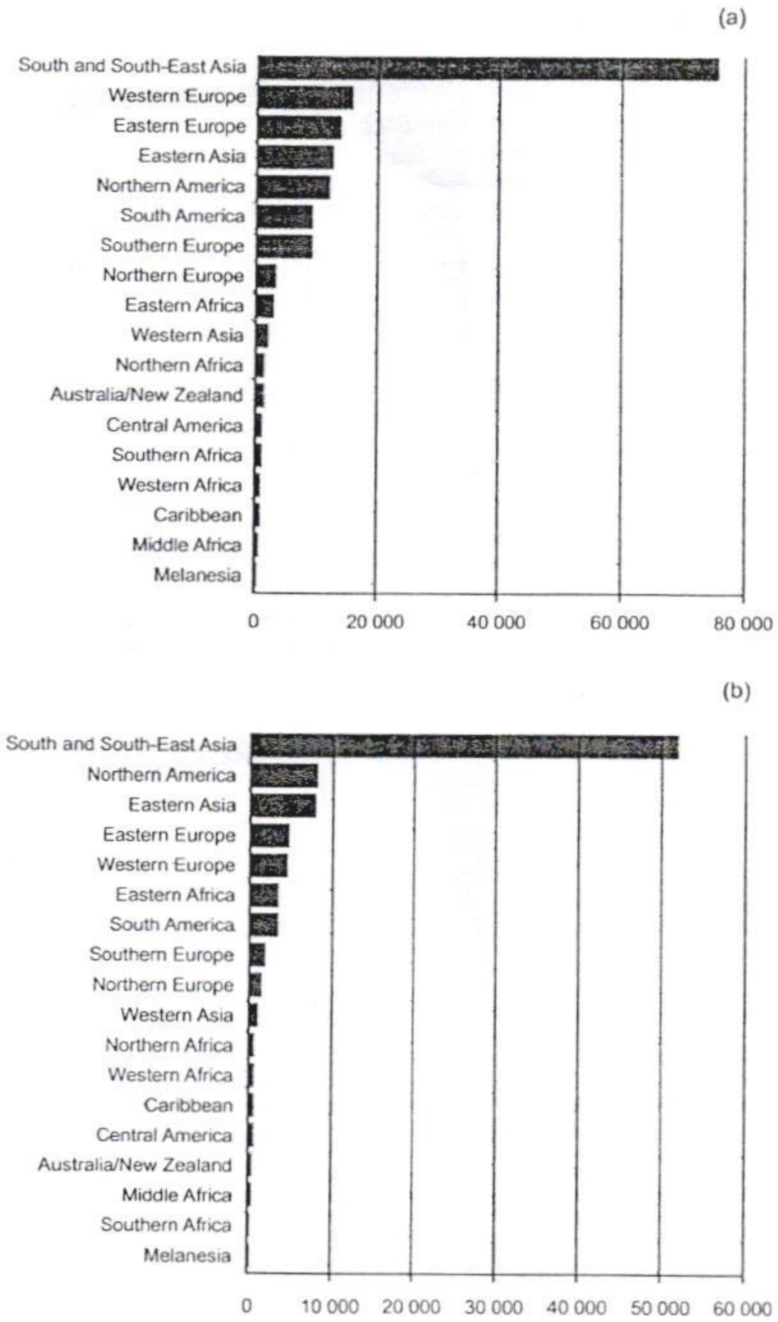
Location	Habit	All cancers (years)	Oral cancer	Reference
South-west Pacific Islands – New Britain	Betel quid without tobacco	60 (1921–40)	7 (11.7%)	Eisen (1946)
Papua New Guinea	Betel quid without tobacco (98%)	–	110	Farago (1963a)
Papua New Guinea	Betel quid without tobacco (129/130)	1160 (1960–61)	210 (18.1%)	Farago (1963b)
Mumbai, India	Tobacco and betel-quid chewing (excessive in 35%)	3627 intra-oral malignant tumours (1941–47)	650 (buccal mucosa)	Paymaster (1956)
Guntur, India	Betel-quid chewers; 9 (3.6%) Betel-quid + tobacco chewers; 29 (12%) Tobacco chewers; 20 (8%)	– (1957–59)	250 (17.4%) (oral + pharyngeal)	Padmavathy & Reddy (1960)
Mumbai, India	36.5% chewers (tobacco + betel) 21.9% chewers and smokers 23.2% smokers 18.4% no habit (among oral-cavity tumour patients)	30 219 carcinomas (1941–55)	14 162 (46.9%) (oral + pharyngeal)	Paymaster (1962)
Mumbai, India	100% tobacco + betel-quid chewers 55.7% chewers and smokers	519	210 (40.5%) (oropharyngeal)	Agarwal & Arora (1964)
Madras, India	76.7% chewers with tobacco 18.6% without tobacco 4.7% non-chewers	13 626 (1950–59)	6728 (49.4%) (oral cavity)	Sidiq *et al.* (1964)
Madras, India	95% betel-quid chewers (83% with tobacco) 34% smokers	3529 (1962–63)	362 (10%) (buccal mucosa)	Singh & von Essen (1966)
Mainpuri, India	26.6% tobacco with lime 15.6% smokers 53.9% both 3.9% no habit 2% betel quid	– (1950–62)	154 (oral + oropharyngeal)	Wahi *et al.* (1966)
Agra, India	32.5% tobacco with lime 30.1% smokers 18.1% both 19.3% no habit 12% betel quid	–	83 (oral + oropharyngeal)	Wahi *et al.* (1966)

Table 34 (contd)

Location	Habit	All cancers (years)	Oral cancer	Reference
Agra, India	85% betel quid with tobacco 51% smokers (85 gingival cancer patients)	6790 (1957–65)	3173 (46.7%) (intra-oral), 85 (gingival)	Srivastava & Sharma (1968)
Jabalpur, India	84% (100 oral cancers) tobacco chewers 28% smokers	– (1958–67)	814 (oral + pharyngeal) (33.8%)	Gandagule & Agarwal (1969)
Kanpur, India	14.8% betel quid without tobacco 22% betel quid with tobacco 49% tobacco + lime 5.4% smoking 5% smoking and chewing	2332 (1958–66)	630 (27%) (oral)	Samuel *et al.* (1969)
Philippines	52 buyo[a] chewers 2 non-chewers 21 uncertain	–	75 (49 of the cheek)	Davis (1915)
Thailand	100% betel quid + tobacco	53 (1922–23)	25 (47%) (oral)	Mendelson & Ellis (1924)
Taiwan	59% betel-quid chewers 82% smokers	– (1953–1963)	89	Chang (1964)
Sri Lanka	Only 3 (1.5%) betel-quid chewers among cases 38 smokers	– (1945 on) 400 new cases seen during 3 months in 1960	508 (buccal mucosa) 214 (53.5%) (buccal mucosa)	Balendra (1965)

[a] Buyo can consist of betel leaves, areca nut, slaked lime and tobacco or any combination of these constituents.

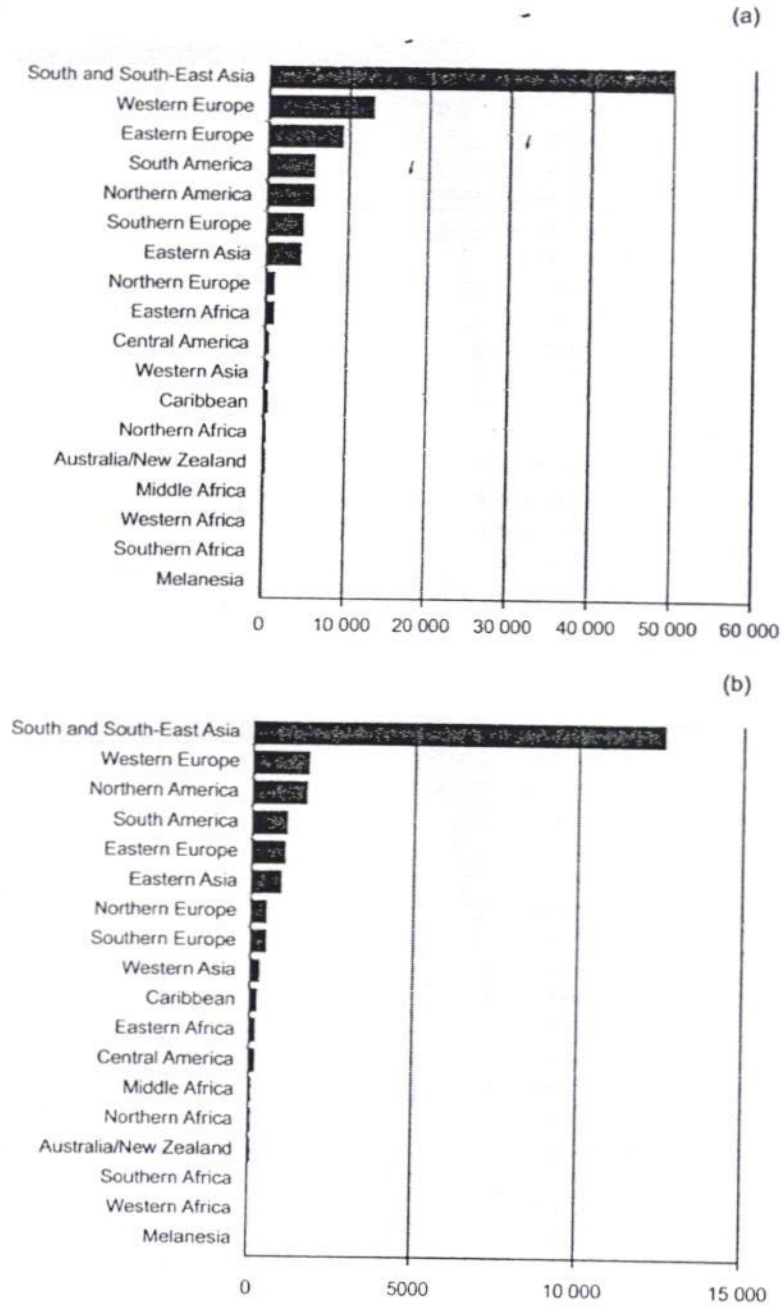
Figure 3. Cancer of the oral cavity (ICD-9: 140–145) in (a) men and (b) women



From Ferlay *et al.* (2001) – GLOBOCAN 2000

196

Figure 4. Oropharyngeal and hypopharyngeal cancers (ICD-9: 146, 148–149) in (a) men and (b) women



From Ferlay *et al* (2001) – GLOBOCAN 2000

197

A study from Mumbai, India, in 1993–97 compared the incidence rates of oral cancer among Parsi and non-Parsi communities (Yeole *et al.*, 2001). Parsis form a very small subgroup (about 0.8%) of the population of the city of Mumbai; few smoke and very few chew (for religious reasons), whereas chewing and smoking are common in the population of Mumbai as a whole. The annual age-adjusted incidence rates (per 100 000) in 1995 of cancers at several sites were lower among Parsi men than among the male population of Mumbai as a whole: tongue and mouth, 4.5 versus 11.9; pharynx, 2.6 versus 10.6; oesophagus, 2.6 versus 8.7; stomach, 2.8 versus 6.6; larynx, 2.2 versus 7.2; and lung, 4.2 versus 12.6.

Gupta (1999) reported an increase in the incidence rates of mouth cancers (ICD 9: 143–145) in 1995 compared with 1983–87 among inhabitants under the age of 50 years in the city of Ahmedabad, India, which is consistent with the hypothesis of an increase in oral cancer among the young due to increased use of *gutka* and *pan masala*.

In Karachi, Pakistan's largest city, the ASR of cancer of the oral cavity per 100 000 population is 17.9 in men and 16.3 in women (Bhurgri, 2001).

(*b*) *Cohort studies*

A population-based prospective study was reported by Wahi (1968) from a temporary cancer registration system established in Uttar Pradesh (Mainpuri district), India. Over a period of 30 months (1964–66), a total of 346 cases of oral and oropharyngeal cancer were detected and confirmed histologically. Exposure data were obtained from these patients by questionnaire, and a house-to-house interview survey was conducted on a 10% cluster sample of the district population. The numbers in various exposure categories were then extrapolated to the population as a whole and used as denominators for calculating oral cancer period prevalence. Chewing *Mainpuri* tobacco was distinguished from other chewing habits. Prevalence rates for the two kinds of chewing habits and for combinations of alcohol and smoking habits are summarized in Table 35. Prevalence rates were highest among users of *Mainpuri* tobacco and higher for all other chewing habits than for no chewing habit, after adjusting for smoking and drinking. The strength of the association between chewing and oral cancer was studied in many ways [frequently intercorrelated] (Table 36) and was reported to be positive by every criterion. [The Working Group of *IARC Monographs* Volume 37 noted that differences in age between cancer patients and the population sample do not seem to have been taken into account; it is possible that the prevalence of habits within the population was age-dependent.]

Mehta *et al.* (1972a) examined a cohort of 4734 policemen in Mumbai, India, for oral precancers, at baseline in 1959, and 5 and 10 years later. Of the 3674 policemen followed successfully, 49% chewed (mostly betel quid with tobacco) and 12% chewed and smoked. Oral cancer was found in one man who chewed and smoked.

Of 57 518 textile industry workers in Ahmedabad, India, examined in the first phase of a study conducted in 1967–71, Bhargava *et al.* (1975) re-examined 43 654 workers 2 years later. They diagnosed 13 new cases of oral cancer, all of which had developed among individuals chewing betel quid with tobacco and/or smoking tobacco (Table 37).

Table 35. Numbers of oral cancers and prevalence per 1000 population in a study in Mainpuri district, India[a]

Habit	No tobacco		Mainpuri tobacco		Other kinds of tobacco	
	No. of cases	Prevalence	No. of cases	Prevalence	No. of cases	Prevalence
No habit	27	0.18	59	14.51	32	0.80
Alcohol drinking	0	0	6	6.59	2	1.08
Smoking	54	0.57	78	8.12	47	1.76
Drinking and smoking	9	1.56	30	11.45	2	0.58
Total	90	0.36	173	6.60	83	1.15

[a]From Wahi (1968)

Gupta *et al.* (1980) followed a random sample of 10 287 individuals in Kerala (Ernakulam district) for a period of 10 years (1966–77) in house-to-house surveys, with a follow-up rate of 87%. Chewing betel quid with tobacco was a common habit in that area, and all 13 new cases of oral cancer were diagnosed among either chewers only or chewers who also smoked. The person–years method was used for data analysis and incidence rates were age-adjusted (Table 37).

Apparently healthy subjects aged 35 years or older in rural Kerala were included from 1995–98 in an intervention trial, in which 59 894 individuals formed the screened group and 54 707 formed the non-screened group. Those in the screened group who chewed betel quid with tobacco, smoked or drank alcohol were advised to stop their habit; 31 and 44% of subjects in the screened and non-screened groups, respectively, reported no tobacco (chewing betel quid with tobacco or smoking) or alcohol habit. About 3 years after the start of the study, 47 cases of oral cancer (incidence, 56.1/100 000 person–years) were identified in the screened group and 16 (incidence, 20.3/100 00 person–years) in the non-screened group (Sankaranarayanan *et al.*, 2000).

(c) *Case–control studies*

Case–control studies for oral (comprising gum, floor of the mouth, buccal mucosa and palate; the tongue may also be included) and other cancers and their association with chewing betel quid with or without tobacco are described in Table 38 and the dose–response relationships found in these studies are summarized in Table 39. [Data for men and women were combined and relative risks were calculated by the Working Group of *IARC Monographs* Volume 37 from the data given in the papers published up to 1985, unless provided by the authors]. The derived relative risk estimates for use of betel quid ranged from 0.1 to 45.9 in different studies.

A case–control study was reported by Shanta and Krishnamurthi (1959), consisting of 206 cancers of the buccal mucosa and the floor of the mouth and 278 randomly selected non-cancerous controls. The proportion of betel and areca-nut chewers was 8.7% in the cancer group and 51.8% in the control group. [The percentages of habits given for cases as well as for controls were inconsistent.]

Table 36. Prevalence of oral cancer by chewing habit

Chewing habit	Estimated population	No. of cases	Prevalence per 1000
Total	349 710	346	0.99
Non-chewers of tobacco	251 330	90	0.36
Frequency of tobacco chewing			
Occasionally	11 680	5	0.43
Daily	86 700	251	2.90
Age started chewing (years)			
≥ 30	38 290	69	1.80
25–29	15 000	28	1.87
20–24	22 230	61	2.74
15–19	16 030	58	3.62
5–14	6 870	40	5.92
Retention of each quid (min)			
1–20	69 030	133	1.93
21–30	18 680	69	3.69
≥ 31	9 650	53	5.49
Period of exposure (min) per day			
Up to 99	53 720	123	2.29
100–299	33 670	90	2.67
300–499	9 400	31	3.30
≥ 500	2 230	12	5.38
Sleeping with quid in mouth			
Never	85 790	175	2.04
Occasionally	10 790	58	5.38
Daily	1 740	23	13.22
Type of tobacco chewed			
Pattiwala	71 610	84	1.17
Mainpuri and *Pattiwala*	8 950	37	4.13
Mainpuri	17 160	134	7.81
Other (*Kapuri, Rampuri, Moradabadi*)	760	1	1.32
Amount of money (paisa)[a] *spent on tobacco per day*			
0–6	67 240	161	2.39
7–37	19 710	77	3.91
38–74	680	4	5.88
75–100	260	9	34.62

From Wahi (1968)

[a] 1 paisa = 0.01 rupee

200

Table 37. Chewing and smoking habits and oral cancer in two cohort studies, India

Habit	Ahmedabad[a]			Ernakulam[b]		
	Number re-examined[c]	New oral cancers	Incidence per 100 000	Person–years	New oral cancers	Age-adjusted incidence per 100 000
Chewing	3 266	1	31	23 416	9	23
Chewing and smoking	16 881	6	36	8 476	4	32
Smoking	15 378	6	39	20 222	0	0
None	7 065	0	0	30 962	0	0

[a] Industrial workers aged 35 years and over; data from Bhargava *et al.* (1975)
[b] House-to-house survey of individuals aged 15 years and over; data from Gupta *et al.* (1980)
[c] Approximately 2 years after the first examination

Chandra (1962) reported a study of 450 cases of cancer of the cheek (287 men, 163 women) and 500 hospital visitor controls (410 men, 90 women) conducted in 1955–59. The proportion of betel-quid chewers was 5.6% and that of chewers of betel quid with tobacco was 23.3% among male cases. Corresponding proportions among male controls were 13.4 and 10.7%, respectively. The proportions among female cases were 18.4 and 43.5% and those among female controls were 16.7 and 18.9%, respectively.

In another case–control study, Shanta and Krishnamurthi (1963) reported on 882 cancer cases (628 men, 254 women) and 400 (300 men, 100 women) controls. Cancer sites included lip (12 men, seven women), buccal mucosa (293 men, 152 women), anterior tongue (69 men, 18 women), posterior tongue (48 men, four women), pharynx (130 men, 25 women), hypopharynx (18 men, 12 women) and oesophagus (57 men, 36 women). For cancer of these different sites, the proportion of male cases who chewed betel quid without tobacco ranged from 8.4 to 38.5% and that among male controls was 49.1%; the proportion of female cases who chewed betel quid without tobacco ranged from 12.4 to 55.5% and that among female controls was 55.5%. [The authors pointed out that most chewers of betel quid without tobacco were occasional chewers and the percentage was high because it was very hard to find Indians who had not chewed betel quid without tobacco at one time or another. They opined that betel-quid and areca-nut chewing was of no statistical significance in etiology and is only a reflection of habit in the general population.]

Hirayama (1966) reported a case–control study of oral and oropharyngeal cancers conducted in India and Sri Lanka. The study included 545 cases of cancer of the buccal mucosa (369 men, 176 women), 143 cases of cancer of the anterior tongue (117 men, 26 women), 37 cases of cancer of the palate (28 men, nine women), 102 cases of cancer of the oropharynx (81 men, 21 women) and 440 controls (277 men, 163 women). The proportion of men who chewed areca nut (reported as betel nut) was 0.8% for cancer of the buccal

Table 38. Case–control studies of oral[a] and other cancers and their association with chewing of betel quid

Location (years)	Cancer site[b]	No. of cases	Habit	No. of controls	Habit	Relative risk (95% CI)	Reference
Up to 1985							
Travancore, India	Lip	100	Q, 98%	100	Q, 66%	25.2	Orr (1933)
Mumbai, India (1952–54)	Base of tongue, oropharynx, hypopharynx, oesophagus	289 (M + F) (oral)	Q, 12% Q + S, 39% S, 47% (M)	400	Q, 9% Q + S, 24% S, 50% (M)	Q, 10.2	Sanghvi *et al.* (1955)
		551 (M + F) (base of tongue, oropharynx, hypopharynx, oesophagus)		400		Q, 4.0	
Assam, India (1954–55)	Lip, pharynx, oesophagus, larynx	238 (108 larynx)	Q, 97%	3678	Q, 79%	7.6	Sarma (1958)
Mumbai, India (1952–54)	Base of tongue, oropharynx, lip	371	Q, 12% Q + S, 38% S, 48%		Q, 9% Q + S, 24% S, 50%		Khanolkar (1959)
		95 (oral)	Q, 28% Q + S, 42% S, 18%	288		Q, 8.0	
		276 (oropharynx and base of tongue	Q, 5% Q + S, 36% S, 58%	288		Q, 10.0	
Madras, India	Only cheek and floor of the mouth	206	BQ, 9% BQ + T, 85% S, 26%	278	BQ, 52% BQ + T, 13% S, 47%	BQ, 0.1 BQ + T, 39	Shanta & Krishnamurthi (1959)

Table 38 (contd)

Location (years)	Cancer site[b]	No. of cases	Habit	No. of controls	Habit	Relative risk (95% CI)	Reference
Calcutta, India (1955–59)	Cheek	450 (M + F)	BQ, 6% (M) BQ + T, 23% (M) T, 6% (M) BQ, 18% (F) BQ + T, 44% (F) T, 3% (F)	500	BQ, 13% (M) BQ + T, 11% (M) T, 40% (M) BQ, 17% (F) BQ + T, 19% (F) T, 2% (F)	BQ, 0.8 (M) BQ + T, 2.5 (M) T, 1.5 (M) BQ, 1.1 (F) BQ + T, 3.3 (F) T, 1.4 (F)	Chandra (1962)
Madras, India	Lip, oropharynx, hypopharynx, oesophagus, tongue	882	BQ, 20% (M) BQ + T, 64% (M) BQ, 50% (F) BQ + T, 71% (F)	400	BQ, 40% (M) BQ + T, 9% (M) BQ, 56% (F) BQ + T, 11% (F)	BQ, 0.3 (M) BQ + T, 17.2 (M) BQ, 0.8 (F) BQ + T, 20.1 (F)	Shanta & Krishnamurthi (1963)
Agra, India (1950–62)	Lip, tongue, tonsil	821	T, 73% T + S, 38% S, 55%	1916	T, 12% T + S, 6% S, 28%	T, 41.2	Wahi *et al.* (1965)
Sri Lanka	Oesophagus only	111	Q, 81%	1088	Q, 30%	9.9	Stephen & Uragoda (1970)
Varanasi, India (1966–70)	–	206	BQ + T, 39% T, 50%	100	Q, 25%	27.0	Khanna *et al* (1975)
Mumbai, India	Anterior two-thirds of tongue, lip	214 M	Q, 29% Q + S, 32% S, 31%	230	Q, 15% Q + S, 20% S, 48%	Q, 4.2	Notani & Sanghvi (1976)
1985–2003							
Kerala, India (1983–84)	Tongue Floor of mouth	158 (M) 70 (F)	BQ + T, 58% (M) BQ + T, 76% (F)	314 (M) 139 (F)	BQ + T, 30% (M) BQ + T, 39% (F)	BQ + T, 6.1 (3.3–11.4) (M) BQ + T + S, 7.02 (3.6–13.5) (M) S, 4.98 (2.5–9.8) (M)	Sankaranarayanan *et al.* (1989a)

Table 38 (contd)

Location (years)	Cancer site[b]	No. of cases	Habit	No. of controls	Habit	Relative risk (95% CI)	Reference
Kerala, India (1983–84)	Gingiva	109 (M) 78 (F)	BQ + T, 80% BQ + T, 88%	546 (M) 349 (F)	BQ + T, 33% (M) BQ + T, 51% (F)	BQ + T, 8.8 (3.6–21.5) (M) BQ + T + S, 16.3 (6.5–40.9) (M) S, 3.8 (1.2–11.7) (M)	Sankaranarayanan *et al.* (1989b)
Kerala, India (1983–84)	Buccal and labial mucosa	250 (M) 164 (F)	BQ + T, 81% (M) BQ + T, 88% (F)	546 (M) 349 (F)	BQ + T, 33% (M) BQ + T, 51% (F)	BQ + T, 14.3 (8.2–24.8) (M) BQ + T + S, 21.5 (11.9–38.5) (M) S, 4.2 (2.09–8.5) (M)	Sankaranarayanan *et al.* (1990a)
Bangalore, India (1982–85)	Oral cavity excl. base of tongue	115 (M) 233 (F)	BQ, 13% (M) BQ + T, 28% (M) BQ, 4% (F) BQ + T, 88% (F)	115(M) 233 (F)	BQ, 13% (M) BQ + T, 10% (M) BQ, 13% (F) BQ + T, 25% (F)	Odds ratio not adjusted BQ, 1.5 (0.6–3.8) (M) BQ + T, 4.0 (1.8–8.9) (M) BQ, 2.2 (0.7–6.5) (F) BQ + T, 30.4 (12.6–73.4) (F)	Nandakumar *et al.* (1990)
Mumbai, India (1980–84)	Anterior 2/3 of tongue	141 (M)	BQ + T, 54%	631 (M)	BQ + T, 40%	BQ + T, 1.7(1.2–2.6)	Rao & Desai (1998)
	Posterior 1/3 of tongue	495 (M)	BQ + T, 35%			BQ + T, 0.9 (0.7–1.2)	
Maharashtra, India	Oropharynx	123 (M + F)	T, 20% Areca, 4% T + areca, 11% BQ, 6% BQ + T, 42%	246 (M + F)	T, 4% Areca nut, 6% T + areca, 4% BQ, 7% BQ + T, 16%	Odds ratio not adjusted T, 15.9 (6.9–36.7) Areca nut, 2.6 (0.9–7.7) T + areca, 10.2 (4.1–25.5) BQ, 2.8 (1.09–7.4) BQ + T, 9.5 (5.1–17.5)	Wasnik *et al.* (1998)
Bhopal, India (1986–92)	Oral cavity	148	BQ, 3% BQ + T, 97% S + T, 33%	260	BQ, 10% BQ + T, 90% S + T, 17%	BQ + T, 5.8 (3.6–9.5) BQ, 1.7 (0.9–3.3)	Dikshit & Kanhere (2000)
Karachi, Pakistan (1996–98)	Oral cavity	79 (M + F)	BQ, 33% BQ + T, 52% Naswar, 17%	149 (M + F)	BQ, 11% BQ + T, 10% Naswar, 7%	BQ, 9.9 (1.8–55.6) BQ + T, 8.4 (2.3–30.6) Naswar, 9.5 (1.7–52.5)	Merchant *et al.* (2000)

Table 38 (contd)

Location (years)	Cancer site[b]	No. of cases	Habit	No. of controls	Habit	Relative risk (95% CI)	Reference
Chennai, Bangalore & Trivandrum, India (1996–99)	Oral cavity	309 (M) 282 (F)	BQ, 5% (M) BQ + T, 45% (M) BQ, 5% (F) BQ + T, 79% (F)	292 (M) 290 (F)	BQ, 2% (M) BQ + T, 13% (M) BQ, 2% (F) BQ + T, 11% (F)	BQ, 4.2 (1.5–11.8) (M) BQ + T, 6.1(3.8–9.7) (M) BQ, 16.4 (4.8–56.5) (F) BQ + T, 45.9 (25.0–84.1) (F)	Balaram *et al.* (2002)
Chennai & Trivandrum, India (1993–99)	Oral cavity	1563 (M)	BQ, 6% BQ + T, 48% S, 73%	3638 (M)	BQ, 5% BQ + T, 10% S, 51%	BQ, 2.2 (1.6–3.0) BQ + T, 5.1 (4.3–6.0)	Znaor *et al.* (2003)
	Tongue					BQ, 1.7 (1.1–2.6) BQ + T, 2.7 (2.2–3.4)	
	Mouth					BQ, 2.6 (1.8–3.7) BQ + T, 7.0 (5.7–8.5)	

M, men; F, women; Q, betel quid with or without tobacco; S, smoking only; BQ, betel quid without tobacco; T, tobacco
[a] Usually comprises gum, floor of the mouth, buccal mucosa and palate; the tongue may be also included.
[b] In addition to oral cancer

Table 39. Dose–response relationship [calculated by the Working Group] between chewing of betel quid with tobacco and oral cancer

Frequency of chewing	Relative risk	
	Hirayama (1966)	Orr (1933)
None	1.0	1.0
< 2 times a day	8.4	4.9
3–5 times a day	14.2	17.7
6 times or more	17.6	68
Retaining quid in sleep	63	212.5

mucosa, 1.7% for cancer of the anterior tongue, 2.5% for oropharyngeal cancer and 2.9% for controls. Among women, the percentage of areca-nut chewers was 4.5% for cancer of the buccal mucosa and 19.6% for controls. Controls were cases of other diseases [not specified] matched for age and sex. [The information on areca-nut use was obtained by interviewing patients and by using hospital records if considered reliable. The proportion of such cases was not mentioned.] A dose–response relationship was calculated by the Working Group of *IARC Monographs* Volume 37 using case–control studies reported by Orr (1933) and Hirayama (1966) and results are given in Table 39. Both studies showed a positive dose–response relationship, the highest relative risk being that of retaining the betel quid during sleep.

The case–control sltudy of Jussawalla & Deshpande (1971) on 2005 cancers of the upper aerodigestive tract also reported increased relative risks for several subsites of oral cancer. These results are described in detail in Section 2.3.

Jafarey *et al.* (1977) reported a case–control study of cancer of the oral cavity and oropharynx conducted in Karachi, Pakistan, in 1967–72, comprising 1192 cases (683 men, 509 women) and 3562 controls (1978 men, 1584 women). Population controls were matched for age, sex and place of birth. Among nonsmokers, the risk for oral cancer of chewing betel quid alone in men and women was 4.2 and 3.2, respectively. When betel quid was chewed with tobacco, the risk among nonsmokers increased to 20.0 in men and 29.9 in women. The joint effect of chewing betel quid with tobacco and smoking was 23 in men and 35.9 in women.

A case–control study on several oral cancer subsites was conducted in Kerala, India. The first part of the study (Sankaranarayanan *et al.*, 1989a) that focused on cancer of the anterior two-thirds of tongue and floor of mouth comprised 228 cases (158 men, 70 women) and 453 hospital non-cancer controls (314 men, 139 women) matched for age, sex and religion. The risk associated with chewing betel quid with tobacco was lower in men than in women. The second part of the study on cancer of the gingiva (Sankaranarayanan *et al.*, 1989b) comprised 187 cases, and the third part on cancer of buccal and labial mucosa comprised

414 cases (Sankaranarayanan *et al.*, 1990a). Hospital controls (n = 895) with no cancers were used for both the second and third studies. Attributable risk in men for chewing betel quid with tobacco was estimated at 54% for gingival cancers. Statistically significant dose–response relationships were observed for all oral cancer sites, for duration of chewing betel quid with tobacco and for number of betel quids with tobacco consumed per day (Tables 38 and 40).

Nandakumar *et al.* (1990) reported a case–control study conducted in Bangalore, India, using cases of cancer of the lip, tongue (excluding base of tongue), alveolus and mouth, registered at the Bangalore population-based cancer registry, and population controls with no evidence of cancer matched by age and area of residence. This study showed increased risk for oral cancer in both genders for chewing betel quid with tobacco (Table 38). Higher risk was seen among those who retained the quid in the mouth while asleep (odds ratio, 17.7; 95% CI, 8.7–36.1) than among those who did not (odds ratio, 8.5; 95% CI, 4.7–15.2). Risk increased with increase in duration of chewing betel quid with tobacco, with the number of tobacco quids consumed per day and with duration (period) of retention of the quid in the mouth (Table 40). Risks for chewing betel quid without tobacco were increased in men (odds ratio, 1.5; 95% CI, 0.6–3.8) and in women (odds ratio, 2.2; 95% CI, 0.7–6.5) and also in the combined analysis of men and women (odds ratio, 1.7; 95% CI, 0.9–3.5); however, these risks were not statistically significant. [The Working Group noted that the results were not adjusted for tobacco smoking. No information was available on other potential confounders.]

A study was conducted in Mumbai, India, of 142 male cases of cancer in the anterior two-thirds of the tongue, 495 male cases of cancer in the posterior third of the tongue and 635 hospital controls without cancer, infection or benign lesion. Information on chewing was available for 141 cases of cancer of the anterior two-thirds of tongue, all cases of cancer of the posterior third of the tongue, and 631 controls. A risk associated with chewing betel quid with tobacco was seen for the anterior two-thirds of the tongue but not for the posterior third (Rao & Desai, 1998) (Table 38).

Wasnik *et al.* (1998) reported a hospital-based case–control study conducted at three tertiary care centres in Nagpur city, Maharashtra, India, comprising 123 histologically confirmed cases of oropharyngeal cancer (73 men, 50 women), 123 cancer controls (sites other than oropharynx) and 123 non-cancer controls, matched by age and sex. Univariate analysis with both types of controls showed an elevated risk for chewing betel quid without tobacco and for chewing areca nut alone, as well as a more than ninefold risk for chewing tobacco alone or with betel quid. Multivariate analysis adjusting for tobacco smoking and occupation showed an eightfold risk (95% CI, 4.1–13.6) for chewing tobacco. The attributable risk for chewing tobacco was estimated at 87%.

A case–control study conducted on 148 cases of cancer of the oral cavity registered in the population-based Bhopal (India) Cancer Registry and 260 population controls showed a sixfold risk for chewing betel quid with tobacco for cancer of the oral cavity. An increased risk (odds ratio, 1.7; 95% CI, 0.9–3.3) was suggested for chewing betel quid without tobacco. The population attributable risk for developing cancer of the oral cavity

Table 40. Dose–response relationship associated with chewing habit

	Cases	Controls	Odds ratio (95% CI)	*p* for trend
Kerala Study				
I. Cancer of anterior 2/3 of tongue and floor of mouth (Sankaranarayanan *et al.*, 1989a)				
Men				
Duration of chewing (years)				
Never chewers	58	216	1.0	
≤ 10	8	8	3.9 (1.2–12.8)	
11–20	11	24	1.7 (0.7–3.96)	
21–30	29	26	4.6 (2.4–9.0)	
31–40	27	23	5.2 (2.5–10.7)	
> 40	17	13	5.6 (2.3–13.8)	< 0.001
Average daily amount (no. of quids/day)				
Never chewers	58	216	1.0	
< 5	32	33	4.0 (2.2–7.5)	
5–9	29	43	2.9 (1.6–5.3)	
≥ 10	31	18	5.5 (2.9–10.7)	< 0.001
Women				
Duration of chewing (years)				
Never chewers	13	84	1.0	
≤ 10	8	8	7.6 (1.97–29.1)	
11–20	9	11	3.5 (1.1–10.8)	
21–30	11	20	4.6 (1.5–13.8)	
31–40	10	7	15.9 (3.6–69.0)	
> 40	15	8	18.3 (4.7–71.4)	< 0.001
Average daily amount (no. of quids/day)				
Never chewers	13	84	1.0	
< 5	19	24	5.8 (2.2–15.2)	
5–9	20	22	6.6 (2.5–17.7)	
≥ 10	14	8	9.3 (3.1–27.6)	< 0.001
II. Cancer of the gingiva (Sankaranarayanan *et al.*, 1989b)				
Men				
Duration of chewing (years)				
Never chewers	19	360	1.0	
≤ 10	4	13	5.8 (1.6–20.7)	
11–20	9	54	2.9 (1.2–6.8)	
21–30	13	49	4.95 (2.3–10.8)	
31–40	28	40	13.6 (6.7–27.7)	
> 40	33	25	32.1 (13.9–73.8)	< 0.001

Table 40 (contd)

	Cases	Controls	Odds ratio (95% CI)	*p* for trend
Average daily amount (no. of quids/day)				
Never chewers	19	360	1.0	
< 5	21	61	5.95 (2.99–11.8)	
5–9	30	80	6.9 (3.7–12.9)	
≥ 10	36	40	15.1 (7.8–29.0)	< 0.001
Women				
Duration of chewing (years)				
Never chewers	6	168	1.0	
≤ 10	4	48	2.4 (0.6–9.3)	
11–20	10	49	5.9 (1.97–17.6)	
21–30	14	48	9.3 (3.3–26.6)	
31–40	18	19	32.3 (10.6–98.4)	
> 40	23	13	54.2 (16.3–180.4)	< 0.001
Average daily amount (no. of quids/day)				
Never chewers	6	168	1.0	
< 5	19	92	6.6 (2.5–17.7)	
5–9	39	63	18.5 (7.2–47.8)	
≥ 10	11	22	13.7 (4.4–42.5)	< 0.001
III. Cancer of the buccal and labial mucosa (Sankaranarayanan *et al.*, 1990a)				
Men				
Duration of chewing (years)				
Never chewers	37	360	1.0	
≤ 10	11	13	6.9 (2.8–16.8)	
11–20	35	55	5.8 (3.3–10.11)	
21–30	39	49	7.7 (4.4–13.4)	
31–40	48	40	13.2 (7.5–23.3)	
> 40	70	25	37.8 (19.5–73.1)	< 0.001
Average daily amount (no. of quids/day)				
Never chewers	37	360	1.0	
< 5	59	61	9.3 (5.6–15.2)	
5–9	75	80	9.04 (5.7–14.5)	
≥ 10	69	40	16.4 (9.7–27.7)	
Women				
Duration of chewing (years)				
Never chewers	19	168	1.0	
≤ 10	11	48	1.8 (0.8–4.1)	
11–20	22	49	3.8 (1.9–7.8)	
21–30	38	48	7.7 (4.0–15.0)	
31–40	33	19	21.3 (9.6–47.4)	
> 40	39	13	54.9 (21.2–142.4)	

Table 40 (contd)

	Cases	Controls	Odds ratio (95% CI)	*p* for trend
Average daily amount (no. of quids/day)				
Never chewers	19	168	1.0	
< 5	36	92	3.7 (1.99–7.0)	
5–9	72	63	10.8 (6.0–19.6)	
≥ 10	35	22	14.2 (6.9–29.5)	
Bangalore study (Nandakumar *et al.*, 1990)				
Men and women				
Duration of chewing (years)				
Never chewers	111	278	1.0	
1–5	4	6	1.7 (0.3–9.3)	
6–15	23	7	10.3 (3.6–29.6)	
16–25	56	20	12.4 (5.6–27.2)	
> 25	154	37	15.95 (8.4–30.2)	
Average daily amount (no. of quids/day)				
Never chewers	111	278	1.0	
1–4	82	33	9.3 (4.9–17.5)	
5–9	98	28	12.8 (6.6–25.0)	
≥ 10	35	8	16.6 (6.3–44.3)	
Chewing period (min)				
Never chewers	111	278	1.0	
≤ 5	5	3	6.4 (0.9–45.1)	
6–10	67	20	9.7 (4.7–19.8)	
11–20	59	13	16.5 (7.2–37.4)	
21–30	54	17	13.2 (5.8–30.0)	
> 30	11	6	6.6 (1.6–27.0)	
Bhopal study (Dikshit & Kanhere, 2000)				
Men				
Duration of chewing (years)				
Never chewers	28		1.0	
1–20	12		1.1 (0.5–2.4)	
21–30	32		5.5 (2.9–10.6)	
> 30	72		23.9 (12.0–47.3)	
Average daily amount (no. of quids/day)				
Never chewers	28		1.0	
1–5	19		2.0 (1.0–3.8)	
6–10	47		6.7 (3.7–12.1)	
> 10	15		13.9 (7.1–27.2)	

Table 40 (contd)

	Cases	Controls	Odds ratio (95% CI)	*p* for trend
Multicentre study in South India: Chennai, Bangalore and Trivandrum (Balaram *et al.*, 2002)				
Men				
Age started chewing (years)				
≥ 25	51	21	1.0	
20–24	42	10	1.5 (0.6–4.2)	
< 20	27	6	1.5 (0.5–5.0)	0.39
Average daily amount (no. of quids/day)				
Never chewers	127	232	1.0	
Former chewers				
< 5	28	11	4.2 (1.9–9.6)	
≥ 5	31	9	5.8 (2.5–13.2)	
Current chewers				
< 5	40	18	3.1 (1.6–5.9)	
5–9	46	12	8.2 (3.9–16.9)	
≥ 10	34	7	7.9 (3.2–19.4)	< 0.001
Women				
Age started chewing (years)				
≥ 25	56	13	1.0	
20–24	74	12	1.9 (0.7–5.3)	
< 20	73	4	5.4 (1.5–19.7)	0.01
Average daily amount (no. of quids/day)				
Never chewers	29	251	1.0	
Former chewers				
< 5	17	6	20.2 (6.4–63.9)	
≥ 5	31	3	60.4 (15.8–230.7)	
Current chewers				
< 5	51	13	22.1 (10.1–48.5)	
5–9	101	13	58.6 (26.6–129.0)	
≥ 10	51	3	112.4 (30.9–409.6)	< 0.001
Study in South India: Chennai and Trivandrum (Znaor *et al.*, 2003)				
Men				
Never chewing	711	3079	1.0	
Duration of chewing (years)				
0–19	250	286	3.1 (2.5–3.9)	
20–39	432	209	5.3 (4.3–6.5)	
≥ 40	170	64	5.2 (3.7–7.3)	
Average daily amount (no. of quids/day)				
1–3	279	343	2.06 (1.7–2.5)	
4–5	273	135	6.02 (4.7–7.7)	
> 5	300	800	11.9 (8.9–15.96)	

Table 40 (contd)

	Cases	Controls	Odds ratio (95% CI)	*p* for trend
Cumulative exposure to chewing				
< 1000	354	158	3.8 (2.95–4.8)	
> 1000	211	26	13.3 (8.5–20.9)	
Time since quitting chewing (years)				
Current chewers	640	460	1.0	
2–4	93	41	1.2 (0.8–1.8)	
5–9	59	20	1.6 (0.9–2.8)	
10–14	30	19	0.7 (0.4–1.4)	
≥ 15	30	19	0.7 (0.4–1.3)	

CI, confidence interval

was 66% for chewers of betel quid with tobacco (Dikshit & Kanhere, 2000) (Tables 38 and 40).

Merchant *et al.* (2000) reported a case–control study in three hospitals in Karachi, Pakistan, comprising 79 (54 men, 25 women) histologically confirmed cases of oral squamous-cell carcinoma and 149 controls (94 men, 55 women) matched for age, gender, hospital and time of occurrence, without past or present history of cancer. An eight- to ninefold risk for developing oral cancer was associated with ever chewing betel quid with or without tobacco, and ever chewing naswar, after adjustment for oral submucous fibrosis, cigarette smoking, alcohol and other chewing habits where appropriate. A dose–response relationship was observed between tertiles of *pan*–years without tobacco (average number of quids per day × average years of use) and the risk for oral cancer (*p*-value for trend = 0.0008), after adjustment for smoking, oral submucous fibrosis, alcohol drinking, and chewing naswar or pan with tobacco. [Possible limitations of the study are the use of hospital controls without exclusion of betel quid-related diseases and adjustment for oral submucous fibrosis, which is a disease that is strongly related to chewing betel quid.]

Balaram *et al.* (2002) reported a multicentre study conducted in three Indian centres, Bangalore, Chennai and Trivandrum, in 1996–99 on 591 cases of cancer of the oral cavity (309 men, 282 women) and 582 hospital controls (292 men, 290 women). Controls were frequency-matched with cases by centre, age and sex. Controls were identified and interviewed in the same hospital as cases. In Chennai and Bangalore, controls were visitors of patients admitted for cancers other than oral cancer. In Trivandrum, controls were non-cancer patients attending the hospital for diagnosis or treatment. The results showed that 80% of male and female chewers combined chewed quid with tobacco; the odds ratio for chewing betel quid without tobacco versus non-chewers was 4.2 (95% CI, 1.5–11.8) in men and 16.4 (95% CI, 4.8–56.5) in women after adjusting for age, centre and education for men and women and smoking and alcohol drinking for men only. The risk associated with chewing betel quid with or without tobacco was higher among women than among men. A significant dose–response relationship with the number of betel quids with or without tobacco chewed per day was found in both sexes ($p < 0.001$), while early age at starting chewing was significantly associated with the risk for oral cancer in women only ($p = 0.01$). Only 13 (eight cases, five controls) and 11 (six cases, five controls) women in the study were smokers and alcohol drinkers, respectively; therefore, results among women had little chance of being confounded by smoking or alcohol drinking. There was a slight decrease in risk 10 years after quitting the habit of chewing (Tables 38 and 40).

Znaor *et al.* (2003) reported a study conducted in two centres in South India, Chennai and Trivandrum, on 1563 male oral cancer cases and 3638 controls (1711 male cancer controls from Chennai and Trivandrum and 1927 healthy male hospital visitor controls from Chennai), during the period 1993–99. Although the two centres involved in this study are the same as those in the study of Balaram *et al.* (2002), different cases and controls were used in the two studies. All cancer cases and cancer controls were histologically confirmed and controls were identified and interviewed in the same hospital as the cases. Odds ratios were adjusted for age, centre, level of education, alcohol consumption and smoking. The risks for chewing betel quid without tobacco were 2.2 (95% CI, 1.6–3.0) for cancer of the oral cavity, 1.7 (95% CI, 1.1–2.6) for cancer of the tongue and 2.6 (95% CI, 1.8–3.7) for cancer of the mouth excluding tongue. The analysis stratified by smoking and alcohol drinking showed the risk for chewing betel quid without tobacco to be 3.4 (95% CI, 2.04–5.7) in nonsmokers and non-drinkers of alcohol. Statistically significant dose–response relationships were observed for duration of the combined habit of chewing betel quid with or without tobacco, average daily amount of betel quid with or without tobacco chewed and cumulative years of chewing betel quid with or without tobacco ($p < 0.001$). The risk associated with oral cancer decreased with duration since quitting the combined habit of chewing betel quid with or without tobacco, but the odds ratios for time since quitting were not statistically significant (Tables 38 and 40).

(*d*) *Cross-sectional surveys*

Cross-sectional studies summarized in Volume 37 of the *IARC Monographs* (IARC, 1985a) are given in Table 41. These studies provide information on prevalence of oral cancer among persons chewing betel quid with or without tobacco, as well as combined or not with smoking. No new prevalence studies were available to the Working Group of this monograph.

(*e*) *Synergism*

Jayant *et al.* (1977) examined the possibility of interaction between chewing and smoking habits in the etiology of cancer of the upper alimentary tract using the data of Jussawalla and Deshpande (1971). It was found that chewing and smoking habits interacted synergistically for cancers of the oral cavity, oropharynx, hypopharynx, larynx and oesophagus.

A significant interaction with the smoking of bidis was observed in the studies from Kerala, India (described in detail in Section 2.1.1(*c*)). The unadjusted relative risk for chewing betel quid with and without tobacco and smoking bidis in the case–control study of oral cancers of the tongue and floor of mouth was 7.02 (95% CI, 3.6–13.5) in men, compared with nonsmokers and non-chewers (p for interaction < 0.01) (Sankaranarayanan *et al.*, 1989a). In the second part of the study on cancer of the gingiva (Sankaranarayanan *et al.*, 1989b), the risk associated with mixed habits of chewing betel quid with tobacco and bidi smoking was 16.5 (95% CI, 7.5–36.1) in men, compared with nonsmokers and non-chewers (p for interaction < 0.05). Risk estimates were not adjusted for age. In the third study on cancer of the buccal and labial mucosa, the risk in men of chewing and smoking bidis was 21.5 (95% CI, 11.9–38.5) compared with nonsmokers and non-chewers (p for interaction < 0.05) (Sankaranarayanan *et al.*, 1990a)

The study by Balaram *et al.* (2002) conducted in southern India with 591 cases of cancer of the oral cavity and 582 hospital controls (described in Section 2.1.1(*c*)) showed a sevenfold risk for developing oral cancer among men who were current chewers of betel quid with or without tobacco and who smoked 20 or more cigarettes/bidis or equivalents per day, and a ninefold risk among those who were current chewers and current drinkers. This study showed a negative interaction between chewing tobacco and smoking (Table 42).

Znaor *et al.* (2003) reported the results of a study in men conducted in two centres (Chennai and Trivandrum) in South India that included 1563 cases of oral, 636 cases of pharyngeal and 566 cases of oesophageal cancer, 1711 disease controls and 1927 healthy controls (see Section 2.1.1(*c*)). Table 43 shows the joint effects of smoking, drinking and chewing habits. Compared with subjects who did not smoke, chew betel quid with or

Table 42. Risk for cancer of the oral cavity among men: interaction between chewing and smoking, and chewing and drinking

	Paan chewing			
	Never		Current chewers	
	Cases/ controls	Odds ratio[a] (95% CI)	Cases/ controls	Odds ratio[a] (95% CI)
Tobacco smoking				
Never smokers	25/106	1.0	49/16	9.2 (4.4–19.3)
Current smokers (cig./day)				
1–19	33/55	1.8 (0.93–3.5)	35/10	8.9 (3.6–21.8)
≥ 20	48/35	3.7 (1.9–7.2)	22/8	6.7 (2.5–18.3)
Alcohol drinking				
Never drinker	64/174	1.0	48/18	7.3 (3.8–14.1)
Current drinker	48/38	2.8 (1.6–5.1)	46/13	8.6 (4.1–18.1)

From Balaram *et al.* (2002)

[a] Unconditional logistic regression adjusted for age, centre, education, oral hygiene, chewing and smoking and drinking habits, as appropriate

CI, confidence interval

215

Table 43. Odds ratios for oral cancer and combinations of smoking, chewing and alcohol drinking

Habit			Oral cavity cancer			
Smoking	Chewing	Alcohol	Controls	Cases	Odds ratios	95% CI
No	No	No	1471	122	1.0	–
No	Yes T–	No	83	24	3.4	2.04–5.7
No	Yes T+	No	127	159	9.3	6.8–12.7
Yes	No	No	1084	268	2.5	1.9–3.1
No	No	Yes	75	16	2.6	1.4–4.6
Yes	Yes T–	No	49	25	4.8	2.8–8.3
Yes	Yes T+	No	102	161	8.5	6.1–11.9
No	Yes T–	Yes	15	6	4.4	1.6–12.3
No	Yes T+	Yes	26	95	24.3	14.9–39.7
Yes	No	Yes	449	287	4.8	3.7–6.2
Yes	Yes T–	Yes	34	33	8.1	4.7–14.0
Yes	Yes T+	Yes	119	342	16.3	12.1–22.0

From Znaor *et al.* (2003)
Adjusted for age, center and level of education
CI, confidence interval; T+, with tobacco; T–, without tobacco

without tobacco or drink alcohol, the risks were 3.4 (95% CI, 2.04–5.7) for chewing betel quid without tobacco, 9.3 (95% CI, 6.8–12.7) for chewing betel quid with tobacco, 4.8 (95% CI, 2.8–8.3) for both smoking and chewing betel quid without tobacco, 4.4 (95% CI, 1.6–12.3) for both drinking alcohol and chewing quid without tobacco and 8.1 (95% CI, 4.7–14.0) for smoking, drinking alcohol and chewing quid without tobacco. In all estimates related to interaction between two habits, the third habit was controlled for in addition to age, centre and level of education. Likelihood ratio tests were statistically significant ($p < 0.05$) for the combination of the different habits — drinking and smoking, chewing and smoking, but not chewing and drinking.

2.1.2 *Taiwan, China*

(*a*) *Descriptive study*

One ecological study in Taiwan, China, found that the increase in incidence trends of oropharyngeal cancer parallels the time trend of consumption of areca nut, which almost doubled from 1985 to 1993 and which was much greater than the trend for the consumption of tobacco and alcohol (Ho *et al.*, 2002). As the majority of betel-quid chewers are men, the large increasing trend of these cancers in men also supports the possibility of the cause being consumption of areca nut. Age-standardized incidence rates for men have increased from 5.4 (95% CI, 5.05–5.8) in 1979–83 to 15.95 (95% CI, 15.3–16.6) in 1994–96 and those for women from 1.6 (95% CI, 1.4–1.8) in 1979–83 to 2.1 (95% CI, 1.8–2.4) in 1994–96 (Ho *et al.*, 2002).

(*b*) *Case–control studies*

Kwan (1976) reported a case–control study of oral cancer in Taiwan, China, in which, out of 103 cases, 20 were betel chewers and 35 were betel chewers with other habits. No control subject chewed betel. [Therefore, it was not possible to estimate the relative risk.]

Three recent case–control studies in Taiwan, China, are summarized in Table 44.

Ko *et al.* (1995) conducted a hospital-based case–control study to assess the effects of betel quid without tobacco, smoking and alcohol on the incidence of oral cancer. A total of 107 oral cancers (104 men, three women) confirmed by histopathology (ICD 140–141, 143–145) between 1992 and 1993 were ascertained from patients at the dental department at Kaohsiung Medical College Hospital, in southern Taiwan, China. Controls were selected from ophtalmology and physical check-up departments in the same period as cases; 93 cases were matched with two controls and 14 cases with one control according to age (± 5 years) and sex. Information on demographic variables, the habit of betel-quid chewing, cigarette smoking and alcohol drinking was collected by a structured questionnaire administered by a trained interviewer. After controlling for education and occupation with a conditional logistic regression model, betel-quid chewing was considered to be the most important risk factor for oral cancer, compared with alcohol drinking and cigarette smoking. The association between chewing betel quid and oral cancer was significant for current chewers, with a sevenfold increase in risk, but was of borderline significance for former chewers, with a fivefold increase. The association between smoking and oral cancer was statistically significant for current smokers (fivefold increase in risk) and of borderline significance for former smokers (fourfold increase). Being a current drinker was also statistically significantly associated with risk for oral cancer, whereas no elevated risk was found for former drinkers. By stratified analysis incorporating the three factors simultaneously, relative risks were estimated at 122.8 (95% CI, 17.1–880.5) for the combination of the three factors, 89.1 (95% CI, 10.0–790.7) for chewing betel quid and smoking, 54.0 (95% CI, 4.4–660) for chewing betel quid and drinking and 28.2 (95% CI, 1.9–414.4) for chewing betel quid only, as compared with participants abstaining from all three habits. The relative risk for combined areca-nut chewing, smoking and alcohol is greater than the risk associated with the three risk factors independently. [A synergistic effect is suggested, but no assessment of interaction was made in this study.] With regard to the type of material chewed, chewers who used *lao-hwa* quid and mixed chewers (*lao-hwa* quid and betel quid) had a 12-fold and ninefold risk, respectively, both of which were statistically significant. Betel-quid chewers with the habit of swallowing the juice had an 11-fold statistically significant risk for oral cancer.

Another matched case–control study was conducted in the central area of Taiwan, China. A total of 40 consecutive histopathologically diagnosed oral cancers (34 men, six women) were ascertained from patients at Changhua Christian Hospital between 1990

Table 44. Case–control studies of betel quid-chewing and oral cancer in Taiwan, China

Reference, place, period	Characteristics of cases and controls	Oral cancer site	Exposure	Cases/ controls	Odds ratio (95% CI)	Comments
Ko *et al.* (1995), Kaohsiung, 1992–93	107 cases (104 men, 3 women) and 200 non-cancer hospital controls (194 men, 6 women) matched on age and sex	ICD 140–141 (lip, tongue), 143–145 (gum, mouth)	Non-drinker	25/89	1.0	Adjusted for education, occupation and each covariate
			Former drinker	14/37	1.0 (0.3–3.3)	
			Current drinker	68/74	2.2 (1.0–4.9)	
			Non-smoker	11/72	1.0	
			Former smoker	11/30	3.6 (0.9–14.6)	
			Current smoker	85/98	4.6 (1.5–14.0)	
			Non-chewer	31/153	1.0	
			Former chewer	5/5	4.7 (0.9–22.7)	
			Current chewer	71/42	6.9 (3.1–15.2)	
			Non-chewer	31/60	1.0	Adjusted for education, occupation, smoking and drinking
			Betel quid	1/7	0.1 (0.0–6.3)	
			Lao-hwa quid	41/13	11.6 (3.7–36.9)	
			Betel + *lao-hwa*	34/25	8.5 (2.7–26.3)	
			Not swallowing juice	3/15	0.2 (0.0–2.9)	
			Swallowing juice	73/31	11.4 (4.0–32.0)	
			Multivariate analysis			Adjusted for education and occupation; reference category: no habit
			D + S + BQ	58/34	122.8 (17.1–880.5)	
			D + BQ	3/2	54.0 (4.4–660.0)	
			S + BQ	12/9	89.1 (10.0–790.7)	
			S + D	18/56	22.3 (3.2–153.8)	
			BQ	3/2	28.2 (1.9–414.4)	
			S	8/29	18.0 (2.4–135.8)	
			D	3/19	10.2 (1.2–86.4)	

and 1992 (Lu *et al.*, 1996). Each case was matched to four neighbourhood non-cancer controls (136 men, 24 women) in Changhua County according to four criteria: sex, age, living in the same community residence as the case for at least 5 years and educational background. Information was gathered from a questionnaire administered by a social worker that covered demographic and socioeconomic factors, duration, type and daily amount of smoking, chewing and alcohol drinking. After adjustment for each individual risk factor, the authors showed that chewing betel quid without tobacco was highly associated with risk for oral cancer but that only a moderate non-significant association was noted for smoking and that no association was found for alcohol drinking. Adjusted odds ratios increased with duration of chewing and quantity of betel quid chewed per day, suggesting a trend for increasing duration and amount.

A case–control study on the association between human papillomavirus (HPV) infection, chewing betel quid without tobacco and cigarette smoking was conducted using biopsies from 29 cases of oral squamous-cell carcinoma and those from 29 controls that included normal or inflammatory mucosa obtained from a negative biopsy, teeth extraction or excision of a benign lesion (mucocele and haemangioma). Case and control biopsies were collected from the archives of the Medical and Dental University Hospital from 1994 to 1997. Betel-quid chewing remained the most significant factor, giving a 17-fold increase in risk after adjusting for HPV sequences 6, 11, 16 and 18, sex, age and smoking (Chen *et al.*, 2002).

2.1.3 *South-East Asia*

Epidemiological data from South-East Asia on the association between oral cancer and the habit of chewing betel quid are rare. However, age-standardized rates for oral cancer in men and women are available for some countries (Tables 45 and 46). Some descriptive studies on oral cancer without details on betel-quid chewing habits have been published from the South-East Asian region (Piyaratn, 1959; Lay *et al.*, 1982; Warnakulasuriya *et al.*, 1984; Kuek *et al.*, 1990; Ikeda *et al.*, 1995; Budhy *et al.*, 2001).

(*a*) *Malaysia*

Ahluwalia and Duguid (1966) reported on the distribution of cancers in different ethnic groups of the Malay Peninsula (Malays, Chinese and Indians), using records from the Kuala Lumpur Institute for Medical Research. Of 4369 cases of cancer (1961–63), 476 (10.9%) were oral cancers in chewers of betel quid with and without tobacco. Of 912 cancers at all sites in Indians who are known to chew betel quid with tobacco, 306 (33.6%) were oral cancers. Of 776 cancers at all sites in Malays who are known to chew betel quid without tobacco, 74 (9.5%) had oral cancer.

Ramanathan and Lakshimi (1976) reported on racial variations of cancer in Indian, Malay and Chinese populations in Malaysia. Of a total of 898 cases of oral carcinoma, 31.1% occurred in Indian women, 29.1% in Indian men, 10.6% in Malay men, 11.1% in Malay women, 14.1% in Chinese men and 4% in Chinese women. Chewing and smoking

Table 45. Cancer of the oral cavity (men, all ages) in South-East Asia in 2000

Country	Cases	Crude rate	ASR (W)	Deaths	Crude rate	ASR (W)
Cambodia	113	2.1	4.6	66	1.2	2.8
Indonesia	1176	1.1	1.5	657	0.6	0.8
Lao	42	1.5	2.6	24	0.9	1.5
Malaysia	191	1.7	2.4	108	1.0	1.4
Myanmar	1387	6.1	8.6	805	3.5	5.1
Philippines	1304	3.4	5.8	755	2.0	3.4
Singapore	68	3.8	3.7	29	1.7	1.7
Thailand	1240	4.0	5.3	735	2.4	3.1
Viet Nam	920	2.3	3.7	520	1.3	2.1

From Ferlay *et al.* (2001)
ASR (W), age-standardized rates (world standard population)

Table 46. Cancer of the oral cavity (women, all ages) in South-East Asia in 2000

Country	Cases	Crude rate	ASR (W)	Deaths	Crude rate	ASR (W)
Cambodia	123	2.1	3.4	71	1.2	2.0
Indonesia	883	0.8	1.0	485	0.5	0.5
Lao	90	3.3	6.0	53	2.0	3.6
Malaysia	156	1.4	1.8	85	0.8	1.0
Myanmar	653	2.8	3.5	371	1.6	2.0
Philippines	1250	3.3	5.4	732	1.9	3.2
Singapore	38	2.1	1.9	16	0.9	0.8
Thailand	1139	3.7	4.0	673	2.2	2.4
Viet Nam	914	2.3	2.8	526	1.3	1.6

From Ferlay *et al.* (2001)
ASR (W), age-standardized rates (world standard population)

habits were not studied in particular. Ethnic differences in the pattern of oral carcinoma were evident and partly attributed to different oral habits such as betel-quid chewing, which is more prevalent in the Indian and Malay populations compared with the Chinese.

Ng *et al.* (1986) studied the betel-quid chewing and smoking habits, as well as alcohol consumption of 100 Indian, Chinese and Malay patients (39 men, 61 women) with histologically confirmed oral squamous-cell carcinoma. Betel-quid chewing was the most common single habit (85%), followed by alcohol consumption (55%) and smoking (29%). Seventy-one per cent of chewers used betel quid with tobacco. The location of the squamous-cell carcinoma in betel-quid chewers was associated with the site where the quid was retained in the mouth.

In one prevalence study of oral mucosal lesions in out-patients at two dental schools in Chiang-Mai, Thailand, and Kuala-Lumpur, Malaysia, Axéll *et al.* (1990) found one case of oral carcinoma among 96 women from Kuala Lumpur (1.0%). This case was diagnosed in a 45-year-old Indian woman who had been chewing betel quid with tobacco daily for many years.

(*b*) *Myanmar*

Sein *et al.* (1992) reported on 70 cases of oral cancer (35 men, 35 women) associated with smoking and betel-quid chewing (with or without tobacco) habits. Information was gathered from records of the Institute of Dental Medicine in Yangon (1985–88). The proportion of persons with oral cancer was 58.6% in regular betel-quid chewers, 12.8% in occasional users, 28.6% in non-chewers, 65.7% in regular smokers and 32.9% in non-smokers.

(*c*) *Thailand*

A multivariate regression analysis was conducted in a case–control study in Thailand (Simarak *et al.*, 1977). Over a period of 16 months (1971–72) at the University Hospital in Chiang Mai, patients with a confirmed diagnosis of cancer of the oral cavity and oropharynx (50 men, 38 women), of the larynx and hypopharynx (84 men, 12 women) or of the lung (60 men, 55 women) were selected as cases; 1113 controls (697 men, 416 women) were selected from among patients attending a radiology clinic, mainly with uro-genital, respiratory or locomotor disorders; a small proportion of controls (7% of men, 15% of women) had cancers at sites other than those under study. Histological confirmation was obtained for about 50% of cases. A questionnaire administered by nurses provided information on personal habits and demographic factors. Variables that showed a significant relationship with cancer, after adjusting for age and residence, and that were included in the multivariate analysis comprised agricultural employment, rural residence and betel chewing for patients of each sex, lack of formal schooling, and cigarette and cigar smoking for men. After adjusting for the effects of covariables, the relative risk estimates for chewing betel were 2.3 ($p < 0.05$) for men and 3.2 ($p < 0.05$) for women for oral and oropharyngeal cancers and 2.4 ($p < 0.01$) for men for cancer of the larynx and hypopharynx. Among cancer cases who chewed betel, 25/26 added tobacco to the quid, whereas less than two-thirds of the control chewers used betel quid with tobacco.

In a case-only study in southern Thailand (1996–98), Kerdpon and Sriplung (2001) investigated the risk for developing advanced-stage oral squamous-cell carcinoma. Of 161 patients (117 men, 44 women) with early- or advanced-stage carcinoma of the oral cavity and lip (ICD-9 140–141, 143–145), 59/99 cases (59.6%) who presented the advanced stage were betel-quid chewers. [The composition of the betel quid (with or without tobacco) was not specified.] No significant association was observed between chewing

222

and the development of advanced-stage cancer (crude odds ratio, 1.7; 95% CI, 0.9–3.2) at the time of diagnosis nor, upon further analysis, between dose or duration of chewing.

2.1.4 *Papua New Guinea*

In Papua New Guinea, the predominant habit is chewing betel quid with areca nut and slaked lime without tobacco, and oral cancer is generally the most common form of cancer. The earliest study (Eisen, 1946) concluded that betel-quid chewing does not appear to cause cancer of the buccal cavity. [The Working Group noted that this conclusion appeared to be based on the finding of no oral cancer in a cross-section of subjects.] In two reports by Farago (1963a,b), 99% and 98% of oral cancer patients were chewers of betel quid. Smoking was also reported to be common.

Two studies (Atkinson *et al.*, 1964; Henderson & Aiken, 1979) were based on a cancer survey and a continuing cancer registration system. Atkinson *et al.* (1964) proposed that, since the occurrence of oral cancer correlated very well with the known distribution of the habit of betel-quid chewing, areca nut and slaked lime may have carcinogenic effects even when chewed without tobacco. [The Working Group noted that the authors did not take into consideration cigarette smoking, which was reported to be common.] Henderson and Aiken (1979) observed that the site distribution of their oral cancer cases was consistent with that reported of oral cancer among betel chewers from other parts of the world. Cooke (1969) observed that only 5% of all oral cancers occurred in people in the highlands [where 50% of the population lived, but where areca nut did not grow and betel-quid chewing was less popular (Henderson & Aiken, 1979)]. Cigarette smoking was reported to be common in both the highlands and lowlands.

In a study in 1971–78 from Papua New Guinea, the age-adjusted incidence rates of oral cancer were compared for different geographical areas (Atkinson *et al.*, 1982). In the highlands, where very few people chew areca nut with slaked lime, the age-adjusted incidence of oral cancer per 100 000 compared with that in the lowlands, where a very high percentage of people practise this habit, was 1.01 versus 6.83 for men and 0.41 versus 3.03 for women. It was observed that, in a part of lowland western Papua, inhabited by a specific tribe among whom very few chew, the incidence of oral cancer was very low. The authors, while pointing out that the numbers were very small, noted that the finding had been consistent for 21 years.

In another study (Scrimgeour & Jolley, 1983), the changes in the incidence of oral cancer were compared with the changes in smoking and tobacco consumption during the periods 1965–69 and 1975–79. It was found that the incidence of oral cancer had increased among men as well as among women; the increase for men was not statistically significant, but that for women was ($p < 0.01$). During the same period, the proportion of adult women in a specific area of Papua who smoked commercial cigarettes had increased from 34 to 76%, although their betel-quid chewing habits had not changed greatly. Smoking habits among men had not changed significantly.

223

2.1.5 *Migrant populations*

Studies of migrant populations have proved of considerable interest to cancer epidemiologists in suggesting the extent to which environmental exposures are important in the etiology of specific cancers. Migrant studies on oral cancer risk have included several Asian groups who have migrated and settled in Britain.

(*a*) *South Africa*

van Wyk *et al.* (1993) conducted a study among Indians in Natal, South Africa, during the period 1983–89, including 54 men and 89 women with oral and oropharyngeal cancer (ICD 140, 141, 143–146). Information on areca-nut chewing for the cases was obtained directly by patient interview ($n = 75$), from families or friends ($n = 42$) or was only available from hospital records ($n = 26$). Controls were of the same ethnicity, obtained from a random sample of households. The proportion of smokers among female cases was 7%, and 93% chewed areca nut with or without tobacco. Seventy per cent chewed areca nut without tobacco. The crude odds ratio in women (89 oral cancer cases, 735 controls) for chewing areca nut with or without tobacco was 47.4 (95% CI, 20.3–110.5) and that for chewing areca nut without tobacco was 43.9 (95% CI, 18.6–103.6). Of the male cases, 17% reported chewing betel quid with tobacco and 6% without tobacco. The proportion of smokers among male cases was 87%. [The percentage of female smokers was small, and it is known that drinking among these women is rare. This analysis is therefore close to a stratified analysis, but with no adjustment for age.]

(*b*) *United Kingdom*

Marmot *et al.* (1984) reported on 15 oral cancer deaths in England and Wales between 1970 and 1972 among male Indian ethnic migrants. A higher than expected proportionate mortality ratio of 221 was observed in this ethnic group. Donaldson and Clayton (1984) reported a significant excess in the number of incident oral cancers during 1976–82 in Asian-named individuals in Leicestershire compared with what they referred to as non-Asians. From 1973 to 1985, Swerdlow *et al.* (1995) examined the risk of cancer mortality in persons born in the Indian subcontinent who migrated to England and Wales. Of the numerous cancers examined, highly significant risks in Indian ethnic migrants were noted for cancers of the mouth and pharynx (odds ratio, 5.5; 95% CI, 3.7–8.2). A later study in the Thames region, which has dense pockets of Asian ethnic communities, supported these observations (Warnakulasuriya *et al.*, 1999). There was a significantly higher proportion of cancers of the oral cavity and pharynx among Asian ethnic migrant groups compared with other natives (for oral cancer in Asian versus other ethnicities, $\chi^2 = 13.6$; $p < 0.01$).

The incidence of oral cancer among migrant Asians is similar to that of Asians in the countries of birth; Asians also appear to retain their habit and their increased risk for oral cancer even several decades after migration (Swerdlow *et al.*, 1995).

2.2 Some betel quid-associated lesions, and precancerous lesions and conditions

2.2.1 *Introduction*

Studies on the natural history of oral cancer suggest that several potentially malignant lesions and conditions precede the development of cancer of the oral cavity. Precancerous conditions include oral submucous fibrosis and oral lichen planus and oral precancerous lesions of relevance are leukoplakia and erythroplakia (Pindborg *et al.*, 1996; see Glossary B). There is no evidence to suggest that tobacco use (smoked or chewed) is associated with the development of oral submucous fibrosis (Murti *et al.*, 1995; Shah & Sharma, 1998).

The studies summarized here include those carried out in Asia and South Africa, with particular reference to the use of betel quid and areca nut with or without tobacco.

2.2.2 *Betel quid-associated oral lesions*

Besides oral precancerous lesions (oral leukoplakia and erythroplakia) and oral precancerous conditions (oral submucous fibrosis, oral lichen planus), some other betel quid-associated lesions of the oral mucosa may be observed. These include betel chewer's mucosa and oral lichenoid lesions, which are of some importance in differential diagnosis.

Areca-induced lichenoid lesions, mostly involving buccal mucosa or the tongue, have been reported at the sites of betel-quid retention (Daftary *et al.*, 1980). In areca-nut chewers, they are found at the site of quid placement and are unilateral in nature. The histology is suggestive of a lichenoid reaction and the lesion resolves following cessation of areca use.

Betel chewer's mucosa was first described by Mehta *et al.* (1971) and is characterized by a brownish-red discoloration of the oral mucosa. This discoloration is often accompanied by encrustation of the affected mucosa with quid particles, which are not easily removed, and a tendency for desquamation and peeling. The lesion is usually localized in and associated with the site of quid placement in the buccal cavity, and is strongly associated with the habit of betel-quid chewing, particularly in elderly women (Reichart *et al.*, 1996). Several epidemiological studies have shown that the prevalence of betel chewer's mucosa may vary between 0.2 and 60.8% in different South-East Asian populations (Table 47). At present, betel chewer's mucosa is not considered to be potentially malignant.

2.2.3 *Leukoplakia and erythroplakia*

The prevalence of oral leukoplakia among chewers of betel quid with or without tobacco in selected population samples in India, Malaysia and the Pacific area reported before 1984 is shown in Table 48.

Table 47. Prevalence of betel chewer's mucosa in different populations

Country	Year	No.	Prevalence (%)	Reference
Cambodia	1991	1319 (M + F)	< 1	Ikeda *et al.* (1995)
	NG	102 (F)	60.8	Reichart *et al.* (1996)
	NG	48 (F)	85.4	Reichart *et al.* (2002)
Malaysia	1993/94	NG	5.2	Rahman *et al.* (1997)
	1993/94	187 (M + F)	1.6	Zain *et al.* (1997)
Thailand	1979–84	1866 (M + F)	13.1	Reichart *et al.* (1987)

M, men; F, women; NG, not given

(*a*) *India*

Gupta *et al.* (1995, 1997) reported on a cohort study conducted in Ernakulam district of Kerala state, India, that comprised 12 212 tobacco users, including betel-quid chewers and smokers, who were followed up for 10 years from 1977–78. All participated in a health education programme on cessation of tobacco use (chewing and smoking). The incidence of leukoplakia dropped significantly following cessation: the incidence among those who stopped chewing was 107 per 100 000 person–years compared with those who did not change their habit (265 per 100 000 person–years, men and women combined).

Gupta (1984) reported a dose–response relationship between the development of leukoplakia and chewing betel quid with or without tobacco. The age-adjusted prevalence of leukoplakia was higher among men than women and the prevalence increased with the number of quids chewed per day (Table 49).

Hashibe *et al.* (2000a) reported on a cross-sectional study in Kerala, India, that included 927 cases of oral leukoplakia (411 women, 516 men) and 47 773 population-based controls without oral disease (29 876 women, 17 897 men). A case–control study design was applied to the baseline data for a population screened by oral visual inspections and interviewed with structured questionnaires by health workers. Clinical diagnosis of oral precancers was confirmed by dentists and oncologists. Cases of leukoplakia who had other oral precancers or oral cancer were excluded. Elevated odds ratios for oral leukoplakia were observed for betel-quid chewing with tobacco, after adjustment for age, sex, education, body mass index, pack–years of smoking and years of alcohol drinking (Table 50). [The majority of chewers in this population chewed betel quid with tobacco.] The adjusted risk was higher for women than for men and higher for patients who swallowed the juice while chewing, or kept the quid in their mouth overnight. Dose–response relationships were observed for both the frequency (times per day, p-value for trend = 0.0001) and duration (years; p-value for trend = 0.0001) of betel-quid chewing and the risk for oral leukoplakia.

Within the same study population, 100 cases of erythroplakia (49 women, 51 men) were identified and included in a case–control study with the same 47 773 controls

Table 48. Prevalence of oral leukoplakia among chewers in selected studies in Asia and the Pacific

Reference	Location	Chewing habit	Size of sample	Prevalence	
				No.	%
Gerry *et al.* (1952)	Guam	Betel quid	822	4	0.5
Mehta *et al.* (1961)	Mumbai, India (police)	Betel quid with tobacco	1898	80	4.2
		Betel quid and smoking	595	42	7.1
		No habit	1112	1	0.001
Forlen *et al.* (1965)	Papua New Guinea	Areca nut and smoking	610	–	9.7–36.3
Pindborg *et al.* (1967)	Lucknow, India (out-patient clinic)	Tobacco alone	206	15	7.3
		Betel quid with tobacco	672	30	4.5
		Betel quid without tobacco	181	6	3.3
		No habit	6699	2	0.03
Pindborg *et al.* (1968)	Papua New Guinea	Areca nut	162	2	1.2
		Areca nut and smoking	767	29	3.8
		No habit	165	–	–
Chin & Lee (1970)	Perak, West Malaysia	Betel quid with tobacco	167	67	40.1
		Betel quid without tobacco	45	9	20.0
		Betel quid with *gambir*	45	5	11.1
Mehta *et al.* (1971)	Ernakulam (Kerala), India	Betel quid with tobacco	2661	47	1.8
		Betel quid without tobacco	38	–	–
		Chewing and smoking	1106	67	6.1
		No habit	4210	8	0.2
	Srikakulam (Andhra Pradesh), India	Betel quid with tobacco	281	–	–
		Betel quid without tobacco	56	–	–
		Chewing and smoking	803	23	2.9
		No habit	2620	3	0.1
	Bhavnagar (Gujarat), India	Betel quid with tobacco	299	3	1.0
		Betel quid without tobacco	157	1	0.6
		Mishri	714	2	0.3
		Chewing and smoking	320	19	5.9
		No habit	5647	–	–
	Darbhanga (Bihar), India	Betel quid with tobacco	1572	6	0.4
		Betel quid without tobacco	138	2	1.4
		Chewing and smoking	1485	6	0.4
		No habit	3719	–	–
	Singhbhum (Bihar), India	Betel quid with tobacco	1293	5	0.4
		Betel quid without tobacco	41	–	–
		Gudakhu	832	–	–
		Chewing and smoking	730	2	0.3
		No habit	4454	1	0.02

227

Table 48 (contd)

Reference	Location	Chewing habit	Size of sample	Prevalence	
				No.	%
Smith *et al.* (1975)	Ahmedabad (Gujarat), India (mainly textile-mill workers)	Tobacco chewing	1515	193	12.7
		Smoking and tobacco chewing	2319	300	12.9
		Betel quid/areca nut without tobacco	2687	144	5.4
		Smoking and betel quid	12 907	2264	17.5
		No habit	8710	112	1.3
Lin *et al.* (1983) (cited in Pindborg *et al.*, 1984a)	Hainan Island, China	Betel quid	954	–	2.5

Table 49. Age-adjusted prevalence of leukoplakia in India by number of quids chewed per day

Gender	1–10 quids per day			> 10 quids per day		
	No. in study	No. of leukoplakias	Age-adjusted prevalence/1000	No. in study	No. of leukoplakias	Age-adjusted prevalence/1000
Men	1059	34	26.6	195	12	49.1
Women	3099	35	8.4	261	5	14.6

From Gupta (1984)

(Hashibe *et al.*, 2000b). An association was observed between chewing betel quid with tobacco and the risk for erythroplakia, after adjustment for age, sex, education, body mass index, pack–years of smoking and years of alcohol drinking (Table 50). [The majority of chewers in this population chewed betel quid with tobacco.] An increase in the risk for erythroplakia was observed with an increase in the frequency and duration of betel-quid chewing, as well as for swallowing the juice and keeping the quid in mouth overnight. [Cases of erythroplakia were clinically diagnosed by dentists and oncologists without histopathological exclusion of other possible oral erythematous lesions. This may contribute to non-specific oral lesions being included in this clinical category.]

(*b*) *Taiwan, China*

Three recent studies addressed the association between chewing betel quid and the occurrence of oral leukoplakia. The details of design, method and results are summarized in Table 51.

Table 50. Epidemiological studies of the association between chewing betel quid and oral precancerous lesions in India

Reference, place	Methods	Precancerous lesion	Exposure measurement	Odds ratio (95% CI)	Comments
Hashibe *et al.* (2000a) Kerala	Cross-sectional study within large intervention study on oral cancer screening. Case–control design with 927 cases (411 women, 516 men) and 47 773 controls (29 876 women, 17 897 men) from intervention cohort	Oral leukoplakia	Non-chewers	1.0	Adjusted for age, sex, education, body mass index, smoking and drinking
			Ever chewers	*Men + women* 7.0 (5.9–8.3)	
				Women 37.7 (24.2–58.7)	
				Men 3.4 (2.8–4.1)	
			Current chewers	9.4 (8.0–11.2)	
			Former chewers	3.9 (2.8–5.6)	
			Occasional chewers	2.4 (1.7–3.3)	
			Swallowed chewed tobacco fluid		
			No	7.5 (6.4–8.8)	
			Yes	13.3 (9.0–16.9)	
			Kept quid in mouth overnight		
			No	7.6 (6.5–8.9)	
			Yes	13.8 (9.3–20.3)	

Table 50 (contd)

Reference, place	Methods	Precancerous lesion	Exposure measurement	Odds ratio (95% CI)	Comments
Hashibe *et al.* (2000b) Kerala	Same study base as Hashibe *et al.* (2000a) 100 cases (49 women, 51 men) and 47 773 controls	Oral erythroplakia	Non-chewers	1.0	Adjusted for age, sex, education, body mass index, smoking and drinking
			Ever chewers	19.8 (9.8–40.0)	
			Current chewers	27.6 (10.8–70.4)	
			Former chewers	25.8 (12.6–52.8)	
			Occasional chewers	2.3 (0.5–10.9)	
			Frequency of chewing (times per day)		
			Continuous	1.04 (1.02–1.06)	
			1–10	28.6 (14.0–58.7)	
			11–20	49.8 (22.0–113.1)	
			> 20	130.8 (52.5–326.3)	
			p for trend	0.0001	
			Duration of chewing (years)		
			Continuous	1.01 (0.99–1.03)	
			1–20	29.3 (14.2–60.8)	
			21–40	53.3 (24.7–114.8)	
			> 40	52.8 (18.3–152.6)	
			p for trend	0.0001	
			Swallowed chewed tobacco fluid		Also adjusted for tobacco chewing (years and times per day)
			No	20.8 (9.8–44.4)	
			Yes	50.6 (17.9–143.4)	
			Kept quid in mouth overnight		
			No	21.2 (10.0–45.2)	
			Yes	36.3 (11.9–111.6)	

CI, confidence interval

Table 51. Epidemiological studies of the association between chewing betel quid and oral precancerous lesions and conditions in Taiwan, China

Reference, place, period	Characteristics of cases and controls	Precancerous lesion and condition	Exposure measurement	Odds ratio (95% CI)			Comments
Shiu *et al.* (2000), Taipei, 1988–98	Nested case–control study; 100 cases selected among cohort of 435 leukoplakia patients, and 100 hospital controls matched on age, gender and date of diagnosis, selected among 25 882 patients with periodontal disease	Leukoplakia	No habit	1.0			Multivariate analysis adjusted for the effects of the three factors on each other
			Former chewer	2.4 (0.3–16.8)			
			Current chewer	17.4 (1.9–156.3)			
			Former smoker	1.04 (0.2–4.6)			
			Current smoker	3.2 (1.06–9.8)			
			Former drinker	0.3 (0.03–2.6)			
			Current drinker	3.0 (0.3–33.5)			
			Level of habit				
			Chewing Low	9.06 (1.0–81.6)			
			High	22.5 (1.4–351.0)			
			Smoking Low	1.7 (0.5–6.3)			
			High	3.1 (0.9–10.3)			
Yang *et al.* (2001), Pingtung, 1997	Prevalence study including 312 participants (119 men, 193 women) out of a source population of 3623 in Mutan country (aboriginal community)	Oral submucous fibrosis (OSF) and oral leukoplakia (OL)	*Duration of chewing (years)*	**OSF**	**OL**	**OL or OSF**	[Relative risks calculated by the Working Group]
			0–10	1.0	1.0	1.0	
			11–20	1.8 (0.7–4.8)	1.9 (0.9–4.1)	1.7 (0.9–3.1)	
			21–30	2.4 (1.01–5.6)	1.9 (0.9–3.9)	1.9 (1.09–3.3)	
			≥ 31	2.4 (1.1–5.0)	2.03 (1.1–3.7)	2.09 (1.3–3.4)	
			No. of quids/day				
			1–10	1.0	1.0	1.0	
			11–20	1.2 (0.7–2.04)	1.03 (0.6–1.7)	1.2 (0.8–1.8)	
			≥ 21	1.3 (0.7–2.2)	1.5 (0.9–2.2)	1.5 (1.04–2.08)	
			Multivariate analysis				
			Areca/betel-quid chewing			8.2 (1.8–37.5)	Adjusted for each other, age and gender
			Smoking			1.05 (0.5–2.2)	
			Drinking			1.8 (0.9–3.7)	
			Smoking/drinking			1.4 (0.6–3.1)	

Table 51 (contd)

Reference, place, period	Characteristics of cases and controls	Precancerous lesion and condition	Exposure measurement	Odds ratio (95% CI)		Comments
				OL	**OSF**	
Lee *et al* (2003), Kaohsiung, 1994–95	125 histologically confirmed cases of OL (118 men, 7 women) and 94 cases of OSF (93 men, 1 woman); 876 population controls (844 men, 32 women) matched on age and sex	Oral leukoplakia (OL) and oral submucous fibrosis (OSF)	*Betel-quid chewing*			Adjusted for education and occupation
			Never chewed	1.0		
			Former chewer	7.1 (2.3–21.5)	12.1 (2.8–51.9)	
			Current chewer	22.3 (11.3–43.8)	40.7 (16.0–103.7)	
			Dose-response	4.6 (3.3–6.4)	6.2 (3.9–9.7)	
			Age started chewing (years)			
			≥ 26	20.6 (9.9–42.7)	32.3 (12.1–86.6)	
			< 26	19.5 (9.3–41.0)	39.4 (14.8–105.3)	
			Dose-response	4.3 (3.1–6.0)	5.8 (3.8–8.8)	
			Duration of chewing (years)			
			1–10	15.9 (7.1–35.6)	30.9 (11.3–84.7)	
			11–20	20.7 (8.9–48.2)	41.9 (14.1–124.9)	
			≥ 21	24.0 (10.8–53.4)	39.3 (11.7–131.7)	
			Dose-response	3.0 (2.3–3.9)	4.2 (3.0–6.1)	
			No. of quids chewed per day			
			1–10	16.6 (8.2–33.8)	31.4 (11.9–82.5)	
			11–20	21.0 (8.9–49.7)	37.4 (12.6–110.4)	
			≥ 21	38.5 (14.1–105.1)	53.5 (16.4–174.8)	
			Dose-response	3.8 (2.8–5.1)	4.1 (2.9–5.8)	
			Cumulative quid–years			
			1–10	12.0 (5.6–25.7)	26.5 (10.0–70.3)	
			11–20	23.7 (9.1–61.7)	47.0 (15.8–139.8)	
			≥ 21	31.4 (14.2–69.2)	51.4 (16.5–159.7)	
			Dose-response	3.1 (2.4–3.9)	4.1 (2.9–5.8)	
			Type of material			
			Lao-hwa	24.5 (11.8–50.7)	38.7 (14.7–101.9)	
			Betel quid	11.5 (4.2–32.0)	18.7 (5.3–66.1)	
			Mixed (betel quid + *lao-hwa*)	17.4 (7.6–39.8)	37.4 (13.1–107.2)	

Table 51 (contd)

Reference, place, period	Characteristics of cases and controls	Precancerous lesion and condition	Exposure measurement	Odds ratio (95% CI)		Comments
Lee *et al* (2003) (contd)			**Synergistic effects**	**OL**	**OSF**	Adjusted for education, occupation and alcohol drinking
			Betel chewing/smoking			
			No habit	1.0		
			Smoking only	2.4 (1.0–5.5)	2.3 (0.6–9.1)	
			Chewing only	10.0 (3.1–32.7)	39.3 (7.5–206.9)	
			Chewing + smoking	40.2 (16.3–99.2)	57.9 (16.0–209.6)	
			Synergy index	3.8 (1.4–10.5)	1.4 (0.4–4.7)	
			Betel chewing/alcohol drinking			Adjusted for education, occupation and cigarette smoking. Synergy index estimated by an additive interaction model
			No habit	1.0	1.0	
			Drinking only	1.0 (0.4–2.6)	0.7 (0.1–3.4)	
			Chewing only	15.6 (7.1–34.3)	26.5 (9.5–74.1)	
			Chewing + drinking	16.8 (7.2–39.5)	31.7 (10.1–99.3)	
			Synergy index	1.1 (0.6–2.1)	1.2 (0.6–2.5)	

CI, confidence interval

Shiu *et al.* (2000) used a retrospective leukoplakia cohort that included 435 hospital patients diagnosed according to WHO criteria between June 1988 and February 1998 to study the effects of betel chewing, smoking and drinking on the occurrence of leukoplakia and malignant transformation to oral cancer. To investigate the association between betel quid and risk for oral leukoplakia, a nested case–control study was conducted with 100 cases randomly selected from among the leukoplakia cohort and 100 controls selected from patients with periodontal disease in the same hospital and period as the cases, and matched by age, sex and date of diagnosis. Information on betel-quid chewing (without tobacco), tobacco smoking and alcohol drinking was collected from medical charts and telephone interviews. Duration and frequency of the three habits was also ascertained. Level of chewing (frequency × duration) was classified as high or low according to the distribution of median values. After adjusting for tobacco smoking and alcohol drinking using conditional logistic regression, a 17-fold significant risk was observed among current betel-quid chewers, whereas the risk for former chewers was only twofold and was non-significant. The risk for oral leukoplakia also increased with the level of intensity, suggesting a dose–response relationship between areca-nut chewing and oral leukoplakia.

A population-based survey, using 312 samples obtained by stratified random sampling with a 62.3% response rate, selected from 2059 residents composed mainly of one aboriginal tribe (Paiwan) in southern Taiwan, China, found the prevalences of oral submucous fibrosis and leukoplakia to be 17.6 and 24.4%, respectively (Yang *et al.*, 2001). The prevalence of chewing areca/betel quid was 69.5% and more women (78.7%) than men (60.6%) chewed. Dose–response relationships between duration and frequency of chewing betel quid and precancerous lesions and conditions were also demonstrated [see Table 51; relative risks calculated by the Working Group]. In a multiple logistic regression analysis, the adjusted odds ratio for chewing areca/betel quid was 8.2 (95% CI, 1.8–37.5) for either oral leukoplakia or oral submucous fibrosis.

Lee *et al.* (2003) designed a case–control study to elucidate the relationships of betel-quid chewing, tobacco and alcohol with oral leukoplakia and oral submucous fibrosis. Cases were selected during 1994–95 among patients of the Kaohsiung Hospital dentistry department and were histologically confirmed. Patients with both oral leukoplakia and oral submucous fibrosis were excluded. There were 125 cases of oral leukoplakia (118 men, seven women) and 94 cases of oral submucous fibrosis (93 men, one woman). Population controls were recruited randomly in the greater Kaohsiung area, and matched to cases by age and sex. A total of 876 controls (844 men, 32 women) participated in the study. All subjects were interviewed by research workers. The major finding was that betel quid conferred a significantly increased risk not only for oral leukoplakia (adjusted odds ratio for current chewers, 22.3; 95% CI, 11.3–43.8), but also for oral submucous fibrosis (adjusted odds ratio for current chewers, 40.7; 95% CI, 16.0–103.7). Chewers of *lao-hwa* quid had the highest risk for oral leukoplakia (adjusted odds ratio, 24.5; 95% CI, 11.8–50.7) and oral submucous fibrosis (adjusted odds ratio, 38.7; 95% CI, 14.7–101.9). Significant dose–response relationships were also demonstrated with respect to duration and frequency of betel-quid chewing. Using an additive interaction model, the synergistic effects in terms of the interaction between betel quid chewing and cigarette smoking were statistically significant for oral leukoplakia but not for oral submucous fibrosis. No synergistic effect between betel quid chewing and drinking was found for oral leukoplakia or oral submucous fibrosis. The proportion of betel-quid chewing contributing to precancerous lesions and conditions in the underlying population (population attributable proportion) was quantified as 73.2% for oral leukoplakia and 85.4% for oral submucous fibrosis.

(c) South-East Asia

(i) Cambodia

Among 953 Cambodian women, of whom 311 (32.6%) chewed betel quid [with or without tobacco not specified], oral leukoplakia was recorded in six (1.9%) (Ikeda *et al.*, 1995).

In a study of 102 rural Cambodian women who chewed betel quid with tobacco, three (2.9%) showed homogeneous leukoplakia (Reichart *et al.*, 1996). In another study in Cambodia that included 48 women who chewed betel quid with tobacco, four (8.3%) had oral leukoplakia (Reichart *et al.*, 2002).

(ii) Thailand

In a field study, Reichart *et al.* (1987) investigated oral mucosal lesions in relation to smoking and chewing habits including betel quid with tobacco in northern Thai tribes. Among betel-quid chewers, oral leukoplakia was recorded in 1.5% of Lahu men, 2.3% of Karen men, 2.6% of Karen women and 3.1% of Lisu men.

(d) Migrants

Pearson (1994) reported areca-nut habits of Bangladeshi adults in London, United Kingdom, in a sample of 158 individuals attending general practices. Seventy-eight per cent chewed *paan* with or without tobacco, and the most common lesion was leukoplakia (22%). In a subsequent study on *paan* chewing and smoking habits among the same subjects, the prevalence of leukoplakia had increased to 24.8% (Pearson *et al.*, 2001).

2.2.4 Oral submucous fibrosis

(a) India and Pakistan

In a survey of over 10 000 villagers in five areas of India, Mehta *et al.* (1971) found submucous fibrosis in people with various chewing and smoking habits. The prevalences are shown in Table 52.

In a 2-year follow-up study of 43 654 industrial workers in Gujarat, India (1969–71), Bhargava *et al.* (1975) found seven new cases of submucous fibrosis among 2105 (0.3%) people who chewed betel quid with areca nut, six new cases among 9506 (< 0.1%) who both chewed and smoked, three new cases among 1161 (0.3%) who chewed tobacco alone and 10 new cases among 7065 (0.1%) with no such habit.

235

Table 52. Prevalence of submucous fibrosis and lichen planus in five areas of India

Area	Chewing habit	No.	Prevalence of submucous fibrosis		Prevalence of lichen planus	
			No.	%	No.	%
Ernakulam (Kerala)	Betel quid with tobacco	2661	29	1.1	50	1.9
	Betel quid without tobacco	38	–	–	–	–
	Chewing and smoking	1106	5	0.4	41	3.7
	No habit	4210	2	0.05	3	0.07
Srikakulam (Andhra Pradesh)	Betel quid with tobacco	281	1	0.4	1	0.4
	Betel quid without tobacco	56	–	–	–	–
	Chewing and smoking	803	–	–	7	0.9
	No habit	2620	–	–	1	0.04
Bhavnagar (Gujarat)	Betel quid with tobacco	299	–	–	1	0.3
	Betel quid without tobacco	157	–	–	–	–
	Mishri	714	–	–	–	–
	Chewing and smoking	320	–	–	1	0.3
	No habit	5647	16	0.3	–	–
Darbhanga (Bihar)	Betel quid with tobacco	1572	–	–	5	0.3
	Betel quid without tobacco	138	2	1.4	–	–
	Chewing and smoking	1485	3	0.2	3	0.2
	No habit	3719	–	–	–	–
Singhbhum (Bihar)	Betel quid with tobacco	1293	–	–	4	0.3
	Betel quid without tobacco	41	–	–	–	–
	Gudakhu	832	–	–	–	–
	Chewing and smoking	730	–	–	–	–
	No habit	4454	–	–	2	0.04

From Mehta *et al.* (1971)

In the 10-year follow-up survey of Gupta *et al.* (1980), the age-adjusted incidences per 100 000 for submucous fibrosis were 7.0 for men and 17.0 for women in Ernakulam. The annual incidences per 100 000 were 2.6 for men and 8.5 for women in Bhavnagar; of the four new cases seen in 38 818 persons, two had no tobacco habit, one chewed and one smoked. In Ernakulam, all 11 new cases (out of 39 828 person–years) occurred among chewers of tobacco or of tobacco and betel quid or those with a mixed habit (including smoking).

Murti *et al.* (1990) calculated the incidence of oral submucous fibrosis from a 10-year prospective intervention study of 12 212 individuals in an intervention cohort and 10 287 in a non-intervention cohort. The intervention consisted in a health education programme

236

on cessation of tobacco habits (smoking and chewing) and betel-quid chewing. The intervention cohort consisted of tobacco chewers or smokers selected from a baseline survey undertaken in 1977–78 on 48 000 individuals from 23 villages. Controls were provided by an earlier random sample in Ernakulam district, followed up from 1966–67 but without health education. Two new cases occurred among men and nine among women in the intervention group and three new cases in men and eight in women among the non-intervention group. The annual incidence was 8.0 per 100 000 among men and 29.0 per 100 000 among women in the intervention cohort and 21.3 per 100 000 among men and 45.7 per 100 000 among women in the non-intervention cohort. However, there was only a small number of oral submucous fibrosis patients and the decrease in incidence in the intervention group was not statistically significant.

A case–control study was conducted at a dental clinic in Bhavnagar, Gujarat, and comprised 60 oral submucous fibrosis patients and an equal number of hospital controls matched on age, sex, religion and socioeconomic status. Relative risks were 78 for chewing areca nut without tobacco ($p < 0.01$), 106 for chewing *mawa* ($p < 0.01$) and 30 for chewing areca nut without *mawa* but with tobacco ($p < 0.01$) were observed. The relative risk increased with increasing frequency and duration of chewing (Sinor *et al.*, 1990).

Another case–control study was conducted in Karachi in 1989–90 comprising 157 histologically confirmed cases and 157 hospital-based controls matched on age, sex and ethnicity. Odds ratios for developing oral submucous fibrosis were similar in men and women, although women were predominant (ratio of men:women, 1:2.3). The risk associated with chewing areca nut alone was 154 (95% CI, 34–693) and that associated with chewing areca nut with tobacco was 64 (95% CI, 15–274). The risk increased with frequency of quids chewed, up to 10 per day, and duration of the habit, up to 10 years (Maher *et al.*, 1994).

Babu *et al.* (1996) reported on a clinico-pathological study of oral submucous fibrosis in Hyderabad. The study included 90 subjects consisting of 50 chewers of betel quid with tobacco and *pan masala* (alone or in combination) who had oral submucous fibrosis (cases) and 40 non-chewers without oral submucous fibrosis (randomly selected hospital controls). Smokers were excluded from the study. *Pan masala/gutka* chewers developed oral submucous fibrosis after 2.7 ± 0.6 years of use, whereas betel-quid chewers developed oral submucous fibrosis after 8.6 ± 2.3 years of use.

Gupta *et al.* (1998) found the highest prevalence of oral submucous fibrosis among users of *mawa* (10.9%) and the lowest among those who did not use areca nut, in a house-to-house survey conducted in 20 villages in Bhavnagar, Gujarat, that included 11 262 men and 10 590 women. This study also showed that the highest relative risk (age-adjusted) for developing oral submucous fibrosis was among users of *mawa* (75.6) followed by users of any kind of areca nut (60.6), including chewing *mawa*, smoking tobacco and chewing tobacco, compared with non-users of areca nut (Table 53).

Shah and Sharma (1998) reported a case–control study conducted in New Dehli on 236 cases of oral submucous fibrosis (188 men, 88 women) and 221 hospital controls (120 men, 101 women) without oral submucous fibrosis matched on age, sex and socio-

Table 53. Survey of areca-nut and tobacco use and oral submucous fibrosis, Gujarat, India

Areca nut habits	No. of users	No. of cases	Prevalence (%) (age-adjusted)	Relative risk (age-adjusted)
No areca nut use	3 232	4	0.12 (0.16)	1.0
Areca nut use	11 786	160	9.0 (9.7)	60.6
Mawa	1 326	144	10.9 (12.1)	75.6
With tobacco	136	2	1.5 (1.5)	9.4
With smoking	324	14	4.3 (5.0)	31.3
Total	15 018	164	3.2 (3.3)	–

From Gupta *et al.* (1998)

economic status. No case was found who did not practise any form of areca-nut chewing, whereas in the control group, 165 subjects (74.7%) had no chewing habit. Among cases, 34.7% chewed betel quid without tobacco, 46.2% chewed betel quid with tobacco and none of them smoked tobacco only. Among controls, 7.3% chewed betel quid without tobacco, 4.5% chewed betel quid with tobacco and 11% were tobacco smokers only. Oral submucous fibrotic changes occurred earlier in people who chewed *pan masala* (41.4 months) compared with those who chewed betel quid (77.9 months) [with or without tobacco not specified].

Hazare *et al.* (1998) reported the results of a case–control study conducted for 1 year (June 1996–May 1997) on 200 cases of oral submucous fibrosis (168 men, 32 women) and 197 age-matched hospital controls (122 men, 75 women) in Nagpur, Maharashtra, India. A statistically significant increase in risk was observed with an increase in the frequency of areca-nut use in the form of betel quid that almost always contained tobacco (Table 54).

Table 54. Dose–response relationship between frequency of areca-nut use and oral submucous fibrosis in India

Frequency/day	Cases	Controls	Relative risk
Non-users	5	110	1.0
1	11	24	10.1
2–3	65	42	34.0
4–5	61	16	83.9
> 5	58	5	255.2
Total	200	197	p for trend < 0.01

From Hazare *et al.* (1998)

238

fibrosis was found among those who did not chew betel quid. The development of oral submucous fibrosis was related to the duration and frequency of chewing (Tang *et al.*, 1997).

On Hainan Island, no oral submucous fibrosis was found among 100 persons (44 men, 56 women) examined within a pilot survey of oral mucosa in betel-nut chewers [with or without tobacco not specified]. However, two cases were suggestive of an early-stage precancerous lesion resembling leukoplakia (Pindborg *et al.*, 1984a).

(*c*) *Taiwan, China*

Two studies reporting on oral submucous fibrosis in Taiwan have been reported in Section 2.2.3 (Table 51).

(*d*) *South-East Asia*

(i) *Cambodia*

In a prevalence study of oral mucosal lesions, submucous fibrosis was diagnosed in two of 1319 individuals (0.2%), one man without any distinctive oral habit and one woman who reported betel chewing and tobacco smoking (Ikeda *et al.*, 1995).

(ii) *Thailand*

Reichart *et al.* (1984) observed one case of submucous fibrosis among the Lisu hill tribe ($n = 139$) who chewed betel quid with tobacco.

(*e*) *Migrants*

(i) *South Africa*

In a survey of 1000 consecutive, unselected Indians from the municipal areas of Johannesburg and Pretoria, all five cases of oral submucous fibrosis detected were in women who chewed areca nut, giving an incidence of 0.5% (Shear *et al.*, 1967). In a further series, five cases of oral submucous fibrosis detected in hospitals by the same authors were also areca-nut chewers. The most frequent habit was chewing betel nut with tobacco in the form of *pan*.

In a stratified survey of 2058 randomly selected Indians in the Durban area in 1981–83, 5% were areca-nut chewers [with or without tobacco not specified]; 71 cases (70 women, one man) of oral submucous fibrosis were detected, all of whom chewed areca nut. Of the cases, 46% had established fibrous bands and 54% were early cases (Seedat & van Wyck, 1988). [The Working Group noted that the criteria for detection of oral submucous fibrosis included very early forms.]

(ii) *United Kingdom*

Canniff *et al.* (1986) described a large case series of 44 Asian patients (eight men, 36 women) treated at a London hospital (22 Indians, 17 Indians who arrived via East Africa and five non-residents including one Pakistani) for oral submucous fibrosis. All had chewed areca nut either alone or with additives of *pan*. The nature of their chewing habits is shown in Table 56. The case series predominantly consisted of chewers of areca nut only (77%); tobacco was used by only a few, although some added other substances to the nut.

Table 56. Details of chewing habits in a case series of oral submucous fibrosis patients among migrants, United Kingdom

Material chewed	No. of patients (%)
Roasted areca nut	28 (64)
Raw areca nut	6 (14)
Roasted nut/slaked lime/betel leaf	4 (9)
Roasted nut/slaked lime/betel leaf/tobacco	2 (5)
Roasted nut/slaked lime/betel leaf/aniseed	1 (2)
Pan parag[a]	3 (6)

From Canniff *et al.* (1986)

[a] Preparation consisting in small pieces of roasted areca nut dusted with a powder of slaked lime and undisclosed flavouring agents

McGurk and Craig (1984) described three cases (two Indians and one Pakistani) of oral submucous fibrosis, two of whom had concomitant oral carcinoma, but whose chewing habits were not accurately recorded. Several other single case studies of oral submucous fibrosis have been reported in Asian migrants to Australia (Oliver & Radden, 1992), Canada (Hayes, 1985) and Great Britain (Zafarulla, 1985; Shah *et al.*, 2001). Some of these cases were in young children who had never been exposed to tobacco or alcohol before and had consumption of areca nut only as a sole risk factor.

2.2.5 *Oral lichen planus*

(*a*) *India*

The prevalence of lichen planus in five areas of India (Mehta *et al.*, 1971) is given in Table 52.

In a house-to-house survey in Ernakulam (Kerala) of 7639 villagers, oral lichen planus was found in 1.5% of men and 1.6% of women. The prevalence in various habit groups is given in Table 57. The highest prevalence was found in chewers of betel quid with tobacco (Pindborg *et al.*, 1972).

In the 10-year follow-up survey of Gupta *et al.* (1997), age-adjusted incidences of lichen planus per 100 000 per year in Ernakulam were 251 for men with mixed habits (including smoking), 329 for men who chewed tobacco or betel quid plus tobacco, 146 for women with mixed habits and 385 for women who chewed betel quid with tobacco.

Table 57. Prevalence of lichen planus in subjects with various habits in Kerala, India

Habit	No. in study	Lichen planus	
		No.	%
Chewing			
Tobacco and lime	212	3	1.4
Betel quid without tobacco	24	–	–
Betel quid with tobacco	1925	61	3.2
Smoking			
Bidi	1334	10	0.7
Other	386	3	0.8
Chewing and smoking	845	31	3.7
None	2911	10	0.3

From Pindborg *et al.* (1972)

(*b*) *South-East Asia*

Among 953 Cambodian women studied for oral mucosal lesions, 365 chewed betel quid only or in combination with smoking. Oral lichen planus was recorded in 20 of these women (5.5%); 19 of the 20 women used betel quid with tobacco (Ikeda *et al.*, 1995).

2.2.6 *Multiple and mixed lesions*

A case–control design was applied to analyse data collected from a screening programme conducted in Sri Lanka. Three hundred and fifty-nine precancer cases (316 men, 43 women, with leukoplakia and submucous fibrosis), age- and sex-matched to population controls from the same villages as the cases, were included in the study. Controls were disease-free following oral examination. The relative risk for chewing betel quid without tobacco among nonsmokers was 5.3 in men and 5.0 in women; both were statistically non-significant. The relative risk for chewing betel quid with tobacco among nonsmoking men was 15.0 ($p < 0.005$) and that among nonsmoking women was 33.0 ($p < 0.001$) (Warnakulasuriya, 1990). Chewers were at higher risk than smokers.

An additional 115 subjects with multiple premalignant oral lesions and conditions (defined as having one or more of the following: oral leukoplakia, erythroplakia, oral submucous fibrosis; 73 women, 42 men) from the Kerala, India, study population with the 47 773 controls described in Section 2.2.3 (Hashibe *et al.*, 2000a,b) were included in another case–control study (Thomas *et al.*, 2003). The odds ratios were 52.8 (95% CI, 22.4–124.4) for chewing betel quid with tobacco and 22.2 (95% CI, 6.6–74.0) for chewing betel quid without tobacco, after adjustment for age, sex, education, body mass index, pack–years of smoking, years of alcohol drinking and fruit and vegetable intake. Dose–response trends were observed for the frequency (times per day; p-value for trend < 0.0001) and duration (years; p-value for trend < 0.0001) of chewing betel quid (with and without tobacco) and the risk for multiple premalignant oral lesions and conditions.

2.2.7 *Malignant transformation*

(*a*) *India and Pakistan*

In many of the earlier histological studies of oral cancer, e.g. Paymaster (1956), leukoplakia was seen concomitantly with the cancer.

In the 10-year follow-up study of Mumbai policemen (Mehta *et al.*, 1961, 1969, 1972a), one oral cancer developed among 117 cases of leukoplakia in an individual who chewed betel quid (presumably with tobacco) and who also smoked bidis.

In the follow-up of Bhargava *et al.* (1975) in Gujarat, India, 22 histologically confirmed cases of oral cancer were seen among 43 654 persons re-examined after 2 years. The authors stated that seven (0.13%) of the cases had developed from leukoplakia.

Of the 4762 persons with leukoplakia who were re-examined after 2 years by Silverman *et al.* (1976), six had developed oral carcinoma, giving an annual incidence of malignant transformation of leukoplakia of 63 per 100 000. One man chewed tobacco plus betel quid only, two both chewed (one tobacco, the other tobacco plus betel quid) and smoked bidis, two smoked bidis only and the one woman took nasal snuff only.

In a 10-year follow-up in Ernakulam (Kerala), South India, of 410 leukoplakia patients, all of whom were chewers of betel quid with tobacco, nine (six men, three women) developed oral carcinoma (Gupta *et al.*, 1980). The crude annual rate of malignant transformation was 3.9 per 1000 in men and 6.0 per 1000 in women. Four other oral cancers were observed: two in patients who had been diagnosed with early leukoplakic changes (preleukoplakia), one in a patient with submucous fibrosis and the other in a case of lichen planus. No oral cancer was seen in subjects who had had normal mucosa at the previous examination.

In an 8-year follow-up of 12 212 tobacco users that started in 1977, the relative risk for developing oral cancer from nodular leukoplakia was 3243 (6 new cases of oral cancer among 13 cases), that from homogeneous leukoplakia was 25.6 (three new cases of oral cancer among 489 cases) and that from lichen planus was 15.8 (one among 344 cases). The relative risk for malignant transformation among individuals with oral submucous fibrosis was 397, based on three new cases of oral cancer among 25 cases of oral submucous fibrosis versus four new cases of oral cancer among 10 145 persons with no precancerous condition (Gupta *et al.*, 1989). The risk for malignant transformation was significant for all lesions except lichen planus.

Gupta *et al.* (1980) also reported malignant transformation in one of 44 cases of oral submucous fibrosis in Ernakulam (Kerala); none were found among five cases in Srikakulam.

A follow-up study over 4–15 years of 66 patients with submucous fibrosis was carried out in Ernakulam. Malignant transformation was observed in three patients 3, 4 and 7 years after initial examination, giving an overall transformation rate of 4.5% (Pindborg *et al.*, 1984b).

In a population sample of 27 600 individuals in Ernakulam district, Kerala, 66 had oral submucous fibrosis and were followed up for 17 years. Five developed oral cancer, giving a malignant transformation rate of 7.6% (Murti *et al.*, 1985).

A study conducted in Karachi, Pakistan (1996–98), on 79 cases of oral squamous-cell carcinoma and 149 hospital controls showed that the risk for developing oral cancer was 19 times higher (95% CI, 4.2–87.7) among cases of oral submucous fibrosis than among subjects with no precancerous condition (Merchant *et al.*, 2000).

Gupta *et al.* (1980) observed one oral cancer case among 332 individuals seen with lichen planus.

(*b*) *Taiwan, China*

In the study by Shiu *et al.* (2000), 60 cases of oral and pharyngeal cancer (including lip, tongue, gum, mouth floor, buccal palate, oropharynx and hypopharynx) were ascertained by linking a retrospective leukoplakia cohort consisting of 435 patients recruited from hospital between 1988 and 1998 to a population cancer registry. The risk for malignant transformation increased with time, particularly for areca-nut chewers. Using a Weibull survival model, the adjusted hazard ratio for chewing areca nut without tobacco was 4.6 (95% CI, 1.3–16.9) after adjusting for age and sex.

(*c*) *Migrants*

McGurk and Craig (1984) reported malignant transformation of submucous fibrosis in two Indian women living in the United Kingdom. Only one of the women had chewed areca nut and both had latent iron deficiency.

2.3 Other upper aerodigestive cancer

2.3.1 *India*

The study by Hirayama (1966) described in Section 2.1.1(*c*) reported a statistically significant six-fold increase in risk for oropharyngeal cancer among nonsmokers chewing betel quid with tobacco.

A comprehensive evaluation of cancer risk among betel-quid chewers and smokers was reported by Jussawalla and Deshpande (1971) in a case–control study in Mumbai. They selected 2005 histologically confirmed cancer patients with cancers of the oral cavity, pharynx, larynx and oesophagus. Equal numbers of controls were selected from the population using electoral roll and were matched to cases for age, sex and religion. Information was collected by interviewing patients and controls. Table 58 shows the assessment of risk for cancer at each site in chewers and non-chewers. The relative risks were highly significant for all studied cancers combined, oral cavity as a whole, and for cancers of the tongue, alveolus, buccal mucosa, hard palate, tonsils, oropharynx, hypopharynx, larynx

Table 58. Relative risks for oral cancer and other cancers of the upper aerodigestive tract among betel-quid chewers, assuming the risk among non-chewers to be unity

Group	Habit		Relative risk
	None (no.)	Chewing (no.)	
Controls	1340	665	
Cancer patients	853	1152	2.7***
Oral cavity	129	282	4.4***
Base of tongue	175	187	2.2***
Soft palate	35	18	1.0 NS
Tonsils	99	128	2.6***
Lip	8	6	1.5 NS
Anterior two-thirds of tongue	36	54	3.0***
Floor of mouth	10	4	0.8 NS
Alveolus	26	44	3.4***
Buccal mucosa	42	160	7.7***
Hard palate	7	14	4.0**
Oropharynx	309	333	2.2***
Nasopharynx	10	7	1.4 NS
Hypopharynx	21	49	4.7***
Larynx	246	314	2.6***
Oesophagus	138	167	2.4***

From Jussawalla & Deshpande (1971)
**, $p < 0.01$; ***, $p < 0.001$; NS, $p > 0.05$

and oesophagus. Table 59 shows the relative risks for cancers at different sites for chewers only, chewers and smokers and smokers only. The relative risks were highly significant for all cancers, except cancer of the nasopharynx, in all habit groups.

A summary of the case–control studies of other upper aerodigestive cancers in India published since 1984 is given in Table 60.

Sankaranarayanan *et al.* (1991) reported a case–control study of cancer of the oesophagus conducted in Kerala, India, in 1983–84, that included 267 cases (207 men, 60 women) and 895 controls comprised of 271 non-cancer cases from the cancer center and 624 patients diagnosed with acute respiratory, gastrointestinal or genitourinary infection. Sixty-seven per cent of cases were histologically confirmed (33% by radiology only). Only four men (controls) and six women (three cases, three controls) chewed betel quid without tobacco. Among men, an elevated risk was suggested for chewing betel quid with tobacco for the age group 31–40 years (odds ratio, 1.2; 95% CI, 0.6–2.1) and a significant risk for chewing betel quid with tobacco was observed for subjects over 40 years of age (odds ratio, 2.0; 95% CI, 1.03–3.9). Among women, risks were elevated for chewing betel quid with tobacco for the age group 30–40 years (odds ratio, 1.4; 95% CI, 0.5–4.3) and

Table 59. Relative risks for oral and other cancers by habit, assuming the risk among persons with no habit to be unity

Group	No habit (no.)	Chewing only (no.)	Relative risk	Chewing and smoking (no.)	Relative risk	Smoking only (no.)	Relative risk
Controls	925	521		144		415	
Cancer patients	243	557	4.1***	595	15.7***	610	5.6***
Oral cavity	57	192	6.0***	90	10.1***	72	2.8***
Oropharynx	49	91	3.3***	242	31.7***	260	11.8***
Nasopharynx	4	4	1.8 NS	3	4.8 NS	6	3.3 NS
Hypopharynx	8	28	6.2***	21	16.9***	13	3.6**
Larynx	55	142	4.6***	172	20.1***	191	7.7***
Oesophagus	70	100	2.5***	67	6.2***	68	2.2***

From Jussawalla & Deshpande (1971)
**, $p < 0.01$; ***, $p < 0.001$; NS, $p > 0.05$

for subjects over 40 years of age (odds ratio, 2.2; 95% CI, 0.6–8.1). [The Working Group noted that, among men, risk estimates were potentially confounded by bidi smoking.]

From 1997 to 1998, a hospital-based case–control study on oesophageal cancer in Assam, India, included 502 cases (358 men, 144 women) and 994 controls (706 men, 288 women) who were attendants to cancer patients. Controls were matched on sex and age. The risk for chewing betel quid (with or without tobacco), adjusted for smoking and alcohol consumption, was 2.6 (95% CI, 1.3–7.4) for men and 1.9 (95% CI, 0.02–7.8) for women. The risk increased with increasing frequency of chewing betel quid with or without tobacco and increased substantially when the chewing habit had lasted 20 years or more. A dose–response relationship was also observed for age at starting the habit, with a higher risk for starting at a younger age (Phukan *et al.*, 2001).

Znaor *et ai.* (2003) reported a study conducted in men in two centres in South India, Chennai and Trivandrum, in 1993–99 that included 636 cases of pharyngeal cancer (except nasopharynx) and 566 cases of oesophageal cancer, who were compared with 1711 cancer controls and 1927 healthy hospital visitor controls. For oesophageal cancer, significantly elevated risks were found for chewing betel quid without tobacco (odds ratio,1.6; 95% CI, 1.1–2.5) and for chewing betel quid with tobacco (odds ratio, 2.1; 95% CI, 1.6–2.6). For pharyngeal cancer, the odds ratios (adjusted for age, educational level, smoking , alcohol consumption and centre) were 1.4 (95% CI, 0.9–2.1) for chewing betel quid without tobacco and 1.8 (95% CI, 1.4–2.3) for chewing betel quid with tobacco. Significant dose–response relationships were observed for duration of chewing with or without tobacco, number of quids consumed per day and cumulative years of chewing for both oesophageal and pharyngeal cancers (Table 61). A non-significant substantial decrease in risk was seen 10 years after quitting the chewing habit. Likelihood ratio tests

Table 60. Case–control studies of upper aerodigestive cancers other than oral cancers and risk associated with chewing betel quid in India (1985–2003)

Location (years)	Cancer site	ICD code	No of cases	Habit	No. of controls	Habit	Relative risk (95% CI)	Reference	Comments
Kerala, South India (1983–84)	Oesophagus	150	207 (M) 60 (F)	BQ + T, 35.4% BQ + T, 45.5%	546 (M) 349 (F)	BQ + T, 33.5% BQ + T, 51.3%	BQ + T, 1.09 (0.8–1.5) BQ + T, 0.8 (0.4–1.4)	Sankaranarayanan *et al.* (1991)	Crude relative risk
Assam (1997–98)	Oesophagus	150	358 (M) 144 (F)	Q, 92% Q, 76%	706 (M) 288 (F)	Q, 65% Q, 47%	Q, 3.4 (1.2–9.5) Q, 3.5 (1.4–10.3)	Phukan *et al.* (2001)	Crude relative risk
Chennai & Trivandrum (1993–99), South India	Pharynx Oropharynx Hypopharynx Pharynx, unspecified	 146 148 149	636 (M)	BQ, 5% BQ + T, 28% S, 86%	3638 (M)	BQ, 5% BQ + T, 10% S, 51%	BQ, 1.4 (0.9–2.1) BQ + T, 1.8 (1.4–2.3)	Znaor *et al.* (2003)	Adjusted for age, center, education, drinking and smoking
	Oesophagus	150	566 (M)	BQ, 5% BQ + T, 25% S, 72%			BQ, 1.6 (1.1–2.5) BQ + T, 2.1 (1.6–2.6)		
Bhopal, Central India (1986–92)	Oropharynx	146	247 (M)	BQ, 1.6% BQ + T, 42.1% S + T, 32.8%	260 (M)	BQ, 4.6% BQ + T, 41.5% S + T, 16.5%	BQ + T, 1.2 (0.8–1.8)	Dikshit & Kanhere (2000)	Adjusted for age and smoking
Kerala, South India (1983–84)	Larynx	161	171 (M)	BQ + T, 29%	541 (M)	BQ + T, 33%	BQ + T, 0.8 (0.6–1.2)	Sankaranarayanan *et al.* (1990b)	Crude relative risk

CI, confidence interval; M, men; F, women; BQ, betel quid without tobacco; T, tobacco S, smoking only; Q, betel quid with or without tobacco

Table 61. Odds ratio for pharyngeal and oesophageal cancer by duration, level and cumulative chewing, South India

Site	Pharynx				Oesophagus		
	Controls	Cases	Odds ratio [a]	95% CI	Cases	Odds ratio[a]	95% CI
Never chewed	3079	424	1.0	–	371	1.0	–
Duration of chewing (years)							
0–19	286	67	1.2	0.9–1.7	71	1.8	1.3–2.5
20–39	209	101	1.97	1.5–2.7	84	2.05	1.5–2.8
≥ 40	64	44	2.6	1.6–4.2	40	2.3	1.4–3.6
p for trend				< 0.001			< 0.001
Average daily amount (no. of quids)							
1–3	343	101	1.2	0.9–1.6	81	1.2	0.9–1.6
4–5	135	55	1.9	1.3–2.8	51	2.2	1.5–3.2
> 5	800	56	4.2	2.7–6.6	63	6.1	4.0–9.1
p for trend				< 0.001			< 0.001
Cumulative exposure to chewing							
< 1000	158	101	1.4	0.97–1.9	69	0.9	0.7–1.3
> 1000	26	31	1.97	1.05–3.7	23	1.7	0.9–3.3
p for trend				= 0.03			= 0.029
Time since quitting chewing (years)							
Current chewers	460	171	1.0	–	160	1.0	–
2–4	41	15	0.8	0.4–1.7	12	0.5	0.2–1.1
5–9	20	10	1.2	0.5–3.0	8	0.9	0.4–2.3
10–14	19	6	0.5	0.2–1.3	8	0.6	0.2–1.6
≥ 15	19	10	0.6	0.2–1.4	7	0.4	0.2–1.1
p for trend				= 0.62			= 0.586

From Znaor *et al.* (2003)
[a] Adjusted for age, centre, level of education, alcohol consumption and smoking
CI, confidence interval

were statistically significant ($p < 0.05$) for (a) the combination of the three habits of chewing, smoking and drinking for oesophageal and pharyngeal cancers; (b) for chewing and drinking, and chewing and smoking, for oesophageal cancer and (c) for the interaction between drinking and smoking, and chewing and smoking, for pharyngeal cancer. Interaction was not tested separately for chewing betel quid without tobacco because only 33 oesophageal and 34 pharyngeal cancer cases had chewed betel quid without tobacco.

A case–control study conducted in 1986–92 on 247 cases of oropharyngeal cancer (all men) registered in the population-based Bhopal Cancer Registry and 260 population controls showed a non-significant risk for oropharyngeal cancer associated with chewing betel quid with tobacco. Those who chewed more than 10 quids with tobacco per day (odds ratio, 3.6; 95% CI, 1.7–7.4) and those who had chewed quid with tobacco for more than 30 years (odds ratio, 3.1; 95% CI, 1.6–5.7) had statistically significant risks (Dikshit & Kanhere, 2000).

A case–control study was conducted in Kerala in 1983–84 on 191 men with histologically confirmed laryngeal cancer and 549 hospital controls; after excluding occasional chewers, the number of cases and controls (hospital patients without cancer) were 171 and 541, respectively. The risk associated with chewing betel quid with tobacco was not increased (Sankaranarayanan *et al.*, 1990b).

2.3.2 *Taiwan, China*

One case–control study in Taiwan, China, in 1996–2000, included 104 cases of histologically confirmed oesophageal squamous-cell carcinoma (94 men, 10 women) and 277 age- and sex-matched controls (256 men, 21 women) without malignant disease from the same hospital. The results showed that subjects who chewed moderate amounts of betel quid without tobacco (lifetime consumption, 1–495 quid–years) had a 3.6-fold (95% CI, 1.3–10.1) risk and those who chewed greater amounts (lifetime consumption, ≥ 495 quid–years) had a 9.2-fold (95% CI, 1.8–46.7) risk for oesophageal cancer after controlling for cigarette smoking and alcohol consumption (Wu *et al.*, 2001).

2.4 Other cancers

The studies from India on cancers of the stomach, lung or cervix are summarized in Table 62.

2.4.1 *Stomach cancer*

A case–control study of stomach cancer conducted in Chennai, India, in 1988–90 included 388 incident cases of stomach cancer (287 men, 101 women; 75% histologically confirmed) and an equal number of cancer controls matched on age, sex, religion and native language, showed a non-significantly increased risk, when adjusted for income group, level of education and area of residence, for current chewing of betel quid with or without tobacco (relative risk, 1.4; 95% CI, 0.96–1.93). This risk disappeared when further adjustment was made for smoking, alcohol drinking and dietary items (relative risk, 0.8; 95% CI, 0.5–1.4) (Gajalakshmi & Shanta, 1996).

2.4.2 *Lung cancer*

A case–control study conducted on 163 male lung cancer cases registered at the population-based Bhopal (India) Cancer Registry and 260 population controls showed no association between chewing betel quid with tobacco and lung cancer (Dikshit & Kanhere, 2000).

Table 62. Case–control studies of chewing betel quid and cancers of the stomach, lung and cervix, India

Location (years)	Cancer site	No. of cases	Habit	No. of controls	Habit	Relative risk (95% CI)	Reference	Comments
Chennai, South India (1988–90)	Stomach	287 (M) 101 (F)	Q, 38.9%	287 (M) 101 (F)	Q, 33.7%	Q, 1.3 (0.95–1.8) BQ, 1.3 (0.8–2.1) BQ + T, 1.3 (0.9–1.98)	Gajalakshmi & Shanta (1996)	Adjusted for income, education and residence
Bhopal, Central India (1986–92)	Lung	163	BQ, 2.5% BQ + T, 31.9% S + T, 27.6%	260 (M)	BQ, 4.6% BQ + T, 41.5% S + T, 16.5%	BQ + T, 0.7 (0.4–1.2)	Dikshit & Kanhere (2000)	Adjusted for age and smoking
Chennai and Trivandrum, South India (1993–99)	Lung	778 (M)	NS	3430 (M)	NG	Q, 0.8 (0.6–1.02)	Gajalakshmi *et al.* (2003)	Adjusted for age, education, centre and smoking
Chennai, South India (1998–99)	Cervix	205 (F)	BQ, 4.9% BQ + T, 13.7%	213 (F)	BQ, 2.8% BQ + T, 4.2%	BQ, 2.6 (0.7–9.8) BQ + T, 2.1 (0.8–5.9)	Rajkumar *et al.* (2003c)	

CI, confidence interval; M, men; F, women; Q, betel quid with or without tobacco; BQ, betel quid without tobacco; T, tobacco; S, smoking only; NG, not given

In a case–control study conducted in men in Chennai and Trivandrum, India, in 1993–99 comprising 778 lung cancer patients, 1711 cancer (non-tobacco related) controls and 1927 healthy controls, no significant association was found between chewing betel quid with or without tobacco and risk for lung cancer, nor was there evidence for increasing trend with prolonged duration of chewing (Gajalakshmi *et al.*, 2003).

2.4.3 *Cervical cancer*

A case–control study of 205 cases of invasive cervical cancer and 213 age-matched hospital controls was conducted in Chennai, India, in 1998–99. A twofold non-significantly elevated risk was noted for chewing betel quid with and without tobacco. A statistically significant association was seen among those who chewed more than five quids with or without tobacco per day and the dose–response relationship was also significant ($p = 0.02$). [The Working Group noted that the number of subjects analysed for the dose–response relationship was small.] (Table 63) (Rajkumar *et al.*, 2003).

Table 63. Dose–response relationship: cervical cancer study in Chennai

Average daily amount (no. of quids)	Cases	Controls	Odds ratio[a]	95% CI
Never chewed	167	198	1.0	
< 5	16	9	1.4	0.5–4.1
≥ 5	22	6	4.0	1.2–13.3
Trend test, $p = 0.02$				

From Rajkumar *et al.* (2003)

[a] Adjusted for age, area of residence, education, occupation, marital status, age at first marriage, number of pregnancies and husband's extramarital affairs

2.4.4 *Liver cancer*

(*a*) *Taiwan, China*

An association was seen in one case report (Liu *et al.*, 2000) of a histologically confirmed hepatocellular carcinoma in a 54-year-old Taiwanese man who had chewed betel quid without tobacco for at least 32 years. He also had an oral squamous-cell carcinoma. He had smoked 1.5 packs of cigarettes daily and consumed alcohol occasionally and in moderate amounts; he was not infected by hepatitis viruses. High concentrations of safrole (a product of the inflorescence of *Piper betle*)-like DNA adducts were detected in oral and liver cells. [The specificity of the DNA adducts was questioned by the Working Group.]

In a prospective study in Taiwan, China, Sun *et al.* (2003) followed a total of 12 008 men aged 30–64 years with no history of hepatocellular carcinoma at baseline from 1990 to 2001. At baseline, information on betel-quid chewing was available for 11 989 subjects; of these, 1463 (12.2%) had a history of chewing. Among the 1463 chewers and 10 526 non-chewers, 10 and 102 cases of hepatocellular carcinoma were ascertained, respectively, to give incidence rates of 74.8 per 100 000 person–years for chewers and 105.7 per 100 000 person–years for non-chewers, and a crude relative risk of 0.7 (95% CI, 0.4–1.3). In a multiple regression model with adjustment for age, smoking, hepatitis B virus surface antigen (HBsAg) status, and family history of liver cirrhosis and/or liver cancer, the relative risks for the combination of hepatitis C virus (HCV) infection and betel-quid chewing were 0.8 (95% CI, 0.4–1.6) for chewers without HCV infection, 2.6 (95% CI, 1.5–4.6) for non-chewers with HCV infection and 6.8 (95% CI, 1.7–28.2) for chewers with HCV infection, compared with non-chewers without HCV infection. The corresponding synergy factor was 4.2 (95% CI, 0.6–30.7), suggesting that the effect of HCV infection on the risk for hepatocellular carcinoma may be modified by betel-quid chewing.

Another case–control study in Kaohsiung in 1996–97 included 263 cases of hepatocellular carcinoma (205 men, 58 women), matched with 263 controls selected from community residents who received a health check-up in the same hospital and had normal serum aminotransferase levels and no space-occupying lesion in the liver (Tsai *et al.*, 2001). Chewing betel quid (without tobacco) was associated with the risk for hepatocellular carcinoma (odds ratio, 3.5; 95% CI, 1.7–7.0) after controlling for sex, age, alcohol drinking, smoking, HBsAg, anti-HCV and education, using a conditional logistic regression model. The risk for hepatocellular carcinoma increased with increasing duration of areca-nut chewing and with frequency of chewing (Table 64). The risk increased in subjects with HCV infection and an interaction between HCV infection and chewing was demonstrated. The risk was also strongly associated with the presence of HBsAg and chewing betel quid (Table 65). Both interactions, in terms of synergism index, were greater than 1, with 5.37 for HBV–areca-nut chewing and 1.66 for HCV–areca-nut chewing. [This finding suggests that the effect of areca-nut chewing on hepatocellular carcinoma may confer an increased risk among subjects who have HBV or HCV infections.]

(*b*) *Thailand*

A case–control study conducted in 1987–88 (Parkin *et al.*, 1991) included 103 cases (71 men, 32 women) of cholangiocarcinoma admitted to three hospitals in North-East Thailand and 103 hospital controls matched by age, sex and residence. The criteria for definition of cases included histology, typical findings on ultrasound examination or percutaneous cholangiography. Controls were selected from individuals visiting various clinics in the same hospital or from a variety of non-malignant diseases considered to be unrelated to tobacco or alcohol consumption. Interviews were conducted using a structured questionnaire, including information on family history, smoking, betel chewing, dietary habits and alcohol use. Blood specimens were examined for HBV serology, antibodies to *Opisthorchis viverrini* and aflatoxin–albumin adducts. The final conditional logistic regression model included anti-

Table 64. Dose–response relationship between duration and frequency of chewing and risk for hepatocellular carcinoma in Taiwan, China

Chewing habits	No. of cases/controls	Odds ratio (95% CI)
Non-chewer	192/241	1.0
Duration of chewing (years)		
< 20	8/14	0.7 (0.3–1.9)
20–30	27/5	6.8 (2.4–20.5)
> 30	36/3	15.1 (4.4–39.1)
p for trend		< 0.0001
Total amount consumed (quids × 1000)		
< 100	11/10	1.4 (0.5–3.6)
100–199	31/7	5.6 (2.3–14.2)
200–299	15/3	6.3 (1.7–20.7)
> 299	14/2	8.8 (1.9–34.0)

From Tsai *et al.* (2001)
CI, confidence interval

Table 65. Interactions between betel-quid chewing and anti-HCV, and betel-quid chewing and HBsAg, and risk for hepatocellular carcinoma in Taiwan, China

Betel-quid chewer	Anti-HCV	HBsAg	No. of cases/ controls	Odds ratio (95% CI)	Synergy index
–	–		121/230	1.0	
–	+		71/11	12.3 (6.0–25.5)	
+	–		57/21	5.2 (2.9–9.3)	
+	+		14/1	26.6 (3.6–116.6)	1.66
–		–	74/187	1.0	
–		+	118/54	5.5 (3.6–8.6)	
+		–	18/18	2.5 (1.2–5.4)	
+		+	53/4	33.5 (11.1–72.7)	5.37

From Tsai *et al.* (2001)
Anti-HCV, antibodies to hepatitis C virus; HBsAg, hepatitis B surface antigen; CI, confidence interval

O. viverrini status, rice consumption and betel-quid chewing with or without tobacco. The odds ratio for betel-quid chewing, comparing weekly to less than monthly use, was 6.4 (90% CI, 1.1–39.3).

A case–control study conducted within the same investigation of liver cancer in Thailand (Parkin *et al.*, 1991) included 65 cases (47 men, 18 women) of hepatocellular carcinoma admitted to the same three hospitals in North-East Thailand and 65 controls matched by age, sex and residence (Srivatanakul *et al.*, 1991). The criteria for definition of cases included cytology, typical findings on ultrasound, or radiological examination. Controls were selected from the same source as in Parkin *et al.* (1991) and interviews were conducted similarly. Blood specimens were examined for HBV and HCV serology, antibodies to *O. viverrini* and aflatoxin–albumin adducts. The final conditional logistic regression model included HBsAg status, alcohol consumption, some dietary items and betel-quid chewing with or without tobacco. The odds ratio for betel-quid chewing, comparing weekly to less than monthly use, was 11.0 (90% CI, 1.0–115.8; $p < 0.05$).

3. Studies of Cancer in Experimental Animals

3.1 Oral administration

3.1.1 *Mouse*

Groups of 15–21 male Swiss mice, 8–10 weeks of age, were administered by gavage 0.1 mL of aqueous extracts of areca nut (containing 1.5 mg arecoline and 1.9 mg polyphenol) or betel leaf or a polyphenol fraction of areca nut (containing 1.9 mg tannic acid) on 5 days a week for life. A group of 30 male C17 mice received 0.1 mL of an aqueous extract of areca nut by gavage. Groups of 20 male Swiss and 20 male C17 mice served as untreated controls. Of the animals treated with aqueous areca-nut extract, 12/21 Swiss mice developed tumours (five hepatocellular carcinomas, two haemangiomas of the liver, two adenocarcinomas of the lung, one adenocarcinoma and one squamous-cell carcinoma of the stomach, and one leukaemia) and 8/30 C17 mice developed tumours (three squamous-cell carcinomas and two adenocarcinomas of the stomach, two leukaemias and one adenocarcinoma of the lung). In Swiss mice fed the areca-nut polyphenol fraction, two developed tumours of the salivary gland and one a haemangioma of the liver. No tumour was observed in either of the control groups or in the mice fed aqueous betel-leaf extract (Bhide *et al.*, 1979). [The Working Group noted the absence of survival data and indication of duration of the experiment for the treated and control mice.]

A group of 14 male and 18 female C17 mice, 10–12 weeks of age, was fed a diet containing 10% (w/w) areca nut coated with saccharin [concentration not specified] for 40 weeks, and the animals were followed for life. Another group of 12 males and 22 females served as untreated controls. In the group fed areca nut, two males developed squamous-cell carcinomas of the forestomach and three females developed uterine malignancies

ANNEXURE - 5

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Tobacco-specific nitrosamines in smokeless tobacco products marketed in India

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Smokeless tobacco products are a known cause of oral cancer in India. Carcinogenic tobacco-specific nitrosamines in these products are believed to be at least partially responsible for cancer induction, but there have been no recent analyses of their amounts. We quantified levels of 4 tobacco-specific nitrosamines, *N'*-nitrosonornicotine (NNN), *N'*-nitrosoanatabine (NAT), *N'*-nitrosoanabasine (NAB) and 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK), in 32 products marketed currently in India. Levels of nitrate, nitrite and nicotine were also determined. The highest levels of tobacco-specific nitrosamines were found in certain brands of khaini, zarda and other smokeless tobacco products. Concentrations of NNN and NNK in these products ranged from 1.74–76.9 and 0.08–28.4 μg/g, respectively. Levels of tobacco-specific nitrosamines in gutka were generally somewhat lower than in these products, but still considerably higher than nitrosamine levels in food. Tobacco-specific nitrosamines were rarely detected in supari, which does not contain tobacco, or in tooth powders. The results of our study demonstrate that exposure to substantial amounts of carcinogenic tobacco-specific nitrosamines through use of smokeless tobacco products remains a major problem in India.
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Key words: tobacco-specific nitrosamines; Indian tobacco; oral cancer; gutka; khaini; zarda; mishri

Oral cancer is one of the most common cancers in India with rates among the highest in the world.[1] In many regions of India, oral cancer incidence rates exceed 6 per 100,000 males and in some parts they are as high as 10.8 per 100,000.[1] Smokeless tobacco products (products in which there is no combustion or pyrolysis at the time of use) account for over one-third of all tobacco consumed in India. There are approximately 100 million users of smokeless tobacco products in India and Pakistan. Traditional forms of smokeless tobacco include betel quid containing tobacco, tobacco with lime and tobacco tooth powder but there are also new products with increasing popularity.[2] Chewing of betel quid containing tobacco is a well-established cause of oral cancer in India.[2–4] Oral leukoplakia and submucous fibrosis, likely precursor lesions to oral cancer, are also strongly linked to smokeless tobacco use. In India and other parts of southern Asia, smokeless tobacco use is a major public health problem.

Tobacco-specific nitrosamines are the most prevalent strong carcinogens in smokeless tobacco products and are widely believed to play a significant role as causes of oral cancer in people who use these products.[5–11] These carcinogens are formed from tobacco alkaloids during the curing and processing of tobacco. Vast amounts of data convincingly demonstrate their presence in various forms of smokeless tobacco, but products available in India have been examined in only scattered studies and there have been no reports since 1989.[6,12–17] In view of the variety of new smokeless tobacco products now available in India and the widespread use of these products, it is important to obtain current data on levels of tobacco-specific nitrosamines. Such data are critical in approaches to the control and regulation of smokeless tobacco products in India, and ultimately to prevention of oral cancer. Therefore, we analyzed a variety of products for *N'*-nitrosonornicotine (NNN), 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK), *N'*-nitrosoanabasine (NAB) and *N'*-nitrosoanatabine (NAT).

Material and methods

Tobacco samples

Indian smokeless tobacco products were purchased from retail stores in Gujarat, Karnataka, and Mumbai, India in October–November 2003. The date and place of purchase and batch number of each purchase was recorded. The 32 brands collected for analysis represent products commonly used in India. Most of them (22 brands), such as zarda, gutka, khaini and mishri, are chewing tobacco products that have become especially popular among teenagers and young adults in many states of India. Other tobacco-containing products were creamy snuff, a toothpaste, and moist Swedish snuff that is being marketed in India under the brand name Click. Three brands of tooth powder were of unknown tobacco content, but suspected to contain tobacco on the basis of previous analyses carried out in India. Five popular brands of chewing mixtures that do not contain tobacco (supari) were also included. University of Kentucky moist smokeless research tobacco 1S3 was analyzed for comparison. For 24 hr before analysis, the tobacco was conditioned in a chamber at a relative humidity of 60%.

Apparatus

Tobacco-specific nitrosamines were analyzed by gas chromatography with nitrosamine selective detection (GC-TEA) using a model 5890 gas chromatograph (Hewlett Packard, Palo Alto, CA) interfaced with a model 610 Thermal Energy Analyzer (Orion Research, Beverly, MA). The GC was equipped with a DB-1301 capillary column (30 m × 0.32 mm × 0.25 μm) [6% (cyanopropylphenyl)methylpolysiloxane; J&W Scientific, Folsom, CA] and a 2 m × 0.53 mm deactivated fused silica precolumn. The flow rate was 2.6 mL/min He; splitless injection port temperature was 225°C. The following oven temperature program was used: 80°C for 2 min, then 12°C /min to 150°C, then 7 min at 150°C, then 12°C /min to 200°C, then 10 min at 200°C.

GC-mass spectrometry (MS)-selected-ion monitoring analysis for nicotine was carried out with a model 6890 GC equipped with an autosampler and interfaced with a model 5973 mass-selective detector (Agilent Technologies, Palo Alto, CA). The GC was equipped with a DB-5MS fused silica capillary column (15 m × 0.25 mm × 0.25 μm). The splitless injection port temperature was 250°C; the oven temperature was 70°C for 0.5 min, then increased to 180°C at 10°C/min, then held for 3 min, then 50°C/min

Abbreviations: C5-NNK, 5-(methylnitrosamino)-1-(3-pyridyl)-1-pentanone; GC-TEA, gas chromatography with nitrosamine selective detection; 5-MeNNN, 5-methyl-*N'*-nitrosonornicotine; MS, mass spectrometry; NAB, *N'*-nitrosoanabasine; NAT, *N'*-nitrosoanatabine; NNK, 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone; NNN, *N'*-nitrosonornicotine.

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to 300°C, and returned to initial conditions. The flow rate was 1 mL/min He.

Nitrate and nitrite content were determined by ion chromatography using a Dionex ICS-2000 Ion Chromatograph.

Reagents

Reference NNN, NNK, NAB, 5-methyl-N′-nitrosonornicotine (5-MeNNN), and 5-(methylnitrosamino)-1-(3-pyridyl)-1-pentanone (C5-NNK) were synthesized as previously described.[18–20] NAT was purchased from Toronto Research Chemicals Inc. (Toronto, Ontario, Canada). [CD_3]Nicotine was obtained from Sigma Chemical Co. (St. Louis, MO).

Tobacco analyses

Tobacco-specific nitrosamines analyses was carried out by a slight modification of a method described previously by Stepanov *et al.*[20] Five-hundred milligram of humidity-conditioned tobacco and 10 mL of citrate-phosphate buffer (pH = 4.5) containing ascorbic acid were added to a 30 mL Nalgene centrifuge tube (Nalge Nunc International, Rochester, NY). Two-hundred nanograms of 5-MeNNN (internal standard for NNN, NAT, and NAB) and C5-NNK (internal standard for NNK) were added. The samples were homogenized for 30 min with a Polytron tissue homogenizer (Brinkmann Instruments, Westbury, NY) and sonicated for 1 hr. The buffer extracts were separated from the particles of tobacco by high-speed centrifugation (15,000*g*, 10 min). The extracts were filtered into 50 mL glass screw-top centrifuge tubes (Kimble, Vineland, NJ), and the pH was adjusted to 7 by adding 100 μL of 10 N NaOH. Each sample was applied to a 20 mL ChemElut cartridge (Varian, Harbor City, CA), eluted with 3 × 20 mL CH_2Cl_2, and the eluants were combined and concentrated to dryness with a model SVT200H Speedvac concentrator (Thermo Savant, Farmingdale, NY). Residues were dissolved in 0.5 mL of CH_2Cl_2 and further purified by solid-phase extraction using Sep-Pak Plus silica cartridges (Waters Corp., Milford, MA), pre-equilibrated with CH_2Cl_2. The cartridges were washed with 5 mL CH_2Cl_2/ethyl acetate: 50/50, and the tobacco-specific nitrosamines were eluted with 10 mL of ethyl acetate. The ethyl acetate eluants were concentrated to dryness (Speedvac). The dry residues were transferred into GC-micro vials with 3 × 50 μL methanol, dried, and re-dissolved in 100 μL of acetonitrile. Three microliters of the prepared sample were injected into GC-TEA.

Nicotine analysis was carried out as described previously.[20] Fifty milligrams of humidity-conditioned tobacco and 20 mL of methanol containing 50 mg of KOH were added to 30 mL Nalgene centrifuge tubes. The samples were homogenized (Polytron) and then sonicated for 3 hr. The methanol extracts were separated from the tobacco by high-speed centrifugation. Methanol extracts (200 μL) were transferred into a silanized 4 mL vial and 20 μL of [CD_3]nicotine internal standard was added. The samples were transferred to GC-micro insert vials and analyzed by GC-MS-SIM.

For nitrate and nitrite analysis, 100 mg of humidity-conditioned tobacco and 10 mL of reagent grade water (Milli-Q, Millipore Corp.) were added to a 50 mL glass screw-top centrifuge tube (Kimble) pre-washed with water. Two water negative controls and three control solutions containing known concentrations of nitrate and nitrite were included in the sample set. Tobacco was homogenized (Polytron), and the tubes were sonicated for 30 min. The suspensions were centrifuged and the aqueous tobacco extract was applied to a C-18 SPE cartridge (Waters Corp., Milford, MA) conditioned with 2 mL of methanol. The first 5 mL of eluant was discarded. The next 2 mL of eluant was collected in a prewashed plastic tube and stored at −20°C until analysis. The samples were diluted 10-fold before analysis by ion chromatography. Conditions were as follows: an AS14 anion exchange column and guard column were eluted with carbonate/bicarbonate using a 50 mL sample loop and a flow rate of 1.0 mL/min. These analyses were carried out at the University of Minnesota Geochemical Analysis Facility.

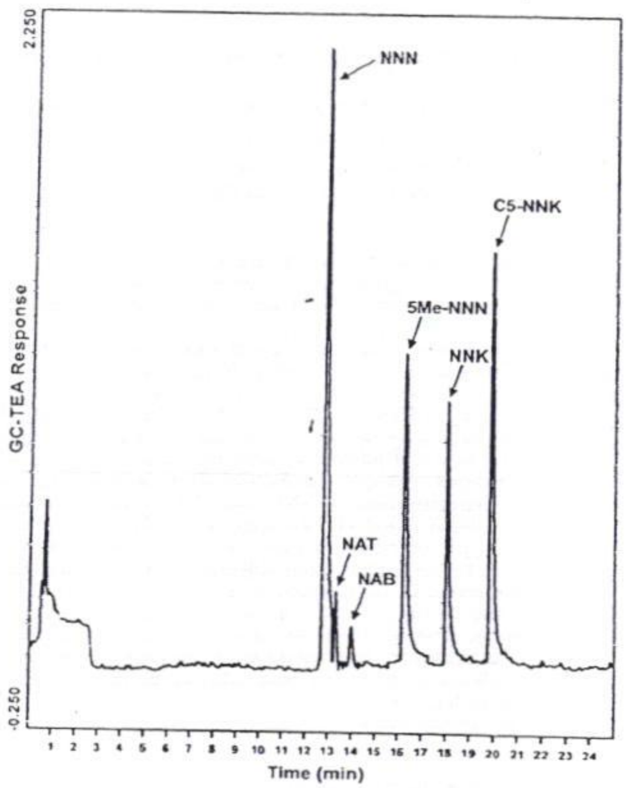

FIGURE 1 – Typical chromatogram obtained upon GC-TEA analysis of tobacco-specific nitrosamines in a smokeless tobacco product marketed in India.

Statistical analysis

Pearson correlations were determined using Sigma Plot 2001, v. 7.101 (SPSS, Inc., Chicago, IL).

Results

A typical GC-TEA trace of tobacco-specific nitrosamines in one of the smokeless tobacco products analyzed here is presented in Figure 1.

Levels of tobacco-specific nitrosamines, nitrate, nitrite and nicotine in the products are summarized in Table I. Each value is the mean of 2 analyses for tobacco-specific nitrosamines; the results agreed on average within <10%. Recoveries of internal standards averaged 42.8%. For nitrate and nitrite, each value represents the mean of duplicate injections of the same sample, with the average difference between the 2 values being <3%. For nicotine, a single sample of each brand was prepared, and each value is the result of a single injection.

On the basis of the tobacco-specific nitrosamine analyses, the products can be divided into 3 groups. The first is products with high levels (Raja and Hans Chhap khaini, Shimla zarda and Gai Chhap tobacco). In these products, levels of NNN and NNK were 38.9 ± 27.0 (SD) μg/g, range = 19.2–76.9 μg/g and 8.99 ± 13.0 μg/g, range = 2.34–28.4 μg/g, respectively. The second group comprises products with medium to low levels of tobacco-specific nitrosamines. NNN and NNK in these products amounted to 2.24 ± 2.63 (SD) μg/g, range = 0.09–8.36 μg/g (n = 20) and 0.71 ± 0.86 μg/g, range 0.04-3.09 μg/g (n = 20), respectively. In the third group (tooth powders and supari), tobacco-specific nitrosamines were rarely detected.

TABLE I – TOBACCO-SPECIFIC NITROSAMINES, NITRATE, NITRITE, AND NICOTINE IN INDIAN SMOKELESS TOBACCO AND RELATED PRODUCTS[1]

Product	Tobacco-specific nitrosamines (µg/g)[2]				NO_3^- (µg/g)[3]	NO_2^- (µg/g)[3]	Nicotine (mg/g)[4]
	NNN	NAT	NAB	NNK			
Khaini							
Raja	76.9	13.8	8.83	28.4	705	1,020	21.3
Hans Chhap	39.4	4.83	3.78	2.34	1,090	1,410	19.6
Zarda							
Goa 1000	8.36	1.98	0.48	3.09	966	2.20	14.6
Moolchand Super	6.47	0.64	0.46	1.64	1,320	ND	15.0
Sanket 999	7.77	1.51	0.36	1.99	1,910	2.08	65.0
Baba 120	4.81	1.40	0.19	1.07	1,700	1.63	44.2
Shimla	19.9	1.53	1.19	2.61	1,360	2.53	13.8
Other Tobacco							
Hathi Chhap	2.75	1.53	0.23	0.85	2,760	1.97	39.5
Gai Chhap	19.2	11.9	1.57	2.61	2,950	8.40	47.8
Miraj	1.74	0.35	0.12	0.08	1,420	13.6	15.6
Mishri							
Shahin	4.21	2.55	0.15	0.87	1,720	5.18	21.0
Gutka							
Star 555	0.47	0.07	0.02	0.13	417	1.61	6.77
Manikchand	0.38	0.05	0.01	0.12	43.9	2.00	3.22
Zee	0.32	0.05	0.01	0.08	62.3	3.42	3.31
Tulsi Mix	0.69	0.07	0.02	0.31	184	2.58	5.67
Wiz	0.31	0.04	0.02	0.13	215	2.82	1.67
Kuber	0.32	0.03	0.01	0.13	47.3	4.50	1.23
Pan Parag	0.44	0.06	0.02	0.12	332	2.84	2.67
Zatpat	1.09	0.08	0.05	0.43	171	1.99	5.48
Vimal	0.09	0.01	ND	0.04	268	1.58	6.82
Josh	0.49	0.08	0.03	0.20	252	1.74	11.4
Supari							
Goa	ND	ND	ND	ND	7.5	4.71	NA
Moolchand	ND	ND	ND	ND	8.5	2.48	NA
Rajanigandha	ND	ND	ND	ND	8.8	3.34	NA
Sanket	ND	ND	ND	ND	8.5	4.27	NA
Shimla	ND	ND	ND	ND	8.0	6.56	NA
Creamy snuff/ toothpaste							
IPCO	3.32	0.53	0.11	1.31	580	ND	4.71
Dentobac	2.52	1.49	0.07	2.16	232	ND	7.71
Snuff							
Click	0.56	0.38	0.02	0.24	2,260	ND	71.4
Tooth powder							
Baidyanath	0.04	ND	ND	ND	48.6	ND	0.72
New Roshanjyot	ND	ND	ND	ND	11.6	1.25	0.25
Dabur	0.04	ND	ND	ND	27.6	ND	0.58
Reference snuff							
Kentucky IS3	3.39	3.15	0.25	0.94	3.86	6.35	36.2

[1]All data per gram wet weight. ND, not detected; detection limit 50 pmol/g tobacco; NA, not analyzed.–[2]Mean of duplicate analyses of product from one package.–[3]Mean of duplicate injections of a single sample.–[4]Single determination.

The highest levels of NNN and NNK, 76.9 µg/g and 28.4 µg/g, respectively, were observed in Raja khaini. The second highest NNN level, 39.4 µg/g, was observed in Hans Chhap khaini. Among the products in which tobacco-specific nitrosamines were commonly detected, the lowest levels were observed frequently in different gutka brands.

Nitrite varied from non-detectable (<0.02 µg/g wet weight tobacco) to 1,020 µg/g and 1,410 µg/g in Raja khaini and Hans Chhap khaini, respectively. The average level of nitrate was 720 ± 870 (SD) µg/g, range = 7.5–2950 µg/g ($n = 32$). Levels of total tobacco-specific nitrosamines did not correlate with nicotine or nitrate. A correlation was observed between total tobacco-specific nitrosamines and nitrite ($r = 0.78$, $p < 0.0001$).

Discussion

We analyzed 32 Indian tobacco products, including smokeless tobacco products, tobacco-free chewing products, creamy snuff, tobacco toothpaste and tooth powder. These products were purchased in 2003 in India and are used commonly in different parts of the country.

Our study shows that the levels of tobacco-specific nitrosamines in these products vary widely. Different brands of the same type of product usually contain similar levels of tobacco-specific nitrosamines, nitrate, nitrite and nicotine. This observation can be explained by similarities in tobacco processing and is in agreement with the general principle that yields of tobacco-specific nitrosamines are influenced greatly by the processes involved in the manufacturing of smokeless tobaccos.[12,21–23] The highest levels of tobacco-specific nitrosamines were observed in 2 different brands of the same variety, khaini. Khaini is a mixture of tobacco, lime and menthol or aromatic spices. The mode of tobacco processing that likely favors the reduction of nitrate to nitrite and nitrosating agents could be responsible for the high tobacco-specific nitrosamine concentrations in these 2 brands. This seems reasonable because the levels of nitrite in these 2 brands are the highest

257

in our study and, arguably, among the highest reported in smokeless tobacco products.[13] It should be mentioned that khaini is usually placed in the mouth and kept there. An extraordinarily high amount of nitrite will then be released into saliva and swallowed. As a result, additional amounts of *N*-nitroso compounds could be formed endogenously.

Another tobacco product with relatively high tobacco-specific nitrosamine levels is zarda, which is usually chewed or kept in the mouth. To produce zarda, tobacco leaf is boiled in water with lime and spices until evaporation. The residual particles are then dried and colored with vegetable dyes. Four brands of this product (Goa 1000, Moolchand Super, Sanket 999, Baba 120) contain an average of 6.85 ± 1.55 (SD) μg/g NNN. The fifth brand (Shimla) is relatively high in NNN content (19.9 μg/g), even though the levels of nitrite and nicotine are similar to the other zarda brands.

The "other tobacco products" (Table I) that are used for chewing may be processed or unprocessed. It is interesting to note that the brand Gai Chhap, which is made from unprocessed tobacco, contains the highest tobacco-specific nitrosamine levels of this group. Clearly, factors other than processing can influence nitrosamine levels in these products.

Mishri is a powdered form of tobacco that is used primarily for cleaning teeth. It is prepared by baking tobacco on a hot metal plate until it becomes uniformly black. The brand Shahin mishri was found to contain 4.21 μg/g NNN and 0.87 μg/g NNK. As with some of the other products studied here, nitrosamine uptake from mishri may increase when it is used habitually (*i.e.*, being placed and retained in the mouth several times a day).

Gutka usually contains powdered tobacco, betel nut, catechu, lime and flavors. It has been commercialized since 1975, having originally been available custom mixed from pan-vendors. The use of these products is strongly associated with oral cancer.[2–4] The levels of tobacco-specific nitrosamines in gutka were lower than those in many of the other products examined here, but were still considerably higher than nitrosamine levels in food and other common products, which are typically in the low ppb range.[11,24] Supari, which is similar to gutka but does not contain tobacco, did not have detectable levels of tobacco-specific nitrosamines.

Tobacco is not mentioned as an ingredient of red tooth powders. Small amounts of nicotine and trace amounts of tobacco-specific nitrosamines were observed in these products, however, raising concerns about their safety. Considerable levels of tobacco-specific nitrosamines and nicotine were found in Dentobac, a tobacco-containing toothpaste. It is remarkable that a product containing relatively high levels of carcinogens and an addictive agent is marketed for the purpose of dental hygiene.

The levels of tobacco-specific nitrosamines in 3 of the products analyzed (Raja khaini, Hans Chhap khaini, Gai Chhap tobacco) are considerably higher than those found in most smokeless tobacco products marketed in Europe and North America, where the total amounts of these compounds are usually <10 μg/g.[12,13,25] Levels of these carcinogens in Kentucky reference smokeless tobacco 1S3 are <8 μg/g (Table I). Our results serve to emphasize the potential hazards of these products marketed in an area of high oral cancer incidence.

To our knowledge, there have been no published reports on tobacco-specific nitrosamines in Indian smokeless tobacco products in the past 15 years. Brunnemann *et al.*[15] reported levels of tobacco-specific nitrosamines in tobacco used in betel quid. The amounts were similar to those reported here in gutka. Nair *et al.*[14] found high levels of tobacco-specific nitrosamines in Indian chewing tobacco and creamy snuff. Tricker and Preussmann [16,17] reported levels of tobacco-specific nitrosamines in zarda tobacco similar to those found here and also observed relatively high levels in Kiwam tobacco. It seems that little has changed in the past 15 years with respect to levels of these carcinogens in tobacco products marketed in India. High exposure to tobacco-specific nitrosamines in smokeless tobacco products is likely a major factor in the continuing epidemic of oral cancer in India. Immediate public health measures are urgently needed to decrease morbidity and mortality associated with the use of these products.

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Global surveillance of oral tobacco products: total nicotine, unionised nicotine and tobacco-specific *N*-nitrosamines

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ABSTRACT

Objective Oral tobacco products contain nicotine and carcinogenic tobacco-specific *N*-nitrosamines (TSNAs) that can be absorbed through the oral mucosa. The aim of this study was to determine typical pH ranges and concentrations of total nicotine, unionised nicotine (the most readily absorbed form) and five TSNAs in selected oral tobacco products distributed globally.

Methods A total of 53 oral tobacco products from 5 World Health Organisation (WHO) regions were analysed for total nicotine and TSNAs, including 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol (NNAL), using gas chromatography or liquid chromatography with mass spectrometric detection. Unionised nicotine concentrations were calculated using product pH and total nicotine concentrations. Fourier transform infrared spectroscopy was used to help categorise or characterise some products.

Results Total nicotine content varied from 0.16 to 34.1 mg/g product, whereas, the calculated unionised nicotine ranged from 0.05 to 31.0 mg/g product; a 620-fold range of variation. Products ranged from pH 5.2 to 10.1, which translates to 0.2% to 99.1% of nicotine being in the unionised form. Some products have very high pH and correspondingly high unionised nicotine (eg, gul powder, chimó, toombak) and/or high TSNA (eg, toombak, zarda, khaini) concentrations. The concentrations of TSNAs spanned five orders of magnitude with concentrations of 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK) ranging from 4.5 to 516 000 ng/g product.

Conclusions These data have important implications for risk assessment because they show that very different exposure risks may be posed through the use of these chemically diverse oral tobacco products. Because of the wide chemical variation, oral tobacco products should not be categorised together when considering the public health implications of their use.

INTRODUCTION

Globally, oral tobacco products represent a diverse assortment of tobacco-containing products that deliver nicotine primarily through the oral mucosa upon placement in the mouth. These products may be chewed, sucked, or held between the gum and teeth for variable time intervals and, in some cases, swallowed in whole or part.[1 2] Oral tobacco product use has varying geographic prevalence. An estimated 8.1 million people use oral tobacco products in the US; however, in Southeast Asia, an estimated 258 million people use oral tobacco products. In addition to its addictiveness, oral tobacco may contribute to diabetes, high blood pressure, cardiovascular disease, oral diseases, and cancers of the oral cavity and pancreas.[1 3] Oral tobacco use is also associated with increased risk of death from myocardial infarction and increased risk of premature birth and pre-eclampsia.[3 4]

Oral tobacco products range from simple cured tobacco to elaborate products containing many non-tobacco ingredients; these products can be handmade or commercially made by using simple or very complex manufacturing processes.[1 5 6] Some oral tobacco products contain significant amounts of plant material (betel leaf, areca nut, catechu, etc.); moreover, additives such as sweeteners, flavour agents and spices (saffron, cardamom, camphor, eucalyptus, etc.) are commonly added. Alkaline modifiers, including certain inorganic salts, slaked lime and ashes produced by burning certain wood (eg, Willow, Mamón) or fungi,[1 5 6] are also added to some oral tobacco products. Unprocessed tobacco is mildly acidic (approx. pH 5–6.5); however, addition of alkaline modifiers boosts product pH converting a greater fraction of nicotine to more rapidly absorbed unionised nicotine,[3 5 6] which contributes to faster spikes in blood nicotine concentrations[7] and could result in such products being more addictive.[7–9]

Regional differences and local preferences contribute to the diversity of oral tobacco products in physical appearance, constituents and chemistry, with some products containing tobacco with little or no alkaline modifier, some augmented with substantial amounts of various alkaline modifiers,[1 5 6] and some mixed with slaked lime (as the alkaline modifier) and areca nut. Some global oral tobacco products have unique characteristics, such as extremely high pH, nicotine-enriched tobacco (eg, *Nicotiana rustica* L.), non-tobacco plant ingredients (eg, catechu, betel leaf, spices, etc.) and alkaline modifiers (plant/fungi ashes; slaked lime, etc.) not associated with Western-style products (ie, snus, snuff, chewing tobacco).[1 5 6] Moreover, some oral tobacco products, particularly those from South Asia (eg, betel quid, gutkha, mawa), also contain appreciable amounts of areca nut, seeds of the Areca palm (*Areca catechu* L.),[5 6] which has been classified as an International Agency for Research on Cancer (IARC) group 1 carcinogen, although the actual carcinogenic constituent(s) has not yet been identified.[10]

259

Oral tobacco products are known to contain more than 30 carcinogens, including volatile aldehydes, lactones, polycyclic aromatic hydrocarbons (PAHs), heavy metals, radioactive metals and tobacco-specific *N*-nitrosamines (TSNAs).[10] Among these chemical constituents in oral tobacco, TSNAs are considered the most potent classes of carcinogens[11] with *N*-nitrosonornicotine (NNN) and 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK), both IARC group 1 carcinogens,[10] linked to the formation of cancers of the oral cavity, oesophagus, lung and pancreas.[1 3] Another TSNA, 4-(methyl-nitrosamino)-1-(3-pyridyl)-1-butanol (NNAL) has recently been reported in US moist snuff products.[12] Clinical studies have shown that NNAL, a metabolite of NNK, is present in the urine of oral tobacco users at levels similar to those found in urine from smokers[13]; the NNAL present in some oral tobacco products[12] may be absorbed directly and add to NNAL formed by metabolism of NNK.

Some products from South Asia, Sudan and South America contain *N rustica*, a tobacco species with higher nicotine and TSNA concentrations than found in cultivated tobacco used in US products (*Nicotiana tabacum* L.).[14] In India, an estimated 35% to 40% of tobacco present in oral tobacco products is *N rustica*.[15 16] Similarly, some Sudanese toombak contains very high concentrations of TSNAs[17] likely from the use of *N rustica*. The type of tobacco and curing of oral tobacco products can influence nicotine content and carcinogenic TSNA content[14 17] and, in turn, could potentially influence addiction and exposure to potent carcinogens.[18]

The primary goal of this study is to provide researchers and policy makers with approximate pH levels and total nicotine, unionised nicotine, and TSNA concentrations for a diverse global set of oral tobacco products. Because all products in this study were tested in a single laboratory using standard methodologies, direct comparisons between product groups are possible.

METHODS

Sample overview

In total, 65 oral tobacco samples were purchased or obtained by research partners in the following countries of origin: Bangladesh, India, Nigeria, Pakistan, South Africa, Sudan, Sweden, Uzbekistan and Venezuela. In all, 12 samples that lacked detectable nicotine were excluded from the analysis list. This study explores the pH levels and the total nicotine, unionised nicotine and TSNA concentrations in 53 oral tobacco products from 5 WHO regions. The geographic distribution and common constituents of representative oral tobacco products from three broad categories, based on product constituents, is presented in table 1; photographs of selected products from each category are shown in figure 1.

In most cases, a list of locally popular types of oral tobacco products was identified in published reference documents[15] and provided to the research partners. In some cases (eg, Uzbekistan), the research partner identified the type of oral tobacco product for testing. In all cases, the research partner was responsible for locating, purchasing and shipping the items to the Centers for Disease Control and Prevention (CDC) (Atlanta, Georgia, USA). Samples were not stored in the country of origin but were promptly shipped at ambient temperature to CDC; upon receipt, samples were labelled and stored in a freezer at −30°C until analysed to prevent product changes (ie, moisture loss), minimise loss of volatile constituents and inhibit the formation of TSNAs during storage. All pH, nicotine and TSNA measurements were performed in the Tobacco Analysis Laboratory at CDC.

Fourier transform infrared spectroscopy

These products differ widely in tobacco type, additives, non-tobacco constituents and production; in select cases, product composition and identification of tobacco (*N tabacum* and *N rustica*) and non-tobacco components (areca nut, alkaline agents) were aided by using Fourier transform infrared (FT/IR) spectroscopy. Samples were ground and homogenised in a handheld grinder prior to FT/IR analysis. Samples of *N rustica*, provided by the Great Lakes Inter-Tribal Epidemiology Center and the Wisconsin Native American Tobacco Network, and *N tabacum*, cultivated tobacco used in US products, were analysed by FT/IR spectra for comparison with international tobacco products. Chimó, a tar-like product from Venezuela, was applied to the attenuated total reflectance (ATR) crystal, analysed and subsequently removed with methanol. Analyses were performed by using a JASCO 6200 FT/IR spectrometer (JASCO, Inc.; Easton, Maryland, USA) fitted with a diamond crystal ATR (Pike Technologies; Madison, Wisconsin, USA). Absorbance mode spectral detection was accomplished by using a wide-band detector cooled to approximately −70°C with liquid nitrogen. Sample spectra were obtained by averaging 64 scans in the spectral range from 425–4000 cm^{-1} at 4 cm^{-1} resolution.

Total and unionised nicotine quantification

To quantify total nicotine, a 1 g sample of oral tobacco was extracted in 50 ml of methyl *tert*-butyl ether (containing quinoline as an internal standard) and 5 ml of 2 N NaOH. For analysis, 1 µl of the extract was injected into a gas chromatograph/mass spectrometer operated in selected ion monitoring mode[19]; analysis of nicotine was done in triplicate. Measurements of pH (±0.001 pH units) were performed by adding 2 g of oral tobacco product to 10 ml of distilled, deionised water. Many of the products analysed in this study were dry powders. In cases where the product absorbed all the water (resulting in a paste-like consistency), an additional 10 ml of deionised water was added prior to pH measurement.[20] By substituting product pH and the pK_a of nitrogen's pyrollic nitrogen (8.02) into the Henderson–Hässelbalch equation, the proportion of nicotine in the unionised form (α_{fb}) was calculated. The amount of unionised nicotine was determined by multiplying total nicotine by the α_{fb} value.[20]

Tobacco-specific *N*-nitrosamines quantification

The concentrations of five tobacco-specific *N*-nitrosamines ((1) NNN, (2) NNK, (3) N'-nitrosoanatabine (NAT), (4) N'-nitrosoanabasine (NAB) and (5) NNAL) in oral tobacco samples were measured in triplicate. Samples were ground, and a 0.25 g portion was transferred to an amber extraction vial and spiked with isotopically labelled internal standards. Samples were extracted with aqueous ammonium acetate on a Lab-Line shaker (Melrose Park, Illinois, USA) at 250 rpm for 1 h. Two quality control samples, Copenhagen moist snuff and 2S3 Reference tobacco (University of Kentucky; Lexington, Kentucky, USA), were prepared with each batch of samples. Extracts were filtered with a 0.45 µm nylon syringe filter and a 20 µl aliquot was injected on a Xterra C18 MS liquid chromatography column (Waters Corporation; Milford, Massachusetts, USA). Compound-specific detection was accomplished by using a triple quadrupole mass spectrometer operated under electrospray ionisation and multiple-reaction monitoring mode. All chromatographic data were processed by using Analyst 4.02 software from Applied Biosystems (Foster City, California, USA).

Stanfill SB, Connolly GN, Zhang L, *et al*. *Tobacco Control* (2010). doi:10.1136/tc.2010.037465

260

Table 1 Description of representative products from three broad categories of oral tobacco products used globally[1 3 5 6] (some products with the same name can fit in more than one category based on formulation).

Product	Common geographic origins	Common ingredients
Category I: tobacco (with or without flavourants)*		
Tobacco leaf	Bangladesh	Tobacco
Misri	India	Tobacco (powdered)
Qimam (kiman)	India	Tobacco,† additives, spices (aniseed, cardamom, saffron)
Loose leaf	USA	Tobacco (air-cured cigar leaf), sweeteners (sugar, molasses), liquorice
Plug	USA	Tobacco (burley, bright, or cigar tobacco) leaves, sweeteners, liquorice
Twist	USA	Tobacco (dark and air-cured leaf), tar-like tobacco leaf extracts
Dry snuff	USA, UK, India	Tobacco (fermented fire cured, Kentucky and Tennessee), flavourings
Snus	Sweden	Tobacco, sodium carbonate, sodium chloride, moisturisers, flavouring
Moist snuff (lower pH)	USA	Tobacco (fermented air cured or fire cured), flavourings, inorganic salts
Category II: tobacco with various alkaline modifiers‡		
Chimó§	Venezuela	Tobacco, sodium bicarbonate, brown sugar, Mamón tree ashes
Naswar (Niswar, Nass)	Central Asia, Pakistan, Iran	Tobacco,† slaked lime,¶ indigo, cardamom, menthol
Khaini	India	Tobacco,† slaked lime paste (sometimes areca nut)
Toombak	Sudan	Tobacco (fermented),** sodium bicarbonate
Iq'mik	USA (Alaska)	Tobacco (air cured or fire cured), willow or punk fungus ashes
Gul	Central/eastern India	Tobacco powder,** molasses, alkaline modifiers
Snuff (higher pH)	USA, South Africa	Tobacco (fermented air cured or fire cured), flavourings, various alkaline modifiers
Category III: tobacco with slaked lime (as an alkaline modifier) and areca nut††		
Gutkha	India, Southeast Asia, UK	Tobacco, slaked lime, areca nut, catechu, saffron, saccharine, flavourings
Mawa	India	Tobacco, slaked lime, areca nut
Manipuri	Pakistan	Tobacco, slaked lime, areca nut, spices
Zarda	India, Arab countries	Tobacco, slaked lime, usually areca nut, spices, vegetable dyes
Betel quid (with tobacco)	South Asia, Southeast Asia, China‡‡	Tobacco, slaked lime, areca nut, flavourings§§ wrapped in betel leaf

*These products may contain small amount of compounds that boost alkalinity.
†These products are made with *Nicotiana tabacum* L. (cultivated tobacco) and/or *Nicotiana rustica* L. (Aztec or shamanic tobacco) that has a higher nicotine content.
‡Alkaline modifiers, which that can boost product pH, may include inorganic salts (sodium bicarbonate, sodium carbonate, potassium carbonate, etc.), slaked lime (calcium hydroxide) and ashes from various plants, Mamón (*Meliccoca bijuga* L.) and willow (*Salix* spp.) trees and from punk fungi (*Phellinus igniarius* (L.) Quél.).
§Chimó may also contain banana peel, avocado seed and yoco (*Pauliinia yoco* L.) as flavourings.
¶Slaked lime (ie, calcium hydroxide) can be obtained from coral, shellfish, or quarried limestone.
**This product may be made of *N tabacum*, *N rustica*, or *Nicotiana glauca* Graham (Brazilian tree tobacco).
††These products made with areca nut (*Areca catechu* L.) can be made with or without piper betel leaf (*Piper betle* L.) and catechu (*Acacia catechu* L.).
‡‡Betel quid with tobacco is used in countries including India, Sri Lanka, Pakistan, Bangladesh, Myanmar, Thailand, Cambodia, Malaysia, Singapore, Philippines, New Guinea, Taiwan, China and Guam.
§§The flavourings used can include menthol, camphor, sugar, rosewater, aniseed, mint and other spices; this handmade product may also contain catechu.

RESULTS

Product characterisation by FT/IR

Of the samples analysed, 25 had definitive product labelling. For example, several samples believed to be gutkha were analysed by FT/IR and the resulting interferograms were matched to known examples. Nut-like plant material from products presumed to contain areca nut were collected, washed and dried to remove other product constituents. The material was then examined by light microscopy. These samples were further analysed by FT/IR analysis and compared with spectra of fresh areca nut for confirmation. In this instance, the samples in question contained unique IR peaks corresponding to areca nut and were confirmed to be handmade gutkha.

Analyses of mawa and mainpuri by FT/IR confirmed the presence of areca nut. One zarda sample from Bangladesh contained areca nut while another zarda sample did not. Neither of the Indian khaini samples contained an FT/IR signature indicative of the presence of areca nut, a popular but non-essential additive in these products. Of the five Sudanese toombak samples received, one product was a coarse, tan-coloured powder that lacked detectable nicotine. Furthermore, FT/IR analysis revealed that this sample did not contain characteristic spectral peaks indicative of tobacco (*N tabacum* or *N rustica*); this non-tobacco product was excluded from further analysis. Another toombak sample, a dry, light brown product, contained nicotine and total TSNA levels three times higher than the other three toombak products, which were black and appeared similar to moist snuff. Determination of the type of tobacco present in the areca nut-containing zarda (Hakim Pury) was inconclusive due to interferences due to the areca nut present in that sample.

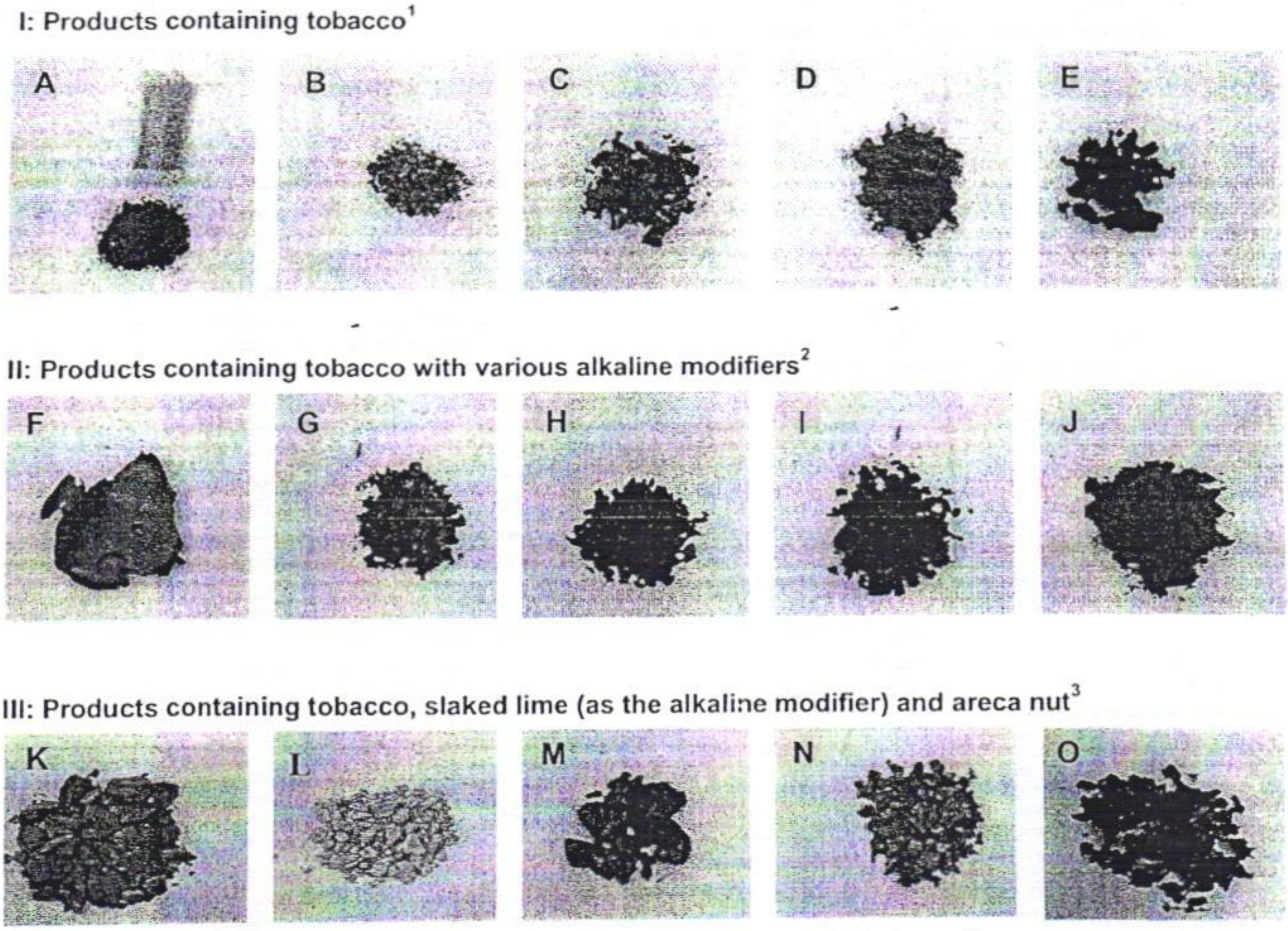
Because some oral tobacco products from Sudan contain *N rustica*, a nicotine-enriched tobacco variety,[5 14 17] we compared the IR spectra of pure *N rustica* tobacco with each of the four toombak samples. A light brown toombak product (sample 5) exhibited spectral patterns corresponding to known samples of *N rustica* tobacco. The three other toombak samples had spectra similar to that found for products made with *N tabacum*, the species commonly used in US products. Some samples of gul and zarda with very high nicotine concentrations had spectral patterns most similar to *N rustica*.; however, these samples did not contain extremely high TSNA concentrations. Identity of tobacco species (*N rustica* or *N tabacum*) in toombak, gul tobacco samples was further confirmed by the ratio of IR-specific absorbances.

Product designations

Product designation categories used in table 2 are based on product constituents listed on the package labelling (if available), product pH and, in the case of some products, confirmation of the presence or absence of areca nut by FT/IR analysis and light microscopy.

pH

The pH in international oral tobacco products tested in the study ranged from pH 5.2 to 10.1, which translates to 0.2% to



1 These products may also contain spices, sweeteners, flavor chemicals, and low levels of alkaline modifiers.

2 These products may also contain spices, sweeteners, flavor chemicals, and substantial amounts of alkaline modifiers that may include sodium bicarbonate, slaked lime, ashes from fungi or plants, or inorganic salts that increase product pH.

3 These products may also contain piper betel leaf, catechu, and various spices.

Figure 1 Photographs of representative products from three broad categories of oral tobacco products used globally. Examples of category I are (A) pouch snus (Sweden), (B) tobacco leaf (Bangladesh), (C) natural leaf chewing tobacco (USA), (D) dry snuff (USA) and (E) low pH moist snuff (USA). Examples of category II are (F) chimó (Venezuela), (G) naswar (Uzbekistan), (H) khaini (India), (I) toombak (Sudan) and (J) medicated dry snuff (South Africa). Examples of category III are (K) handmade gutkha (India), (L) manufactured gutkha (India), (M) mawa (Pakistan), (N) mainpuri (Pakistan) and (O) zarda, areca nut-containing variety (Bangladesh).

99.1% of nicotine being in the unionised form (figure 2). The highest pH values were found in khaini (India), toombak (Sudan) and snuff (South Africa) (table 2). In terms of pH, handmade gutkha (pH 7.4–8.6) had a wider range of pH than the commercially manufactured gutkha (pH 8.5–8.9) analysed. The pH level in tobacco-only products (pH 5.2–7.2) was generally lower than oral products known to contain alkaline modifiers (pH 7.40–10.1) (figure 1), whereas areca nut-containing products ranged from pH 6.5–8.9.

Total nicotine

Nicotine concentrations ranged from 0.2–34.1 mg nicotine/g product (mg/g) (table 2). Total nicotine in most products ranged from 0.2–21.3 mg/g; however, a few products, such as gul powder (Bangladesh), zarda (India), chimó (Venezuela) and toombak (Sudan), had higher nicotine concentrations ranging from 27.5–34.1 mg/g. One toombak sample (sample 5), with a FT-IR spectral pattern most similar to *N rustica*, had a nicotine concentration (28.2 mg/g) that was almost three times higher than the other three toombak samples (9.56–10.7 mg/g). Several other products, including Eagle Gul, Baba Zarda and tobacco leaf (Bangladesh), with higher nicotine values (19.7–33.4 mg/g) had FT/IR spectral features consistent with *N rustica*. Some chimó samples had high nicotine values (27.5–30.1 mg/g); however, FT/IR was inconclusive as to the tobacco type it contains.

Unionised nicotine

Unionised nicotine content, calculated by using product pH and measured total nicotine, spanned over four orders of magnitude (table 2). Calculated unionised nicotine concentrations for most products ranged from about <0.1–13.8 mg/g, except for two chimó products (27.4 and 30.1 mg/g) and two gul powder products (29.1 and 31.0 mg/g). Unionised nicotine was lowest in handmade gutkha from Pakistan (0.1 mg/g), Sada Pata tobacco leaf (0.2 mg/g) and wet zarda (0.2 mg/g). In terms of unionised nicotine concentrations, handmade gutkha (0.2–3.3 mg/g) was

Table 2 Levels of pH, nicotine and unionised nicotine found in international oral tobacco products

Product description/name	Product category*	Country of origin	WHO region†	pH		Total Nicotine		Percentage of nicotine unionised	Unionised nicotine, mg/g
				Mean	SD	mg/g	SD		
Special Gul Powder	II	Bangladesh	SEARO	8.79	0.25	34.1	0.1	85.2	29.1
Eagle Gul Powder‡§	II	Bangladesh	SEARO	9.22	0.13	33.4	0.1	92.8	31.0
Sada Pata Tobacco Leaf§	I	Bangladesh	SEARO	5.92	0.14	19.7	0.2	0.77	0.15
Hakim Pury Wet Zarda (with areca nut)¶**	III	Bangladesh	SEARO	6.51	0.04	21.3	0.2	2.95	0.63
F. Rahman & Co Zarda††	I	Bangladesh	SEARO	6.28	0.03	9.55	0.15	1.76	0.17
Baba Zarda 120§	I	India	SEARO	5.22	0.02	30.4	0.8	0.16	0.05
Super Raja Khaini††	II	India	SEARO	9.65	0.02	4.79	0.22	97.7	4.68
Spitt Raja Chap Khaini**††	II	India	SEARO	9.79	0.09	2.53	0.04	98.3	2.48
Gutkha product 1 (handmade; Rapar)¶	III	India	SEARO	7.45	0.19	0.91	0.21	20.8	0.19
Gutkha product 2 (handmade; Rapar)¶	III	India	SEARO	7.99	0.08	0.92	0.19	47.4	0.44
Gutkha product 3 (handmade; Rapar)¶	III	India	SEARO	8.60	0.05	1.41	0.19	78.6	1.11
Gutkha product 4 (handmade; Rapar)¶	III	India	SEARO	8.48	0.07	2.24	0.52	50.2	1.13
Gutkha product 5 (handmade; Rapar)¶	III	India	SEARO	8.61	0.25	4.20	0.61	79.4	3.33
Gutkha product 7 (handmade; Rapar)¶	III	India	SEARO	7.43	0.01	1.76	0.59	20.1	0.35
Rajdarbar Gutkha	III	India	SEARO	8.46	0.02	1.57	0.17	72.8	1.14
Shikhar Gutkha	III	India	SEARO	8.88	0.07	1.67	0.22	87.7	1.47
Sitar Gutkha	III	India	SEARO	8.59	0.02	1.09	0.16	78.3	0.86
Bahar Gutkha‡‡	III	India	SEARO	8.64	—	1.29	0.15	80.3	1.03
Dhamaal Gutkha (Saffron)‡‡	III	India	SEARO	8.54	—	2.33	0.08	76.4	1.78
RMD Gutkha‡‡	III	India	SEARO	8.49	—	1.73	0.46	74.3	1.28
Gutkha (handmade; Karachi)¶	III	Pakistan	EMRO	8.48	0.03	0.16	0.01	73.6	0.12
City Gutkha (Saffron)	III	Pakistan	EMRO	8.20	0.03	2.08	0.05	43.1	0.90
JM Extra Strong Gutkha	III	Pakistan	EMRO	8.54	0.12	1.41	0.25	76.5	1.08
Mawa¶	III	Pakistan	EMRO	8.31	0.02	0.16	0.02	65.4	0.11
Mainpuri¶	III	Pakistan	EMRO	7.65	0.22	1.28	0.14	29.3	0.38
Naswar, sample 1§§	II	Pakistan	EMRO	9.14	0.02	14.2	0.1	92.8	13.2
Naswar, sample 2§§	II	Pakistan	EMRO	8.76	0.04	10.5	0.0	84.4	8.84
Toombak, sample 1 (black)§§	II	Sudan	EMRO	9.84	0.07	10.3	0.1	98.5	10.2
Toombak, sample 2 (black)§§	II	Sudan	EMRO	10.1	0.0	9.56	0.23	99.1	9.47
Toombak, sample 5 (brown)§	II	Sudan	EMRO	7.38	0.05	28.2	0.5	18.3	5.16
Toombak, sample 7 (black)‡‡	II	Sudan	EMRO	9.88	0.20	10.7	0.4	98.6	10.6
Nigerian Snuff (traditional)**	II	Nigeria	AFRO	9.42	0.16	2.49	0.33	96.1	2.39
Joseph & H. Wilson Medicated 99 Snuff§§	II	Nigeria	AFRO	9.02	0.17	7.41	0.07	90.7	6.72
NTSU Ugway Snuff§§	II	South Africa	AFRO	9.15	0.14	14.9	0.1	92.9	13.8
South African Snuff (traditional)**	II	South Africa	AFRO	9.29	0.03	5.29	0.16	94.8	5.01
Singleton's Super Menthol Snuff**	II	South Africa	AFRO	9.35	0.10	2.95	0.02	95.4	2.82
Super Taxi Snuff§§	II	South Africa	AFRO	10.1	0.2	1.17	0.04	99.1	1.16
Peter Stuyvesant Menthol Snus	I	South Africa	AFRO	6.79	0.08	14.1	0.1	5.44	0.77
Peter Stuyvesant Blue Snus	I	South Africa	AFRO	6.48	0.02	17.2	0.7	2.74	0.47
Svenskt Tobacco-rette Snus	I	South Africa	AFRO	6.56	0.05	15.0	0.1	3.28	0.49
Lucky Strike Original Red Snus	I	South Africa	AFRO	7.02	0.17	13.4	0.2	8.90	1.19
Lucky Strike Menthol Snus	I	South Africa	AFRO	6.66	0.00	15.2	1.3	4.09	0.62
General Original Snus	I	Sweden	EURO	7.01	0.02	8.34	0.08	8.98	0.75
General Loose Snus	I	Sweden	EURO	6.61	0.00	7.79	0.07	3.77	0.29
General White Portion Wintergreen Snus	I	Sweden	EURO	7.07	0.01	7.76	0.24	10.0	0.78
General White Portion Snus	I	Sweden	EURO	6.86	0.04	8.09	0.03	6.48	0.52
Catch Peppermint Snus	I	Sweden	EURO	7.21	0.02	15.2	0.3	13.3	2.03
Nasway¶¶**	II	Uzbekistan	EURO	8.43	0.09	8.89	0.64	71.5	6.36
Vencedor Chimó**	II	Venezuela	AMRO	6.98	0.09	16.1	0.2	8.18	1.32
Fabrica De Chimó**	II	Venezuela	AMRO	9.40	0.03	5.29	0.14	95.9	4.99
El Tigirito Chimó**	II	Venezuela	AMRO	8.56	0.03	10.4	0.3	77.2	8.02
El Tabacote Chimó**	II	Venezuela	AMRO	9.12	0.08	27.5	1.2	92.5	25.4
Chimó La Chinata C.A.**	II	Venezuela	AMRO	9.04	0.01	30.1	2.2	91.1	27.4

Total nicotine values represent measurements made in triplicate unless noted otherwise; total nicotine and calculated unionised nicotine are presented as mg/g wet weight. pH and total nicotine values were produced form measurements of three separate samples of tobacco (n=3) unless otherwise noted.

*Product categories are: I) tobacco only (with or without flavorants), II) tobacco with alkaline modifier, and III) tobacco with areca nut and slaked lime (with or without piper betel leaf and catechu). These product designations were made based on ingredients listed on packaging, product pH and the presence or absence of areca nut based on analysis by Fourier transform infrared spectroscopy (FT/IR).

†WHO Regions: SEARO=Southeast Asia; EMRO=Eastern Mediterranean; AFRO=Africa; EURO=Europe; AMRO=Americas.

‡Due to limited sample size, pH measurements were made in duplicate (n=2).

§The tobacco in this product is most similar to *Nicotiana rustica* L., a high nicotine-containing species, as determined by FT/IR.

¶The presence of areca nut (*Areca catechu* L.) in this product was confirmed by FT/IR.

**FT/IR determination of tobacco type was inconclusive because the sample did not match the spectra for *N tabacum* or *N rustica*; these products may contain another tobacco species. Identification of chimó by FT/IR may be affected by product preparation.

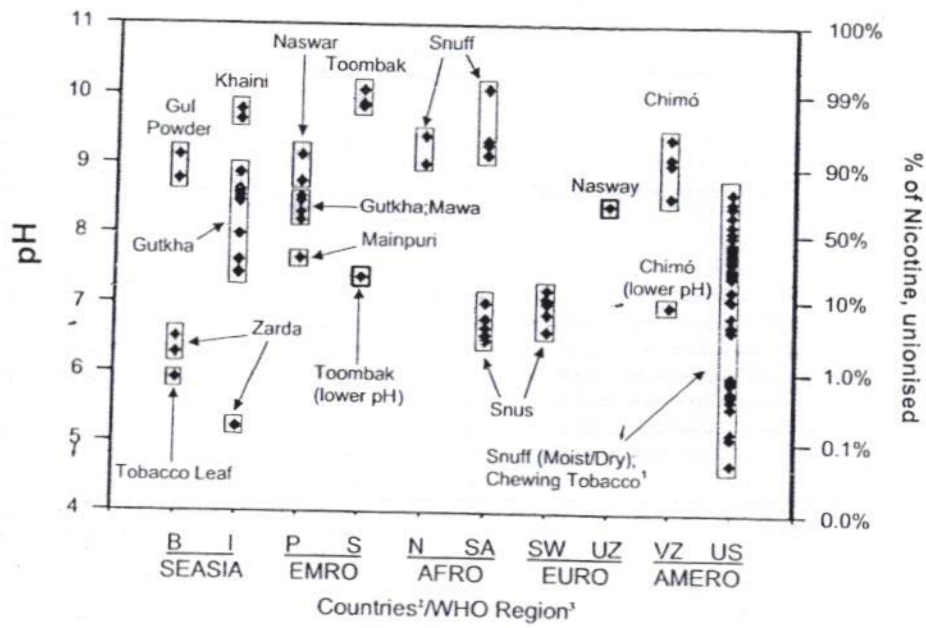
††FT/IR analysis revealed that these products contain little or no areca nut (*A catechu* L.).

‡‡Due to limited sample size, only one pH measurement was performed.

§§The tobacco in this product is most similar to *N tabacum* the species most commonly used in U.S. products when analysed by FT/IR.

¶¶Total nicotine values for this product were measured eight times (n=8).

Figure 2 The range of pH and percentage of unionused nicotine in various oral tobacco products from 10 countries from 5 WHO regions.



1 Data for U.S. moist snuff brands was previously reported[12]. The data range of pH and percentage of unionised nicotine for chewing tobacco (e.g., loose leaf, plug, and twist) and dry snuff were determined by Lawler *et al.* (unpublished results from the CDC Tobacco Analysis Laboratory).

2 Countries: B=Bangladesh; I=India; P=Pakistan; S=Sudan; N=Nigeria; SA=South Africa; SW=Sweden; UZ=Uzbekistan; VZ=Venezuela; US=United States.

3 WHO Regions: SEASIA=Southeast Asia Region; EMRO=Eastern Mediterranean Region; AFRO=African Region; EURO=European Region; AMERO=Region of the Americas.

similar to the manufactured gutkha (1.0–1.8 mg/g) samples analysed in this study.

Tobacco-specific *N*-nitrosamines

The TSNA concentrations varied widely among the international samples (table 3). The highest concentrations of NNK were found in toombak from Sudan (516 000 ng/g). Dry zarda from Bangladesh had 3840 ng/g of NNK, much higher than most of the products tested. The highest concentrations of NNN were found in products from Sudan (368 000 ng/g), Bangladesh (28 600 ng/g) and India (18 600 ng/g) (table 3). Handmade gutkha and mawa from Pakistan contained the lowest NNK concentrations. Oral tobacco products contained a wide range of NNAL concentrations (3.58–6770 ng/g), unlike cigarette smoke, which does not usually contain detectable concentrations of this compound. The highest NNAL concentrations were found in four samples of toombak, and also in dry zarda and khaini.

All four nicotine-containing toombak samples from Sudan had high TSNA concentrations. This toombak product, with the highest NNK concentrations (516 000 ng/g) and extremely high nicotine (28.2 mg/g), was identified by FT/IR as containing *N rustica*. Zarda (Pakistan) and khaini (India) analysed in this study had very high TSNA concentrations. The NNN content in Zarda exceeded 28 000 ng/g and concentrations in khaini exceeded 17 000 ng/g. Among the gutkha products analysed, a handmade gutkha (product 1; Rapar, India) had the highest concentration of all five TSNAs, whereas a handmade gutkha from Pakistan had the lowest concentrations of the five TSNAs. The concentration of total TSNAs in the international products analysed in this study ranged from 83.9–992 000 ng/g (table 3).

DISCUSSION

Confirmation of product identity or composition using FT/IR was performed on 34 samples, including gul powder, tobacco leaf, zarda, khaini, gutkha, mawa, mainpuri, naswar, toombak, snuff, nasway, and chimó. Furthermore, FT/IR was used to determine whether a product contained tobacco similar to that used in U.S. products (*N tabacum*) or a higher nicotine-containing tobacco species (*N rustica*) or neither and whether or not it contained areca nut (*A catechu*). In a few cases, products contained a spectral pattern unlike either *N tabacum* or *N rustica* and may indicate the use of a different tobacco species (such as *Nicotiana glauca* Graham) in these products. Chimó is made by cooking tobacco, sodium bicarbonate, flavouring, brown sugar and Mamón tree ashes until the mixture becomes a concentrated black tar.[1 5] Some products made in South America contain *N rustica*[14]; however, due to the tar-like consistence of chimó, FT/IR was inconclusive in determining the tobacco species present in these products. The high concentration of nicotine in chimó products is undoubtedly influenced by the nicotine content of the tobacco used and the preparation of the product.

The pH values in the international products (pH 5.2–10.1) (see figure 2) exceed the pH values found recently among top selling US moist snuff products (pH 5.5–8.6). Approximately 40% of the international products had pH values exceeding the highest value found for US moist snuff products (pH 8.6).[12] Total nicotine among the international brands ranged from 0.16 to 34.1 mg/g product. For comparison, US moist snuff products range from 4.4–14.2 mg/g product with a single product as high as 25.0 mg/g product.[12] Due to higher alkalinity and, in some cases, higher nicotine values, unionised nicotine had a much wider range (0.05–31.0 mg/g product) in many international products than found among US moist snuff products (<0.1–7.8 mg/g product).[12]

In this study, one toombak product had the highest concentrations of all five TSNA compounds, with NNN and NNK concentrations of 368 000 and 516 000 ng/g product, respectively. For comparison, the highest levels of NNN and NNK in

Table 3 The concentrations of five tobacco-specific *N*-nitrosamines (TSNAs) found among various international oral tobacco products

Sample description	Country of origin*	TSNAs,† ng/g NAB Mean	NAB SD	NAT Mean	NAT SD	NNK Mean	NNK SD	NNN Mean	NNN SD	NNAL Mean	NNAL SD	Total TSNAs (ng/g)
Special Gul Powder	B	2370	20	4770	90	1370	50	8020	370	590	40	17100
Eagle Gul Powder	B	1980	30	4240	80	1330	20	5190	410	630	80	13400
Sada Pata Tobacco Leaf	B	68.9	10.4	294	25	21.7	4.1	165	15	24.5	7.6	574
Hakim Pury Zarda	B	6030	190	11800	500	3840	250	28600	1600	3460	310	53700
F. Rahman & Co Zarda	B	1020	5	3110	60	457	4	4280	120	248	13	9120
Baba Zarda 120	I	210	11	1150	50	829	29	2910	120	390	30	5490
Super Raja Khaini	I	2580	70	2220	30	502	23	16800	400	1440	30	23500
Spitt Raja Chap Khaini	I	2190	120	303	10	288	30	17500	700	1350	50	21600
Gutkha product 1 (handmade)‡	I	1600	450	2310	600	375	84	18600	4800	1030	290	23900
Gutkha product 2 (handmade)	I	10.0	1.8	51.8	7.8	20.2	5.3	154	28	27.7	4.8	264
Gutkha product 3 (handmade)	I	13.9	0.6	41.5	3.2	7.1	1.2	192	3	23.4	1.4	278
Gutkha product 4 (handmade)	I	9.64	0.94	125	2	20.4	0.8	208	17	10.8	0.9	374
Gutkha product 5 (handmade)	I	184	12	284	10	47.3	2.4	1610	30	57.9	2.2	2180
Gutkha product 7 (handmade)	I	28.6	1.1	85.4	7.8	46.2	5.3	292	23	13.5	0.9	466
Rajdarbar Gutkha	I	11.3	3.3	111	19	57.1	9.3	167	24	23.2	2.7	370
Shikhar Gutkha	I	6.2	0.69	110	14	58	6.5	177	28	36.2	4.4	387
Sitar Gutkha	I	85.3	8.9	282	15	241	29	1080	80	77.2	6.6	1770
Bahar Gutkha	I	16.2	4.6	100	25	68.7	20.4	206	50	29.6	6.2	420
Dhamaal Gutkha-Saffron	I	133	30	126	31	456	121	1280	280	258	77	2250
RMD Gutkha	I	52.9	7.5	118	26	236	42	587	96	103	15	1100
Gutkha (handmade; Karachi)§	P	5.44	0.64	14.4	1.1	11.6	1.1	45.4	4.9	7.02	1.52	83.9
City Gutkha-Saffron	P	12.8	0.6	76.9	6.7	64.5	2.3	174	10	37.3	3.2	366
JM Gutkha Extra Strong	P	91.4	13.2	290	29	208	12	913	39	53.5	10.6	1560
Mawa	P	5.49	0.23	16.2	2	4.47	1.4	65.5	4.2	3.98	0.24	95.6
Mainpuri	P	17.3	1.8	63.5	3	6.05	1.26	106	3	25.9	2	219
Naswar, sample 1	P	19.8	0.6	56.9	1	29.4	3.4	363	16	8.56	1.48	478
Naswar, sample 2	P	85.3	8.9	342	13	309	12	545	14	104	1	1380
Toombak, sample 1 (black)	S	119000	400	17100	200	149000	3000	119000	300	5790	4950	302000
Toombak, sample 2 (black)	S	302000	200	17200	1300	152000	8000	119000	7000	4550	230	305000
Toombak, sample 5 (brown)	S	41500	800	59600	4900	516000	53000	368000	3000	6770	360	992000
Toombak sample 7 (black)	S	11100	200	16600	300	147000	6000	115000	2000	5470	3590	295000
Nigerian Snuff (traditional)	N	50.2	4.2	444	20	285	3	711	19	29.5	6.3	1520
Joseph & H. Wilson 99 Snuff	N	51.9	2.0	418	50	365	54	1460	180	125	16	2420
NTSU Ugway Snuff	SA	29.4	12.9	653	21	130	6	892	94	3.58	2.35	1710
South African Snuff (traditional)	SA	629	7	12600	30	1610	78	5570	150	71.8	6.8	20500
Singleton's Super Menthol Snuff	SA	58.0	12.4	696	80	347	69	1590	250	40.1	19.2	2730
Super Taxi Snuff	SA	175	14	565	49	242	77	3400	60	287	27	4670
Peter Stuyvesant Menthol Snus	SA	65.4	8.8	827	33	275	37	1290	40	30.4	13.0	2490
Peter Stuyvesant Blue Snus	SA	41.9	0.8	521	26	202	48	925	61	30.1	7.5	1720
Svenskt Tobacco-rette Snus	SA	114	4.0	1360	10	1340	20	2950	110	84.2	0.4	5850
Lucky Strike Original Red Snus	SA	73.0	11.2	632	135	171	35	1190	260	18.6	8.7	2080
Lucky Strike Menthol Snus	SA	86.4	7.9	881	76	267	31	1440	40	29.4	8.7	2700
General Original Snus	SW	20.8	0.4	248	14	96.4	4.2	345	32	12.5	0.7	723
General Loose Snus	SW	17.7	1.1	224	13	105	4	293	12	12.8	3.0	652
General White Wintergreen Snus	SW	17.1	1.8	214	24	89.8	9.5	267	23	12.8	1.3	601
General White Portion Snus	SW	17.5	1.5	225	10	96.8	4.6	296	22	13.1	2.8	648
Catch Peppermint Snus	SW	13.4	1.4	229	18	84.5	8.2	295	23	8.57	0.77	630
Nasway	UZ	71.4	7.2	297	39	88.3	8.6	628	43	10.5	2.1	1100
Vencedor Chimó	V	57.3	2.8	602	16	902	65	3310	210	290	66	5160
Fabrica De Chimó	V	173	11	668	56	2600	100	4620	240	1330	110	5880
El Tigrito Chimó	V	103	2	965	96	1760	160	2620	92	431	37	954
El Tabacote Chimó	V	21.7	2.4	224	30	532	46	329	30	53.3	12.4	1160
Chimó La Chinata CA	V	19.1	5.9	292	49	310	131	318	87	14.9	5.6	9390

All TSNA measurements were made in triplicate and presented as ng/g wet weight. TSNA values were produced from measurements of three separate samples of tobacco (n=3) unless otherwise noted.

*Tobacco-specific N-nitrosamines measured in the study include N′-nitrosoanabasine (NAB), N′-nitrosoanatabine (NAT), N′-nitrosonornicotine (NNN), 4(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK), and 4-(methylnitrsoamino)-4-(3-pyridyl)-1-butanol (NNAL).

† Countries are identified as B=Bangladesh, I=India, P=Pakistan, S=Sudan, N=Nigeria, SA=South Africa, SW=Sweden, UZ=Uzbekistan, and V=Venezuela.

‡ Handmade gutkha products bought from street vendors in Rapar, India.

§ Handmade gutkha products bought from street vendors in Karachi, Pakistan.

265

US moist snuff products were 42 600 ng/g and 9950 ng/g product, respectively.[12] The highest NNK levels in one toombak product was 50 times greater than the maximum concentration found among US moist snuff products.[12] The total TSNAs (sum of all five TSNAs) in the international products analysed in this study ranged from 83.9–992 000 ng/g (table 3), whereas total TSNAs in US moist snuff ranged from approximately 4900–90 000 ng/g.[12] A combination of factors, such as pH, tobacco type, nitrate fertilisation/uptake, curing, fermentation and storage conditions, could contribute to these extremely high TSNA concentrations. Moreover, salivary TSNA concentrations in the oral cavity of toombak users reach the low ppm (μg/ml) range,[17 18] thus, it is not surprising that 68% of oral cancers in Sudanese men are attributed to the use of toombak or other oral products.[3]

In addition to toombak, several other products, including zarda (Pakistan) and khaini (India), also had very high TSNA concentrations compared with US moist snuff.[12] Even though oral tobacco products, such as zarda, gutkha, or snuff, share the same name, in different countries the chemical composition can be different. Swedish snus had relatively low concentrations of most of the TSNAs, particularly NAB, NNK and NNAL. Although snus products purchased in South Africa had relatively low TSNA concentrations, Swedish snus products were at least four times lower. The concentrations of TSNAs in South African snus were also higher than a local South African snuff product (NTSU) not manufactured by using GothiaTek,[21] the strict Swedish tobacco industry standards governing allowable toxicant content in snus. This observation, together with lower TSNA concentrations in other traditional products, suggests that such products could be produced with lower TSNA concentrations. Effective product regulation and testing and the dissemination of best manufacturing practices across nations, particularly with respect to manufacture of traditional products, could have a positive net effect in reducing carcinogen levels. The Surgeon General concluded that tobacco products should be no more harmful than necessary given available technology.[22]

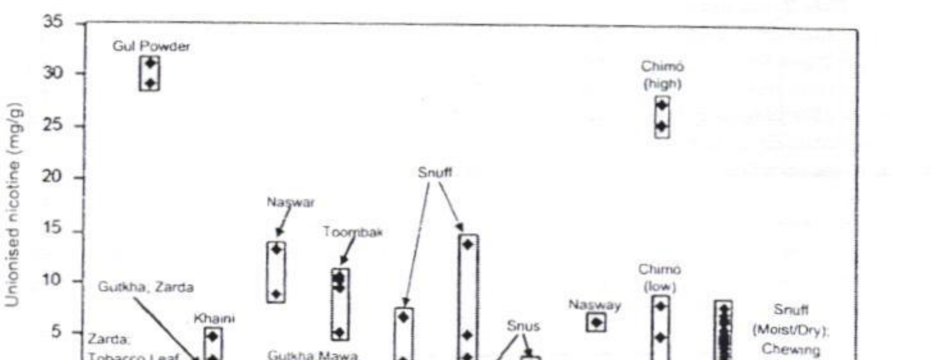
Our findings confirm that TSNA levels vary widely in oral tobacco products. Factors, such as pH, nitrate content, tobacco type, curing, fermentation and storage conditions, which can be altered, could influence the TSNA content of a product. The data in this paper suggest that oral tobacco products can be produced with lower TSNA content. Efforts to reduce TSNAs in tobacco would likely reduce exposure to these known human carcinogens. Moreover, individual use factors, such as the type and amount of product used and duration of use, may affect the delivery, exposure and health risk. Oral tobacco products are highly diverse and present a complex array of potential health hazards. The use of cigarettes and oral tobacco makes estimating the cumulative exposure risks more difficult. Even among dedicated oral tobacco users, the availability and opportunity for using a wide variety of different oral tobacco product types makes risk assessment more challenging.

The concentration of unionised nicotine in an oral product is likely the primary characteristic that determines the extent of tobacco-dependent addiction that, in turn, results in repeated exposure to many harmful tobacco-related constituents during long-term use. The concentration of total nicotine alone may not adequately explain nicotine delivery and response. Alkaline agents can substantially increase nicotine absorption rates by converting nicotine to its most rapidly absorbed form. Moreover, use of nicotine-enriched tobacco (ie, *N rustica*) in some products (eg, gul powder, toombak) or processes that concentrate nicotine in a tar-like product (ie, chimó), could contribute to high nicotine concentrations, which in the presence of elevated pH, yield high unionised nicotine concentrations (figure 3). Potential modification of pH levels through addition of varying levels of alkaline modifiers could produce products with lower unionised nicotine levels suitable for initiation and products with progressively higher unionised nicotine and greater addiction potential that might facilitate product graduation.[3 7 8] The wide concentration ranges seen among certain product types (eg, toombak, chimó, snuff) could help provide data useful on an empirical basis for specifying different or multiple maximum allowable concentrations for nicotine, pH and various toxicants as a function of product type by organisations such as WHO[23] and the US Food and Drug Administration.[24]

Limitations

Oral tobacco products sent to CDC were a convenience sample available to our research partners at the time of the request and with their available financial resources; research partners were not reimbursed for the purchase or shipping of these products. These products do not represent an exhaustive sampling of

Figure 3 Unionised nicotine concentrations (mg/g) in oral tobacco products from 10 countries from 5 WHO regions.



¹ Data for U.S. moist snuff brands were reported previously[12]; range of pH and percentage of unionised nicotine for chewing tobacco (e.g., loose leaf, plug, and twist) and dry snuff were determined by Lawler *et al.* (unpublished results from the CDC Tobacco Analysis Laboratory).
² Countries: B=Bangladesh, I=India, P=Pakistan, S=Sudan, N=Nigeria, SA=South Africa, SW=Sweden, UZ=Uzbekistan, VZ=Venezuela, US=United States.
³ WHO Regions: SEASIA=Southeast Asia Region, EMRO=Eastern Mediterranean Region, AFRO=African Region, EURO=European Region, AMERO=Region of the Americas.

266

individual countries geographically or a particular product group (eg, snuff, chimó, etc.). Due to wide variety of values found among the entire set of global products, analysis of one or a few samples of a particular product type gives a limited but informative view of product constituents. Further research with a larger set of products from each product group and more extensive sampling (ie, greater number of analyses) will be required to fully characterise these products so that they can be compared within a product group. In this study, sample measurements were made in triplicate. A greater number of measurements would be required to provide the level of statistical power necessary to make meaningful comparisons between individual products with very similar values. The results for these international products represent the analyte concentration in the products at the time of testing. The amount measured also does not translate directly into absorbed amount. The amount actually absorbed by users depends on numerous product characteristics, use parameters (e.g. amount used) and physiological differences in individual users. Even with these limitations, a clearer picture of oral tobacco as an inhomogeneous and diverse group of products has emerged from this global study.

Conclusions

Oral tobacco products are a chemically diverse group of products that can contribute to numerous health problems, including cancer and cardiovascular disease. Differences in the tobacco used, the various methods of curing and preparation, and the nature of other substances added to these products prior to use yield a varied group of products. When referring to such a diverse group of products, the term 'oral tobacco' is preferable to 'smokeless tobacco', as some of these products (eg, snuff, fire-cured dry snuff, iq'mik)[1 5 6] are made using fire-cured tobacco that contains smoke-derived chemicals including phenols, PAHs and TSNAs also found in cigarette smoke.[10 25]

The global sample of oral tobacco products analysed here contained a wide range of pH levels and total nicotine, unionised nicotine, and TSNAs concentrations with some products containing NNN and NNK levels exceeding daily levels delivered in cigarette smoke.[26] Tobacco products with higher unionised nicotine and TSNA levels generally leads to greater deliveries[7 13 26] and, in some cases, may translate to higher risks for adverse health outcomes.[3] Our data does not support oral tobacco products, as a class, being viewed as 'safer' or as providing a 'reduced harm' alternative to smoking. The possibility of dual use of tobacco products expands the potential for addiction and exposure to harmful constituents and may reduce the likelihood of complete abstinence from all tobacco products. At present, the only known means to reduce risk from tobacco is through cessation.

Oral tobacco products should not be routinely lumped together as a homogenous product category and considered as a single, equivalent product nor should their use be considered in isolation from other concurrent tobacco use. The drawing of broad conclusions about oral tobacco products based on limited data obtained on select samples from specific localities could be very misleading. Further studies to better characterise individual oral tobacco products, their diverse contents, the exposure of users to these products and the role of oral tobacco taken alone or in combination with other forms of tobacco are needed to provide crucial science to help inform consumers and also those involved in policy decisions and recommendations for tobacco control.

What this paper adds

- Oral tobacco is often viewed as a homogenous set of products; however, on a global basis, oral tobacco products vary from simple tobacco-only products to those containing substantial amounts non-tobacco ingredients including various flavour additives or pH modifiers. Past studies have focused primarily on groups of related products or products from a particular geographical region or country. This study treats smokeless tobacco on a global basis to show the ranges of nicotine, tobacco-specific *N*-nitrosamines (TSNAs) and pH that exist among these heterogeneous products.
- This paper is one of the first to examine nicotine, pH and toxic constituents across a diverse spectrum of oral tobacco products distributed globally. Because these diverse products were characterised in a single laboratory, the differences in concentration levels are meaningful and can be readily used to compare product categories. The observed wide concentration ranges of nicotine, unionised nicotine, TSNAs and pH values suggest that the impact on addictiveness, toxicity, or carcinogenicity of a given product type are not uniform and the oral tobacco products should not be lumped into a single category.

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Competing interests JEH serves as a consultant through Pinney Associates to GlaxoSmithKline Consumer Healthcare on an exclusive basis regarding matters relating to smoking cessation, has a financial interest in a potential new nicotine replacement product, and has provided expert testimony against the tobacco industry. The other authors declare they have no competing interests.

Contributors SBS was project manager, performed FT/IR analysis, 30% of pH analysis, 40% of nicotine analyses and was author of the first draft. GNC was study originator, coordinated sample acquisition and was involved in writing/editing of the paper. LZ performed 100% of TSNA analyses and was involved in editing the paper. LTJ performed 60% of the nicotine analysis and 30% of pH analyses. JEH was involved with extensive writing/editing of the paper. PR performed sample acquisition and extensive writing/editing of the paper. TL performed 40% of pH analysis, sample preparation for 40% of nicotine analysis, and extensive editing of the paper. OAA-Y performed extensive writing/editing of the paper. DLA was involved with writing/editing of the paper. CHW was involved with writing/editing of the paper and statistical analysis.

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817

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ANNEXURE - 1

BRIEF REPORT

Levels of toxins in oral tobacco products in the UK

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Objective: This study examined the constituents of smokeless tobacco products available in the UK and compared them with products available in India, Sweden, and the USA.
Methods: Seven UK brands of smokeless tobacco, including a tooth cleaning powder, and four international brands of smokeless tobacco were tested for a range of toxins and known carcinogens, such as tobacco specific N-nitrosamines (TSNA), as well as nicotine availability.
Results: Ten of the 11 brands tested had detectable levels of tobacco specific nitrosamines, which are proven carcinogens, and levels varied 130-fold. All had detectable levels of benzo(a)pyrene, another proven carcinogen (with around 175-fold variation) and several toxic metals (with nearly 150-fold variation). Nicotine availability varied in the UK products from 0.1 mg/g to 63.2 mg/g. All the tobacco products tested are likely to be hazardous to users' health, but the data indicate that it should be possible to reduce key toxins to non-detectable levels.
Conclusions: Smokeless tobacco products should be regulated and standards set for maximum levels of toxins and carcinogens.

Cigarettes are by far the dominant form of tobacco used in the UK, with small numbers of people also smoking tobacco in other forms such as cigars and pipes. Smokeless tobacco products are much less common in the UK than in countries like India where they represent over a third of all tobacco consumed.[1] Nevertheless, one main form of smokeless tobacco, chewing tobacco (a form of smokeless tobacco consisting of loose leaf tobacco in pouches of tobacco leaves, "plug" or "twist" form), is used in the UK, particularly among people of South Asian origin. Of the 2.4 million South Asians in the UK, estimates of smokeless tobacco usage vary from 27–98% depending on the community and sex.[2] The other main form of smokeless tobacco, oral snuff, is banned throughout the European Union[3] except in Sweden because of the traditional and widespread use there among men of snus (a form of moist oral snuff in which a pinch of tobacco or a teabag-like sachet of tobacco is placed between the lip and gum).

The chewing tobacco forms used in the UK are similar to those commonly used in Southern Asia and often involve other substances, and include:

- Gutkha—a sweet chewing tobacco containing betel leaf, catechu, and saffron.
- Zarda—a moist or dry chewing tobacco mixed with a variety of colourings, spice essences, and perfumes.
- Dried whole and chopped tobacco leaves—often purchased in shops to be used in oral preparations (the leaf can be ground to prepare a type of zarda).
- Tooth cleaning powders—originating from Southeast Asia and comprising abrasive powdered tobacco with aromatic ingredients added to make the breath sweet.

Some of these products, such as zarda and dried leaves, are used in conjunction with paan (or betel quid which is a combination of betel leaf, areca nut, and lime paste) and are individually made to one's own taste, so the ingredients vary and commercialisation of the products is limited.

Smokeless tobacco products deliver nicotine and are dependence forming. In South Asia the use of chewing tobacco causes considerable health risks; in particular, it is a major cause of oral cancer and is also harmful in pregnancy.[4] A recent study[1] demonstrated substantial amounts of tobacco specific nitrosamines (TSNAs) in smokeless tobacco products marketed in India. TSNAs are the most common carcinogens in unburnt tobacco which are formed during the aging, curing, and fermentation of tobacco.[5] Given similar types of tobacco are allowed on the market in Europe, concerns have been expressed that they may also pose health risks. This study therefore examined chewing tobacco products purchased from outlets in the UK and compared their toxin content and nicotine availability with snus and three other forms of smokeless tobacco purchased in India and the USA.

METHODS

Twenty five consumers and 25 shopkeepers (aged 16 or above) were selected opportunistically from South Asian communities from two locations in the UK, chosen because of their high prevalence of people from South Asian communities, and administered a short questionnaire requesting information concerning popular smokeless tobacco products used by these communities. The responses of the two populations were compared in order to identify 17 most popular brands, a method used in other studies.[6] Samples of these were then purchased randomly from different shops and locations and analysed by the Laboratory of the Government Chemist for a variety of toxins. The results of this pilot test were used to identify a smaller subsample of seven products, including some having the highest levels of some of the toxins: two gutkha products (Manikchard and Tulsi mix), three zarda products (Hakim Pury, Dulal Misti, and Baba Zard Gulabi Patti), one tooth cleaning powder (A Quardir Gull) and a tobacco leaf. These products were then tested alongside four international products: the most popular zarda product in India (Baba 120), snus (general pouch) from Sweden, and two smokeless tobacco products available in the USA (US Copenhagen snuff original fine cut, the leading snuff brand for a few decades, and Ariva, a more recent addition to the US market, a tablet of tobacco placed in the mouth and allowed to dissolve slowly). Zarda products in India were recently shown to have

Abbreviations: BaP, benz(a) pyrene; NAB, N-nitrosoanabasine; NAT, N-nitrosoanatabine; NDMA, N-nitrosodimethylamine; NNK, 4(methylnitrosamino)-1-(3-pyridyl)–butanone; NNN, N-nitrosonornicotine; TSNA, tobacco specific nitrosamine

216

relatively high TSNA levels.[1] In contrast, the manufacturers of snus and Ariva claim that these products have very low levels of certain toxins and carcinogens.[7,8] Levels of TSNA have recently been found to be very low in snus[9] with some evidence that users of this product have minimal levels of carcinogen uptake.[10]

The products were purchased using a consistent methodology. Five samples of each product were chosen randomly from shop displays from each of three shops chosen randomly from the East London area, Mumbai in India, Stockholm in Sweden, and New Jersey in the USA. The products were received over a period of four months and stored in a freezer before being tested when the 15 samples were mixed thoroughly to yield representative samples of each product.[11]

The products were tested for 4 TSNAs (N-nitrosonornicotine (NNN), N-nitrosoanatabine (NAT), N-nitrosoanabasine (NAB), and 4(methylnitrosamino)-1-(3-pyridyl) – butanone, (NNK)), N-nitrosodimethylamine (NDMA), a marker for volatile nitrosamines and a carcinogen, toxic metal content, nitrites (which react with nicotine or other alkaloids contained in tobacco to form TSNAs), and benz(a) pyrene (BaP), another established carcinogen. Total TSNA content was calculated by adding NNK, NNN and NAB. Moisture content, nicotine content, and pH (a measure of alkalinity thought to influence buccal absorption of nicotine through affecting the proportion of nicotine in freebase form) were measured and the latter two measures used to calculate the proportion of freebase nicotine (unprotonated nicotine, absorbed much more quickly through the mucous membrane than protonated nicotine[12,13]). Methodologies used were based on Centers for Disease Control, Health Canada, International Standards Organisation (ISO) Standards or in house techniques based on the most up to date literature.

RESULTS

Table 1 shows the characteristics of the products measured in this study. Dry weight measurements are given as the moisture levels of the samples varied considerably (from 1.7–48%).

TSNA levels ranged from non-detectable (in Ariva) to 5.12 μg/g n the tooth cleaning powder and to 29.7 μg/g in Hakim Pury. Four other samples had significant levels of total TSNAs (>1 μg/g). For benz(a)pyrene (BaP), all the products had detectable levels, ranging from 0.11 ng/g in the tobacco leaf to 19.33 ng/g in the Copenhagen samples. Among the UK purchased products Dalal Misti Zarda had the highest level with 8.89 ng/g content of BaP. All products had non-detectable levels of NDMA except the tooth cleaning powder, and non-detectable levels of nitrite except for Copenhagen. All products had detectable levels of the four toxic metals tested in this study. Although the two UK gutkha products had the lowest toxic metal content, in all cases except for lead (where the highest level was in the Indian purchased brand) the highest toxic metal contents were found in other UK purchased products. The tooth cleaning powder generally showed the highest levels. Nickel was the most predominant metal found.

Nicotine content ranged from 3 mg/g in one gutkha product to 83.5 mg/g in the tobacco leaf. The pH ranged from 4.9 to 9.9 for these samples, the tooth powder and the two gutkha products being the most alkaline. Freebase nicotine was highest in the tooth cleaning powder at 63.2 mg/g nicotine; it was high also in the two gutkha products (at 3 and 8 mg/g nicotine in Manikchard and Tulsi mix, respectively), and in the products originating from Sweden (6.3 mg/g) and the USA (2.4 mg/g for Ariva and 4.9 mg/g for Copenhagen), with the remaining products less than 1 mg/g.

DISCUSSION

To our knowledge this is the first study to examine the toxin content of chewing tobacco products used in the UK. All of the products had detectable levels of at least some of the carcinogens examined, and are therefore likely to be hazardous to users' health. Some UK products (in particular one zarda product and the tooth cleaning powder) are of great concern as they have high levels of some established carcinogens and are clearly putting the health of users at risk. These products also had the highest toxin levels in the pilot test. It is not clear why the levels of toxins varied and further research is needed to establish the contribution played by selection, curing, and manufacturing processes,[14] and shelf life.[15] It cannot be assumed that products with low levels of the toxins measured in this study are safe as only a small number of toxins were measured.

The high levels of carcinogens appear unnecessary as levels of the same toxins in other smokeless tobacco products (some of which are banned in the UK) are considerably lower. In addition, while all the products release nicotine, two UK products had the highest proportions of freebase nicotine suggesting that they may also be the most addictive.

As the UK products have established usage within Asian communities in the UK and are very much part of their culture, we are not suggesting that these products be banned. Instead, toxin standards should be set for all the smokeless tobacco products available on the UK market, with a reasonable timescale for compliance. The toxin standards set by parts of the industry—for example, the Gothiatek Standard by Swedish Match[7]—could be used as a starting point, but it should be possible over a short time frame to reduce the key toxins and carcinogens to the lowest levels which are technically feasible which in most cases would be non-detectable levels (shown in this study and other research to be technically feasible[9]). Standards for other similar products could also be used as a starting point—for example, the tooth cleaning powder should be subject to the same regulations as other toothpastes or removed from the market. It is also clear that standards would need to apply for imported products and such a regulatory framework may therefore need to be agreed internationally so that the proposed standards are implemented and monitored in countries where these products are manufactured. Where the products are not commercially produced (for example, the tobacco leaf) it will be more difficult to set stringent standards for toxins. A starting point may be to set a higher level, with random testing carried out by local trading officers to check that the leaves sold comply with the regulations. Further research into the demand for tobacco leaves is necessary before deciding how to apply stronger regulations to the product or take them off the market.

When reducing carcinogens, however, the products must be monitored to ensure that the reduction of, for example, TSNAs is not accompanied by unwanted side effects in the form of increased levels of other toxins. No communication about these reductions should be made to the consumer because although they are likely to make the products less harmful, they will not make the products safe.

Over time, consideration could be given to setting standards for a broader range of specifications such as pH and free nicotine. However, further research is needed because the consequences of such a strategy are unknown and may lead to greater use of the products to satisfy a consumer's addiction.

The introduction of toxin standards will raise the need to consider lifting the ban on oral snuff in the UK for compliant products.[16] If the ban is lifted, tight regulatory controls would be needed on the marketing of such products to prevent an increase in demand for them. The dangers of smokeless

270

Table 1 Content of smokeless tobacco products tested in this study*

Brand	Moisture % w/w	TSNA† µg/g	BaP ng/g	NDMA ng/g	Nitrite µg/g	Chromium mg/kg	Nickel mg/kg	Arsenic mg/kg	Lead mg/kg	Nicotine mg/g	Average pH	Free nicotine mg/g
UK purchased products												
Gutkha products												
Manikchard	1.68	0.289	0.40	ND	ND	0.26	1.22	0,04	0.15	3.1	9.19	3.0
Tulsi mix	1.25	1.436	1.28	ND	ND	0.33	1.43	0.06	0.19	8.2	9.52	8.0
Zarda products												
Hakim Pury	4.91	29.705	0.32	ND	ND	2.15	5.35	0.29	1.36	42.7	6.00	0.4
Dalal Misti Zarda	8.96	1.574	8.89	ND	ND	0.87	2.09	0.11	1.14	8.6	6.15	0.1
Baba Zarda (GP)	7.88	0.716	2.04	ND	ND	2.34	5.88	0.24	1.18	48.4	5.32	0.1
Tooth cleaning powder												
A. Quardir Gull	3.35	5.117	5.98	7	ND	3.56	5.31	0.46	1.39	64.0	9.94	63.2
Dried tobacco leaves												
Tobacco leaf	5.16	0.223	0.11	ND	ND	2.34	4.37	0.20	1.06	83.5	5.52	0.3
Products purchased outside UK												
Baba 120 (India)	13.18	2.361	2.83	ND	ND	2.08	2.94	0.40	1.56	55.0	4.88	0.04
Snus (Sweden)	45.84	0.478	1.99	ND	ND	1.54	2.59	0.30	0.50	15.2	7.86	6.3
Ariva (USA)	2.40	ND	0.40	ND	ND	1.40	2.19	0.12	0.28	9.2	7.57	2.4
Copenhagen (USA)	48.10	3.509	19.33	ND	6.7	1.69	2.64	0.23	0.45	25.8	7.39	4.9
Detection limits		0.025 for each		5	0.2							

*All figures are averages of two measurements except for pH which gives the average of three measurements. On average measurements agreed by less than 10%.

†Total TSNA = total tobacco specific N-nitrosamines = NNK+NNN+NAB.

BaP, benz(α)pyrene; NDMA, N-nitrosodimethylamine.

What this paper adds

It is already known that types of smokeless tobacco commonly used in Southern Asia contain high levels of toxins and carcinogens and cause considerable health risks. Similar tobacco products are used in the UK, particularly among people of South Asian origin, but no research has been carried out on their content.

This work demonstrates that smokeless tobacco products available in the UK vary greatly in concentrations of nicotine, toxic metals, and carcinogens, often containing higher levels than products which are not allowed on the market. We recommend that these products are regulated and standards set for maximum levels of toxins and carcinogens, which could be internationally applied.

tobacco use would need to be communicated widely to all consumers in the UK and users should be actively encouraged to give up.[17] However, smokeless tobacco users should also be informed about the much greater health risks of cigarette smoking to prevent them switching to this more dangerous form of nicotine delivery.

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Annexure 8

Final Report

Of

Project on Laboratory Testing of Smokeless tobacco products

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INDEX

Annexes

275

1. Objectives

1. To catalogue different categories of tobacco products from different parts of India
2. To collect sample of these products by purchasing them and documenting purchases
3. To photographically document the tobacco product samples
4. To do chemical analysis of these products with primary aim of getting nicotine content

2. Justification

Smokeless tobacco products are tobacco products without combustion or pyrolysis at the time of use. Tobacco induced disease is a major international public health challenge of which Smokeless tobacco induced disease is a significant part. Governments and health workers sometimes ignore the actual and potential health damage caused by Smokeless tobacco use. The prevalence of smokeless tobacco use is relatively high in South Asia. Approximately 100 million people in India and Pakistan use smokeless tobacco, mainly as a constituent of traditional chewing mixtures.

In India a vast array of smokeless tobacco products are used. All these products reveal adverse health consequences. Oral tobacco use can lead to nicotine dependence and addiction. There is conclusive scientific evidence that the use of smokeless tobacco causes cancer in humans. The evidence is strongest for cancers of the oral cavity, but the risk of cancers of the pharynx, larynx, oesophagus, pancreas and urinary tract are also increased. Smokeless tobacco use also increases the incidence of periodontal disease and causes oral leukoplakia, which in some cases may become malignant, and may contribute to cardiovascular disease, and peptic ulcer. A few cohort studies from India demonstrate significant excess of all cause mortality among smokeless tobacco users. Several studies of smokeless tobacco use by pregnant women in India demonstrate adverse reproductive outcomes, especially low birth weight. In India, as in many parts of South East Asia, oral cancer is a leading type of malignancy. Oral leukoplakia and oral submucous fibrosis, assumed to be precursors of oral cancers are also highly prevalent and increasing in the young.

During the Global Youth Tobacco Survey that has been completed in 13 states and ongoing in eight more, several new smokeless tobacco products that are in use in different parts of the country have been discovered. They include a large variety of manufactured pan masala and gutka products, red tooth powders, gul and toibur (nicotine water). In fact some of them for example red tooth powders, do not even mention that they contain tobacco. We got some samples of red tooth powders tested for their nicotine content in a laboratory and the results showed substantive nicotine content. It is obvious that they do contain tobacco. These results combined with general ignorance amongst the lay public as well as scientists working on tobacco control clearly underscore a need for conducting a systematic study of different smokeless tobacco products

3. Smokeless tobacco products: an overview.

Chewing tobacco in India is made from Nicotiana rustica and N tabacum. The tobacco leaves are harvested when they turn yellow and brown spots start appearing: the leaves remain in the field and are turned over to achieve uniform drying. They are then tied in bundles and moistened by sprinkling with water; the bundles are stacked for fermentation for a couple of weeks, separated and dried again. The leaves are cut into various sizes. Tobacco is chewed in betel quid and may sometimes be chewed as such. Chewing tobacco in betel quid being the commonest form of smokeless, tobacco use in India. The tobacco used in the quid however varies; it may be processed (Zarda, Kiwam) or unprocessed (Hogesoppu, Kadippudi in Karnataka).

Tobacco is commonly used with lime, (Khaini), and placed in the mouth, in one or both cheeks or in the mandibular groove. This mixture is available in various pouches or may also be prepared fresh. Mawa, popular among teenagers especially in Gujarat, contains thin shavings of areca nut with some sun-dried tobacco and slaked lime. A similar product used in Maharashtra is called Kharra.

Zarda, which is produced and used in India, is also exported to countries across the world. Tobacco leaf, broken into small pieces is boiled in water with lime and spices until evaporation. The residual particles are then dried and colored with vegetable dyes to produce Zarda. It is typically flavoured with cardamom and saffron. Zarda is usually chewed mixed with finely cut areca nut and spices, or is placed in the betel quid.

Gutka, a dry preparation commercialised since 1975, containing areca nut, slaked lime, catechu, condiments and powdered tobacco, was originally available custom mixed from pan-vendors. For the last couple of decades, Gutka has been available in several brands. A similar packaged mixture without tobacco, often with identical brand name is called pan masala. These products have become especially popular among teenagers and young adults in many states of India. Moist Swedish snus is now being marketed in India under the brand name Click.

Mishri is a form of tobacco used in India as a substitute for chewing tobacco. It is a roasted or half-burnt tobacco, prepared by baking tobacco on a hot metal plate until it becomes uniformly black. It is then powdered and used primarily for cleaning teeth. However its use frequently becomes habitual, and a user may apply and retain mishri in the mouth (usually along the teeth and sulcus) several times a day. Bajjar and Gul are used as dentifrice in Gujarat and eastern parts of India. Gudakhu is tobacco paste made with molasses. Creamy snuff or tobacco toothpaste advertised as being antibacterial is popular in western parts of India.

toxicity. Chromium exposure is associated with lung and certain upper respiratory tract cancers and also with renal tubule dysfunction.

pH:- pH is an important factor that influences nicotine delivery, (determines the absorption rate of nicotine into the body). Nicotine is protonated and occurs in the particulate form in weakly acidic environment, whereas it occurs in the more toxic unprotonated form, and also in the vapour phase in alkaline environment.

Additives to smokeless tobacco products:-

Hundreds of ingredients are used in the manufacture of tobacco products. Additives make smokeless tobacco more acceptable to the consumer —control nicotine delivery, improve taste, flavour and aroma, and prolong shelf life. Many products are highly engineered, exquisitely designed "nicotine delivery devices".

Sodium carbonate and ammonium carbonate: - Increase the level of "free" nicotine by raising the pH level. Unprotonated (free) nicotine is the chemical form of nicotine that is most readily absorbed through the mouth into the bloodstream. Therefore, increases in pH can increase the user's nicotine absorption rate. Studies with nicotine and other addictive drugs suggest that the absorption rate of drugs into the body is an important determinant of their addiction potential.

Products with low nicotine content and pH levels have a smaller proportion of free nicotine. In contrast, products with high nicotine content and pH levels have a higher proportion of free nicotine

Ammonia: - increasing ammonia levels increase the pH thereby possibly enhancing nicotine delivery.

Eugenol and menthol: numb throat and facilitate tobacco use.

Sorbic acid: - added to tobacco as an anti-microbial agent.

Triacetin: added to tobacco as a flavorant.

Sodium propionate: - added to tobacco as a mold preventative or fungicide.

5. Activities

Major categories of smokeless tobacco products were identified. Commonly used Smokeless tobacco products from different parts of India were purchased with the help of friends and colleagues, mainly from stores in Gujarat, Karnataka and Mumbai. These products were purchased from regular retail shops and date of purchase, place of purchase and batch number of each purchase recorded (Annex-1). Gutka has been banned in the state of Maharashtra; Pan masala and Zarda of the same brand are available in separate pouches, which when mixed by the consumer is equivalent to Gutka. Some Gutka brands were also purchased from Gujarat.

As a first step towards chemical analysis of the Smokeless tobacco products, a thorough literature search was undertaken and a comprehensive list of toxigenic, mutagenic and carcinogenic components in smokeless tobacco products were identified and listed. Important additives to smokeless tobacco products were also listed. Though it was initially decided that only the Nicotine content and TSNA (tobacco specific Nitrosamines) content of each of these products would be measured, a host of other important ingredients were subsequently included for measurement. This dictated that the number of samples tested would be lesser, but would offer greater comprehensiveness.

The major components identified for testing were the alkaloids including nicotine, the tobacco specific nitrosamines, Benzo-a-pyrene, ammonia, nitrates and nitrites, heavy metals, triacetin, sodium propionate, humectants, sorbic acid, Eugenol, and animal hemoglobin.

Several laboratories that would possibly carry out these tests were contacted. The laboratory, which was finally identified as being the most credible and offering high quality assurance for its testing processes for most constituents identified, was the Indian Institute of Environmental Medicine, Mumbai. Dr. Rohini Chowgule is the Founder-Director, with the laboratory headed by Dr R. N. Khandekar, a retired scientist from the Bhabha Atomic Research Centre. Dr Khandekar was involved with testing of constituents of cigarette smoke, and was very much interested in proceeding with the proposed project. The list of constituents for which testing would be required was discussed with Dr Khandekar. The only one they were unable to do was animal hemoglobin.

The costs involved were negotiated; the cost for testing for all of the constituents for each of the Smokeless tobacco samples was negotiated at Rs. 13500 provided the testing was done in a batch of minimum of 20 smokeless tobacco products totalling Rs. 270000. This cost was 9 times higher than the cost we originally estimated and budgeted.

20 commonly used smokeless tobacco products were submitted to the Institute of Environmental Medicine, Mumbai. This included a range of products including the Gutkas, khainis, some brands of chewing tobacco, toothpastes, toothpowders, tobacco water and Click. Annex-1 lists the products tested.

The lab In contrast to 30 g of each sample that had been initially required by the lab for completing all of the testing processes, it was later realised that 300g would be required. 500g of each product was purchased and the extra 200g that remained after testing was retained in our office for future use and verification.

Smokeless tobacco products are available in pouches of various weights, ranging from 1-13g each, depending on the brand. A weighing scale with an error of 2g (max 500g, min 20g) was purchased for weighing of the smokeless tobacco products before dispatch to the laboratory. Few pouches of each product were opened and the contents weighed without the wrapper. It was found that all products contained approximately the same quantity as reported on the wrapper.

300g of each of the 20 products were handed over to the lab in their original pouches. Thus the lab was not blinded to the brands being tested. This was with the intention of not contaminating the products while transferring to a different pouch, preserving their shelf life, and for the ease of laboratory testing, in which small quantities are used at time.

6. Analytical techniques: An overview

In general, the Canadian standards for testing smokeless tobacco constituents were followed.

Weighing of tobacco samples was done accurately by means of Metlar analytical balance (0.1mg). All reagents used are recognised as analytical reagent grade in quality. Cleaned and dried glassware was used for testing purposes, so that contamination from glassware does not occur. Health and safety practices have been established prior to testing according to existing applicable regulatory requirements.

All analyses were done in duplicate. The control sample in each test served as a quality control measure. Each analytical run also included a laboratory reagent blank to evaluate the extent of any interference due to glassware, reagents and analyser effects. Each measurement was made against a blank preparation.

Procedures for estimation of the constituents was as follows.

The sample was first ground and sieved on a 20micron sieve. It was then extracted with known quantity of a suitable solvent and by appropriate physical means; use of ultrasonic bath, mechanical shaker, or after appropriate distillation as for triacetin.

The tobacco extract was subjected to analysis by most sensitive instrument and conditions of analyses for each constituent. A tabulation of the method of analysis used for the various constituents can be found in Annex-3.

pH was determined with a pH meter and magnesium carbonate by the titrimetric method. Quantification for most other constituents was achieved by internal or external standard calibration procedures where the relative response of the samples was compared against calibration with known standards.

A calibration curve was prepared by plotting the concentration of the standards versus their respective peak areas. The response factor was determined from the calibration curve. The calibration curves developed for each of the constituents are presented in Annex-4.

7a. DETERMINATION OF pH

This method is used to determine the pH of 10% w/v suspension of sample in water by means of a pH meter. The method utilizes a combination electrode and potentiometer standardized by buffer solutions to measure the pH.

Two g of homogenized tobacco from a freshly opened sample is extracted into 20 ml of degassed water on a mechanical shaker for 30 minutes. The sample is allowed to stand in dark for 1 hour. The supernatant is decanted into a 10 ml disposable polystyrene beaker.

The electrode and auto-temp probe are then inserted into the beaker containing the supernatant. The beaker is gently moved in swirling motion to create movement of the supernatant passing by the electrode.

A buffer of known pH (ph 6 – 7) is measured and the value obtained should be within 0.10 pH units of the expected value. The pH of the tobacco sample extract is then read. The pH in duplicate for the 20 samples are as presented under.

Sr. no	Product Name	pH analysis	
		pH1	pH2
1	Sanket 999Jarda + Sanket No. 1 Supari Mix	8.9	8.89
2	Moolchand Superb Jarda +Moolchand Superb Supari	8.56	8.55
3	Shimla Jarda + Shimla Supari Mix	8.8	8.79
4	Goa 1000 Zarda + Goa 1000 Supari	8.8	8.81
5	Gutkha Pan Parag	8.63	8.62
6	Gutkha Manikchand	8.75	8.74
7	Click Eucalyptus	6.95	6.94
8	Baba Zarda 120	5.21	5.22
9	Dentobac Creamy Snuff	7.52	7.5
10	Lime Mix - Miraj Tobacco	10.1	10.11
11	Shahin Mishri	6.53	6.54
12	Dabur Red Tooth Powder	6.76	6.75
13	Baidhyanath Red Tooth Powder	5.74	5.75
14	Gai Chhap Zarda	5.96	5.95
15	Raja Khaini	8.45	8.46
16	Gutkha Tulsi Mix	9.25	9.24
17	IPCO Creamy Snuff	8.35	8.34
18	Kuber Gutkha	8.92	8.93
19	Vimal Gutkha	9.06	9.07
20	Tuiber Tobacco Water	9.26	9.25

7b. ESTIMATION OF AMMONIA BY U.V. SPECTROMETRY

One gram of sample was mixed with 200 ml of D.D.W. and transferred to the distillation flask of Kjeldahl's apparatus. Few antibumping granules were also added to the flask to promote regular ebulliation in the subsequent distillations.

100 ml of standard 0.1 M HCl was placed in a receiver and the flask was adjusted so that the end of the condenser just dips into the acid. 100 ml of NaOH was placed in the funnel and run into the flask opening the tap. The tap was closed as soon as the alkali had entered. The flask was heated so that the contents boiled gently and the distillation was continued for 40-50 minutes by which time ammonia passed over into the receiver.

Absorbance was measured at 420 nm following the Vogel's procedure.

Sr.no	Product Name	Ammonia µg/g	
		1	2
1	Sanket 999Jarda + Sanket No. 1 Supari Mix	6.05	6.15
2	Moolchand Superb Jarda +Moolchand Superb Supari	4.42	4.45
3	Shimla Jarda + Shimla Supari Mix	12.88	12.32
4	Goa 1000 Zarda + Supari	3.8	3.92
5	Gutkha Pan Parag	16.6	16.42
6	Gutkha Manikchand	11.7	11.4
7	Click Eucalyptus	3224.8	3288
8	Baba Zarda 120	8.6	8.34
9	Dentobac Creamy Snuff	4.33	4.46
10	Lime Mix - Miraj Tobacco	7.76	7.92
11	Shahin Mishri	3387.1	3320
12	Dabur Red Tooth Powder	4.42	4.34
13	Baidhyanath Red Tooth Powder	4.04	4.12
14	Gai Chhap Zarda	4827.2	5280
15	Raja Khaini	12.43	12.31
16	Gutkha Tulsi Mix	163	152
17	IPCO Creamy Snuff	12.8	12.54
18	Kuber Gutkha	7.39	7.26
19	Vimal Gutkha	0.7	0.77
20	Tuiber Tobacco Water	31.9	30.96

285

7c. ESTIMATION OF MAGNESIUM CARBONATE.

1. Ground tobacco sample is extracted with 50 ml of double distilled water on a wrist action rotary shaker for 60 minutes.
2. The extract is then filtered. Colour if present, is removed by adding Aluminium Hydroxide solution. Magnesium Carbonate is determined by EDTA titration
3. To the extract 1 ml of ammonia buffer and Eriochrome Black T indicator is added. In alkaline conditions EDTA reacts with Ca and Mg ions to form a soluble chelated complex. Ca and Mg ions develops wine red colour with the indicator under alkaline condition. When EDTA is added as a titrant Ca and Mg ions get complexed resulting in sharp colour change from wine red to blue. Which indicates the end point of the reaction. The pH for this reaction has to be maintained at pH10.0. Record Burette reading as Total Ca + Mg (x ml)
4. To the extract two ml of 2N NaOH and Murexide indicator is added. At higher pH i.e. about 12.0 magnesium ion precipitates and only calcium ions remain in the solution. At this pH Murexide Indicator forms a pink colour with calcium ion. When EDTA is added calcium gets complexed resulting in colour change from pink to purple indicating end point. Record Burette reading as Total Ca (y ml)
5. $MgCO_3$ content in the solution is found out by subtracting calcium concentration from total of calcium and magnesium (x – y ml).
6. This method is sensitive upto 1 ppm.

Calculations:

$$1)\ \text{Total Ca + Mg} = \frac{0.01\ \text{N (EDTA)} \times x\ (\text{ml})}{50\ \text{ml}}$$

$$2)\ \text{ppm } MgCO_3 = (x - y\ \text{ml}) \times 4.861$$

Estimation of Total Carbonate, Calcium Carbonate and Magnesium Carbonate

Sr. no	Product Name	Total carbonateµg/g		CaCO3 µg/g		MgCO3 µg/g	
		1	2	1	2	1	2
1	Sanket 999Jarda + Sanket No. 1 Supari	540	580	293	315	247	265
2	Moolchand Superb Jarda +Moolchand Superb Supari	500	560	272	304	228	256
3	Shimla Jarda + Shimla Supari Mix	440	480	239	261	201	219
4	Goa 1000 Zarda + Goa Supari	520	540	283	293	237	247
5	Gutkha Pan Parag	600	580	326	315	274	265
6	Gutkha Manikchand	520	560	283	304	237	256
7	Click Eucalyptus	620	560	337	304	283	256
8	Baba Zarda 120	2040	2000	1109	1087	931	913
9	Dentobac Creamy Snuff	660	620	359	337	301	283
10	Lime Mix - Miraj tobacco	1480	1440	804	783	676	657
11	Shahin Mishri	1760	1820	957	989	803	831
12	Dabur Red Toothpowder	160	140	87	76	73	64
13	Baidhyanath Red Toothpowder	220	180	120	98	110	82
14	Gai Chhap Zarda	1840	1900	1000	1016	840	884
15	Raja Khaini	380	420	207	228	173	192
16	Gutkha Tulsi Mix	620	600	337	326	283	274
17	IPCO Creamy Snuff	560	600	304	326	256	274
18	Kuber Gutkha	800	720	435	391	365	329
19	Vimal Gutkha	700	720	380	391	320	329
20	Tuiber Tobacco Water	140	160	76	87	64	73

7d. ESTIMATION OF NICOTINE IN SMOKELESS TOBACCO SAMPLES:

Nicotine was extracted from tobacco by using chloroform, and tobacco extracts were analysed by gas chromatography to determine the nicotine content.

Extraction:

One gram of sample is soaked in 15 ml distilled water and 5 ml of 2% NaOH. Soaking is done for one hour with intermittent shaking. Decant the supernatant and extract with 20 ml Chloroform in a separating funnel. Collect the chloroform solution separately. Extract the aqueous phase two more times with 15 ml of chloroform each time. Collect all the three extracts together. Proceed for the estimation of Nicotine on a Gas Chromatograph.

Analytical Conditions:

Column:	3 % ov – 101.
Detector:	FID.
Oven Temp. :	175 degree C.
Injector port Temp. :	220 degree C.
Detector Port Temp:	250 degree C.
Carrier gas:	Nitrogen.
Attenuation:	8.
Injection volume:	1 ul.

Calculation of nicotine concentration was using the following equation:

$$\text{Nicotine ug / g} = \frac{\text{Area of Sample}}{\text{Area of standard}} \times \frac{\text{Conc. of Standard}}{1}$$

Nicotine content of the samples tested.

Sr.no	Product Name	Nicotine ug/g	
		1	2
1	Sanket 999Jarda + Sanket No. 1 Supari Mix	1778	1765
2	Moolchand Superb Jarda +Moolchand Superb Supari	5224	4691
3	Shimla Jarda + Shimla Supari Mix	3296	3277
4	Goa 1000 Zarda + Goa Supari	3702	3344
5	Gutkha Pan Parag	3277	3494
6	Gutkha Manikchand	1021	1082
7	Click Eucalyptus	3315	3042
8	Baba Zarda 120	8443	9650
9	Dentobac Creamy Snuff	9856	10160
10	Lime Mix - Miraj Tobacco	3832	4346
11	Shahin Mishri	2670	2790
12	Dabur Red Tooth Powder	4455	4479
13	Baidhyanath Red Tooth Powder	5051	5134
14	Gai Chhap Zarda	2579	2631
15	Raja Khaini	1242	1325
16	Gutkha Tulsi Mix	703	708
17	IPCO Creamy Snuff	5267	5978
18	Kuber Gutkha	1792	2089
19	Vimal Gutkha	1460	1662
20	Tuiber Tobacco Water	<0.0001	<0.0001

289

7e. ESTIMATION OF ALKALOIDS IN SMOKELESS TOBACCO SAMPLES:

The alkaloids were extracted from tobacco by using potassium hydroxide in methanol, and the tobacco extracts were analysed by gas chromatography to determine the alkaloid content.

Extraction: 1 ml of extraction solution i.e. 0.05N KOH in Methanol was added to 25 mg of tobacco Sample. The sample was sonicated in the ultrasonic bath for one hour. The sample was removed from the bath after one hour to vortex, swirling the tube to get all the tobacco into the solvent, and returned to the sonicator for another 2 hours. After sonication was complete, the tubes were centrifuged for five minutes at low speed to separate the tobacco from the solvent. The supernatant was transferred to a sampler vial to be analysed on the GC.
Estimated time for extraction: 3 hrs 25 min per sample.
Estimated time for analysis: 35 min per sample.

Analytical Conditions:

Column:	BP 5. 50 m X 0.22 I.D. X 1.0 um.
Detector:	: Thermionic Ionisation Detector.(TID)
Oven Temp.	: 110 degree C for 1 minute.
Rate	: 5 Degrees per minute hold for 5 minutes.
Total Run Time	: 29 minutes
Injector port Temp.	: 220 degree C.
Detector Port Temp	: 300 degree C.
Carrier gas	: Helium at 15 psi.
Attenuation	: 4.
Injection volume	: 1 ul.

Calculations:

$$\text{Alkaloids ug / g} = \frac{\text{Area of Sample}}{\text{Area of standard}} \times \frac{\text{Conc. of Standard}}{1} \times \frac{\text{ml of Extract}}{\text{Wt. of Sample}}$$

Nornicotine and anabasine concentrations in smokeless tobacco samples

Sr.no	Product Name	Nornicotine ug/g		Anabasine ug/g	
		1	2	1	2
1	Sanket 999 Jarda + Sanket No. 1 Supari Mix	<0.0001	<0.0001	<0.0001	<0.0001
2	Moolchand Superb Jarda +Moolchand Superb Supari	0.01	0.12	<0.0001	<0.0001
3	Shimla Jarda + Shimla Supari Mix	<0.0001	<0.0001	<0.0001	<0.0001
4	Goa 1000 Zarda + Goa Supari	<0.0001	<0.0001	<0.0001	<0.0001
5	Gutkha Pan Parag	<0.0001	<0.0001	<0.0001	<0.0001
6	Gutkha Manikchand	<0.0001	<0.0001	<0.0001	<0.0001
7	Click Eucalyptus	<0.0001	<0.0001	<0.0001	<0.0001
8	Baba Zarda 120	0.21	0.23	0.006	0.009
9	Dentobac Creamy Snuff	0.032	0.028	<0.0001	<0.0001
10	Lime Mix - Miraj Tobacco	<0.0001	<0.0001	<0.0001	<0.0001
11	Shahin Mishri	<0.0001	<0.0001	<0.0001	<0.0001
12	Dabur Red Tooth Powder	<0.0001	<0.0001	<0.0001	<0.0001
13	Baidhyanath Red Tooth Powder	<0.0001	<0.0001	<0.0001	<0.0001
14	Gai Chhap Zarda	0.016	0.014	<0.0001	<0.0001
15	Raja Khaini	<0.0001	<0.0001	<0.0001	<0.0001
16	Gutkha Tulsi Mix	<0.0001	<0.0001	<0.0001	<0.0001
17	IPCO Creamy Snuff	0.046	0.044	<0.0001	<0.0001
18	Kuber Gutkha	<0.0001	<0.0001	<0.0001	<0.0001
19	Vimal Gutkha	<0.0001	<0.0001	<0.0001	<0.0001
20	Tuiber Tobacco Water	0.13	0.11	<0.0001	<0.0001

Myosmine and anatabine concentrations in smokeless tobacco samples

Sr.no	Product Name	Myosmine ug/g		Anatabine ug/g	
		1	2	1	2
1	Sanket 999 Jarda + Sanket No. 1 Supari Mix	0.066	0.079	<0.0001	<0.0001
2	Moolchand Superb Jarda +Moolchand Superb Supari	<0.0001	<0.0001	<0.0001	<0.0001
3	Shimla Jarda + Shimla Supari Mix	<0.0001	<0.0001	<0.0001	<0.0001
4	Goa 1000 Zarda + Goa Supari	<0.0001	<0.0001	<0.0001	<0.0001
5	Gutkha Pan Parag	<0.0001	<0.0001	<0.0001	<0.0001
6	Gutkha Manikchand	<0.0001	<0.0001	<0.0001	<0.0001
7	Click Eucalyptus	<0.0001	<0.0001	<0.0001	<0.0001
8	Baba Zarda 120	<0.0001	<0.0001	<0.0001	<0.0001
9	Dentobac Creamy Snuff	<0.0001	<0.0001	<0.0001	<0.0001
10	Lime Mix - Miraj Tobacco	0.027	0.03	0.01	0.02
11	Shahin Mishri	<0.0001	<0.0001	<0.0001	<0.0001
12	Dabur Red Tooth Powder	<0.0001	<0.0001	<0.0001	<0.0001
13	Baidhyanath Red Tooth Powder	<0.0001	<0.0001	<0.0001	<0.0001
14	Gai Chhap Zarda	0.009	0.01	0.028	0.026
15	Raja Khaini	<0.0001	<0.0001	<0.0001	<0.0001
16	Gutkha Tulsi Mix	<0.0001	<0.0001	<0.0001	<0.0001
17	IPCO Creamy Snuff	<0.0001	<0.0001	<0.0001	<0.0001
18	Kuber Gutkha	<0.0001	<0.0001	<0.0001	<0.0001
19	Vimal Gutkha	<0.0001	<0.0001	<0.0001	<0.0001
20	Tuiber Tobacco Water	<0.0001	<0.0001	<0.0001	<0.0001

292

7f. DETERMINATION OF NITROSAMINES IN TOBACCO SAMPLES:

Nitrosamines have been recognized as extremely potent chemical carcinogens and there has been considerable interest in the determination of nitrosamines by a number of analytical techniques. Differential Pulse Polarography (DPP) is a very sensitive analytical technique for the determination of nitrosamines and their metabolite by-products.

Extraction Procedure:

Weigh 1 g of tobacco sample in a conical flask. Add 25 ml methylene chloride. Extract for 1 hour on wrist action shaker, centrifuge if necessary. Collect the extract in another flask. Add 25 ml methylene chloride into the sample. Extract for another hour on wrist action shaker. Collect the extract and pool both the extracts. Centrifuge the extract and collect the supernatant in a beaker. Evaporate to dryness by Nitrogen gas. Reconstitute the residue with 10 ml of 0.1 M HCl and analyse the analyte on DPP.

Time for extraction: - 3.15 min for each sample.
Time for estimation: - 20 min for each sample.

Estimation by Differential Pulse Polarography:

Instrument:	EG&G Princeton Applied Research Integrator: Model No. 394. PARC: Model No. 303 A SMDE Stirrer: Model No. 305.
Ref. Electrode:	SCE.
Ref. Value:	0.2415
Working electrode:	HMDE
Drop size:	Small.
Electrolyte:	0.1 M HCl.
Purge Time:	50 seconds.
Initial potential:	- 0.04 V.
Final potential:	-1.1 V.
Scan rate:	2 mV/second.
Scan increment:	2 mV.
Drop time:	1 second.
Electrolyte area:	1 sq. cm.
Pulse height:	50 mV.

Concentrations of N-Nitrosonornicotine (NNN), 4(N-methyl-N-Nitrosamino)1-(3-pyridyl)-1-butanol (NNK), N-nitrosoanabasine (NAB), N-nitrosoanatabine (NAT), in the smokeless tobacco samples.

Sr. no	Product Name	NAB	NAB	NAT	NAT	NNK	NNK	NNN	NNN
		µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
1	Sanket 999Jarda + Sanket No. 1 Supari Mix			4.57	3.6				
2	Moolchand Superb Jarda +Moolchand Superb Supari					4.9	5.13		
3	Shimla Jarda + Shimla Supari Mix	11.58	12.58			11.58	9.54		
4	Goa 1000 Zarda + Goa Supari							1.92	2.45
5	Gutkha Pan Parag					10.68	11.51		
6	Gutkha Manikchand	5.75	6.89						
7	Click Eucalyptus	*	*	*	*	*	*	*	*
8	Baba Zarda 120							6.55	7.36
9	Dentobac Creamy Snuff	*	*	*	*	*	*	*	*
10	Lime Mix - Miraj Tobacco	*	*	*	*	*	*	*	*
11	Shahin Mishri							4.02	4.77
12	Dabur Red Tooth Powder	*	*	*	*	*	*	*	*
13	Baidhyanath Red Tooth Powder	*	*	*	*	*	*	*	*
14	Gai Chhap Zarda	*	*	*	*	*	*	*	*
15	Raja Khaini	*	*	*	*	*	*	*	*
16	Gutkha Tulsi Mix							1.87	2.15
17	IPCO Creamy Snuff					4.88	4.38		
18	Kuber Gutkha			6.53	6.27			5.73	6.01
19	Vimal Gutkha							5.03	4.74
20	Tuiber Tobacco Water							20.12	19.65

*These samples contain Nitrosamines other than the four Nitrosamines mentioned above

7g. ESTIMATION OF BENZO [a] PYRENE IN SMOKELESS TOBACCO SAMPLES:

Extraction: Weigh 1g of tobacco sample; add 25 ml of hexane and mix on a wrist action rotary shaker for 60 minutes. Sit the sample for 30 minutes. Decant the clear supernatant into the beaker after centrifugation. Repeat extraction with 25ml hexane, and pool the extracts. Evaporate the extract to total dryness by passing Nitrogen gas. Reconstitute the residue with Acetonitrile. Proceed to analyse the sample on Gas Chromatograph. Time for extraction: 3 hrs 30 min per sample.

Time for analysis: 45 min per sample.

Analytical Conditions:

Column:	BP5, Capillary column, 50 m X 0.22 mm X 1.0 um.	
Detector:	Flame Ionisation Detector. (FID)	
Attenuation:	2, Range 10.	
Autozero :	On.	
Carrier:	Helium	1 ml / min.
	Air:	300 ml/min.
	Hydrogen	420 ml/min.

Temperature Programme:

Oven Temp.:	130 degree C.
Time:	---- min.
Rate:	4.0 degree / min. to 290 degree C.
Total Run Time:	40 minutes.
Injector Temp:	200 degree C.
Detector Temp:	250 degree C.
Polarity:	Negative.
Back off:	Negative.
	X 10.

Standards: Standards of different known concentrations of benzo[a]pyrene were run and the calibration curves of the concentration against peak area were plotted.

Calculations:

$$\text{Concentration ug / g} = \frac{\text{Area of sample}}{\text{Area of standard}} \times \frac{\text{Conc. of Standard}}{1} \times \frac{50}{1}$$

Concentration of Benzopyrene in smokeless tobacco samples

Sr. no	Product Name	Benzo[a]pyrene ug/g	
		1	2
1	Sanket 999Jarda + Sanket No. 1 Supari Mix	<0.0001	<0.0001
2	Moolchand Superb Jarda +Moolchand Superb Supari	0.46	0.44
3	Shimla Jarda + Shimla Supari Mix	0.27	0.29
4	Goa 1000 Zarda + Goa Supari	<0.0001	<0.0001
5	Gutkha Pan Parag	<0.0001	<0.0001
6	Gutkha Manikchand	0.61	0.62
7	Click Eucalyptus	<0.0001	<0.0001
8	Baba Zarda 120	<0.0001	<0.0001
9	Dentobac Creamy Snuff	0.88	0.79
10	Lime Mix - Miraj Tobacco	<0.0001	<0.0001
11	Shahin Mishri	<0.0001	<0.0001
12	Dabur Red Tooth Powder	<0.0001	<0.0001
13	Baidhyanath Red Tooth Powder	<0.0001	<0.0001
14	Gai Chhap Zarda	<0.0001	<0.0001
15	Raja Khaini	0.5	0.56
16	Gutkha Tulsi Mix	0.45	0.47
17	IPCO Creamy Snuff	0.94	0.89
18	Kuber Gutkha	0.45	0.47
19	Vimal Gutkha	0.64	0.61
20	Tuiber Tobacco Water	<0.0001	<0.0001

7h. ESTIMATION OF NITRATE

The ground tobacco sample is extracted with 50 ml of 5 % acetic acid on a wrist action rotary shaker for 60 minutes and then filtered. The nitrate ion in the filtrate is reduced upon reaction with hydrazine sulphate at 37^0C in the presence of copper at a pH of 10.2. The nitrite formed is reacted with sulphanilamide under acidic conditions to yield a diazo compound, which then mixed with N- (1-Napthyl) – ethylenediamine which forms a red colour complex.

The absorbance is measured with a colorimeter with 550 nm filter. Standards of different known concentrations of Nitrate are run and the calibration curves of the concentration against absorbance are plotted, and from this the concentration of nitrate in unknown sample is calculated. Time for extraction: 60 min per sample. Time for analysis: 30 min per sample.

Calculations:

$$\text{Concentration } \mu g / g = \frac{\text{ppm Nitrogen } (\mu g/ml) \times 50\ (ml)}{0.5 \text{ g sample}}$$

297

Sr. no	Product Name	Nitrate µg/g	
		Nitrate 1	Nitrate 2
1	Sanket 999 Jarda + Sanket No. 1 Supari Mix	< 0.1	< 0.1
2	Moolchand Superb Jarda +Moolchand Superb Supari	6.68	8.01
3	Shimla Jarda + Shimla Supari Mix	< 0.1	< 0.1
4	Goa 1000 Zarda + Goa Supari	< 0.1	< 0.1
5	Gutkha Pan Parag	< 0.1	< 0.1
6	Gutkha Manikchand	< 0.1	< 0.1
7	Click Eucalyptus	8.01	5.34
8	Baba Zarda 120	12.02	10.68
9	Dentobac Creamy Snuff	8.01	9.35
10	Lime Mix - Miraj Tobacco	13.85	10.68
11	Shahin Mishri	13.35	5.34
12	Dabur Red Tooth Powder	< 0.1	< 0.1
13	Baidhyanath Red Tooth Powder	< 0.1	< 0.1
14	Gai Chhap Zarda	4.01	4.01
15	Raja Khaini	12.02	9.35
16	Gutkha Tulsi Mix	< 0.1	< 0.1
17	IPCO Creamy Snuff	9.35	9.35
18	Kuber Gutkha	5.34	5.34
19	Vimal Gutkha	< 0.1	< 0.1
20	Tuiber Tobacco Water	< 0.1	< 0.1

7i. ESTIMATION OF HEAVY METALS IN SMOKELESS TOBACCO SAMPLES

The concentration of the heavy metals is very low (few micrograms to nanograms) as compared to the other constituents in tobacco. Reliable estimation thus requires an ultrasensitive method of detection and measurement. After studying some of the sensitive techniques capable of analysis of ultra-trace levels, differential pulse stripping voltammetry was chosen due to its ability to analyse simultaneously many metals at ultra-trace levels even without prior chemical separation in addition to high sensitivity, inherent reliability and accuracy being added advantages.

Apparatus and Reagents:

Voltammetric measurements were carried out with Princeton Applied Research electrochemical trace analyser model No 394 and Voltammograms were recorded on computer. A static mercury drop electrode assembly (PARC-303 A) was used with PARC-305 stirrer.

All chemicals used were Merck, Suprapur, Analar or electronic grade. Standard stock solutions (0.01 M) of Ni, Pb, Cd, Cr, As, Se and Hg were prepared and necessary dilutions were made as and when required.

Pretreatment:

In view the low concentrations of the trace metals generally expected in tobacco samples, extreme care was taken to avoid contamination. One gram of each sample was digested with nitric acid (1ml) and perchloric acid (0.5ml), for about 2 hours. The residual was taken in 10 ml of 0.25% Nitric acid (Electronic grade) and taken into the electrolytic cell.

An aliquot of digested solution (0.1-0.5) was added to 10 ml of supporting electrolyte (5 ml of 0.25% HNO_3 + 5 ml of 0.15 M ammonium acetate). The solution was deaerated for 8 minutes with highly purified nitrogen gas. The initial potential was kept -1.2 volt. The solution was stirred and electrolysis was carried out for 1.0 minute. After a rest period of 30 seconds the stripping voltammogram was recorded. The concentrations of metals were calculated with the help of calibration curves as well as by the method of standard solutions.

Quality assurance:

Analysing the standard reference materials has checked the reliability of the procedure of estimation of the heavy metals in the tobacco samples.

The values have also been independently checked with measurements using other sensitive techniques such as atomic absorption spectrophotometry. One of the important factors for achieving reliability has been our endeavour to maintain clean blanks with extremely low background concentrations for heavy metals. The precision for replicate analysis is usually better than $\pm$ 8.0%.

Measurement procedure for estimation of Lead:

After nitrogen purging Lead is electrodeposited for one minute on Hanging Drop Mercury Electrode with initial potential of - 0.6 V.

Rest period 30 seconds.

Voltamogram recorded with instrumental settings as under:

Scan rate:	5 mV/sec.
Pulse repetition time	0.5 seconds.
Modulation amplitude	50 mV.
Lead peak obtained at	- 0.42 V.

Measurement procedure for estimation of Cadmium:

After nitrogen purging cadmium is electrodeposited for one minute on Hanging Drop Mercury Electrode with initial potential of - 0.6 V.

Rest period 30 seconds.

Voltammogram recorded with instrumental settings as under:

Scan rate:	5 mV/sec.
Pulse repetition time	0.5 seconds.
Modulation amplitude	50 mV.
Cadmium peak obtained at	- 0.6 V.

Measurement procedure for estimation of Selenium:

After nitrogen purging Selenium is electrodeposited for one minute on Hanging Drop Mercury Electrode with initial potential of - 0.8 V.

Rest period 30 seconds.

Voltamogram recorded with instrumental settings as under:

Scan rate:	2 mV/sec.
Pulse repetition time	0.5 seconds.
Modulation amplitude	50 mV.
Selenium peak obtained at	- 0.6 V.

Measurement procedure for estimation of Arsenic:

After nitrogen purging Arsenic is electrodeposited for one minute on Hanging Drop Mercury Electrode with initial potential of - 0.4 V.

Rest period 30 seconds.

Voltammogram recorded with instrumental settings as under:

Scan rate:	2 mV/sec.
Pulse repetition time	0.5 seconds.
Modulation amplitude	50 mV.
Arsenic peak obtained at	- 0.5 V.

Measurement procedure for estimation of Nickel:

After nitrogen purging Nickel is electrodeposited for one minute on Hanging Drop Mercury Electrode with initial potential of - 1.6 V.

Rest period 30 seconds.

Voltammogram recorded with instrumental settings as under:

Scan rate:	2 mV/sec.
Pulse repetition time	0.5 seconds.
Modulation amplitude	50 mV.
Nickel peak obtained at	- 0.9 V.

Measurement procedure for estimation of Chromium:

Chromium standard solution was prepared from K2Cr2O7. Stock standard solution of 50 ppb was prepared. Different standard solutions were prepared by making suitable dilutions.

Calibration was done by 100ul addition from 50 ppb standard in 6 ml (Cell volume) of background electrolyte.

Chromium	Peak Potential	=	- 1.262	V
	Initial Potential	=	- 1.0	V
	Final Potential.	=	- 1.5	V

Preparation of background electrolyte:-
Background electrolyte was prepared in D.D.W.

1) Sodium Acetate (0.2 mol/L)
2) DTPA [Diethylene Triamine Penta Acetic Acid] (0.05mol / L)
3) NaNo3 (2.5 mol/L)

Finally pH was adjusted to 6.2 in 30 % NaOH.

Sample preparation:

Sample is digested in HNO3 and HCl 4, evaporated to dryness and finally taken in background electrolyte as per required volume from this.
6 ml of sample was taken, pH was adjusted to 6.2 in 30% NaOH and analysed by anodic stripping voltammetry after calibration.

Estimation procedure for Mercury :

Mercury is analysed by Çold Vapour AAS procedure.

Apparatus and Reagents:

Mercury estimations are carried out on MA 5640 Atomic Absorption Spectrometer.

All chemicals used are of Merck, Suprapur, Analar or electronic grade.

Pretreatment:

Sample: 100g + Acid 250ml. Keep for wet digestion till white residue is obtained.

Add 25 ml of 0.25% Nitric acid and take it for analysis.

Measurement Procedure:

Switch to HOLD mode operation.
Switch ON the absorbance switch (%T/Abs)
Mercury free air is purged through the reaction vessel.
Note the absorbance as early as possible.
Switch back to Normal Mode. The meter indication should be back to 100% T.
Switch OFF the lamp and stirrer.
Adjust 0% and 100 just before each measurement.

Sr.no	Product Name	Cadimum µg/g		Lead µg/g		nickel	ug/g	Arsenic µg/g	
		Cd1	Cd2	Pb1	Pb2	Ni 1	Ni 2	As 1	As 2
1	Sanket 999Jarda + Sanket No. 1 Supari Mix	0.07	0.07	0.15	0.15	0.02	0.04	0.72	0.64
2	Moolchand Superb Jarda +Moolchand Superb Supari	0.27	0.25	0.34	0.27	0.01	0.01	1.94	1.86
3	Shimla Jarda + Shimla Supari Mix	0.19	0.2	0.2	0.22	0.07	0.08	0.19	0.2
4	Goa 1000 Zarda + Supari	0.19	0.2	0.043	0.02	0.02	0.03	0.3	0.38
5	Gutkha Pan Parag	0.17	0.17	0.14	0.11	< 0.005	< 0.005	0.6	0.54
6	Gutkha Manikchand	0.19	0.19	0.23	0.22	0.02	0.02	0.17	0.18
7	Click Eucalyptus	0.03	0.03	0.08	0.07	< 0.005	< 0.005	0.08	0.07
8	Baba Zarda 120	0.5	0.51	0.94	0.98	0.04	0.03	0.43	0.36
9	Dentobac Creamy Snuff	0.14	0.16	0.56	0.61	0.02	0.04	0.73	0.56
10	Lime Mix - Miraj Tobacco	0.07	0.07	0.14	0.17	< 0.005	< 0.005	0.78	0.88
11	Shahin Mishri	0.11	0.12	0.29	0.31	< 0.005	< 0.005	1.53	0.1
12	Dabur Red Tooth Powder	0.17	0.19	4.85	4.97	< 0.005	< 0.005	0.16	0.1
13	Baidhyanath Red Tooth	0.25	0.22	5.14	5.04	0.01	0.01	0.25	0.21
14	Gai Chhap Zarda	0.23	0.23	0.53	0.53	0.04	0.05	0.39	0.35
15	Raja Khaini	0.04	0.04	0.31	0.35	0.05	0.05	0.11	0.17
16	Gutkha Tulsi Mix	0.11	0.12	0.18	0.2	0.02	0.01	0.3	0.22
17	IPCO Creamy Snuff	0.07	0.07	0.13	0.13	0.06	0.05	0.84	0.74
18	Kuber Gutkha	0.08	0.08	0.24	0.25	< 0.005	< 0.005	1.11	1.08
19	Vimal Gutkha	0.011	0.01	0.02	0.03	0.03	0.02	0.14	0.13
20	Tuiber Tobacco Water	0.011	0.012	0.015	0.018	0.03	0.01	1.08	1.02

Sr.no	Product Name	Mercury µg/g	Mercury µg/g	Selenium µg/g	Selenium µg/g	Chromium µg/g	
						µg/g	
1	Sanket 999Jarda + Sanket No. 1 Supari Mix	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
2	Moolchand Superb Jarda +Moolchand Superb Supari	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
3	Shimla Jarda + Shimla Supari Mix	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
4	Goa 1000 Zarda + Supari	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
5	Gutkha Pan Parag	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
6	Gutkha Manikchand	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
7	Click Eucalyptus	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
8	Baba Zarda 120	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
9	Dentobac Creamy Snuff	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
10	Lime Mix - Miraj Tobacco	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
11	Shahin Mishri	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
12	Dabur Red Tooth	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
13	Baidhyanath Red	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
14	Gai Chhap Zarda	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
15	Raja Khaini	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
16	Gutkha Tulsi Mix	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
17	IPCO Creamy Snuff	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
18	Kuber Gutkha	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
19	Vimal Gutkha	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
20	Tuiber Tobacco Water	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002

7j. Determination of Eugenol

Summary:

This method is used to separate and identify Eugenol in the ethanol extract of the sample. The extract is filtered and analysed using reversed phase/isocratic High Performance Liquid Chromatography with ultra violet detection. For standards external standard calibration procedure is observed. 20 ul of each standard is injected into HPLC and analysed. A calibration curve is prepared by plotting concentration of Eugenol vs. peak area. The response factor is determined from the calibration curve.

Preparation of Standards:

1) Prepare primary Eugenol stock solution by accurately taking 190 ul of pure Eugenol liquid into 100 ml of Ethanol.
2) Six working standards are prepared (ranging from 2 ug/ml to 1000 ug/ml) by diluting appropriately with ethanol.
3) Eugenol calibration standards are prepared afresh every five working days, which are stored in dark and at 4 °C until analysed.

Sample Preparation: (Extraction of sample)

1) The sample removed from the original package is inspected for any extraneous material.
2) Tobacco sample is ground / pulverized to pass through a 20 mesh screen.
3) The sample is conditioned.
4) Weigh 2g of ground tobacco into 250 ml conical flask.
5) Add 50 ml of ethanol to the sample and seal the cap with parafilm.
6) Extract in a shaker for 2 hours at 50 °C.
7) Centrifuge at 1200 rpm for 10 minutes.
8) Allow cooling to room temperature.
9) Filter the aliquot into a 50 ml amber colour bottle (in duplicate) using a syringe filter.
10) Cap and store in dark and at 4 °C. until analysed.

**** Estimated time of extraction for one sample is 3hrs 10min.**

Reversed Phase HPLC Analysis. (Chromatographic conditions)

1) Columns: RP 18e column.
2) Column Temp.: 30 °c.
3) Mobile Phase : Solvent A: Methanol.
   Solvent B: Type I water
4) Sample wash: Solvent.

5) Mobile phase gradient

Flow rate: 0.7 ml / minute.

Time: Min.	Composition:		
0.0	80% A	20% B	0% C
20.0	80 % A	20% B	0% C
Method end action:	80% A	20% B	0% C
(Equillibrate 10 min.)			

**** Estimated time for each sample to analyse is 20min.**

Sample Analysis:

1) 20 ul of each sample vial is injected onto HPLC column and analysed.
2) Identification of peaks is done by comparison of retention times with standards and the spiking of the samples.

Calculations and Quantification:

Determination of Eugenol deliveries in ug / g:

$$\text{Eugenol (ug/g)} = \frac{\text{Peak Area}}{\text{Resp.Factor}} \times \frac{\text{ml of solution}}{\text{Wt (g) of tobacco}}$$

By entering correct multiplier (overall volume of original sample in ml) and divisor (original sample wt. in grams) the concentration of eugenol is calculated in ug/g.
To convert this conc. in a percentage (%) the ug/g result is divided by 10,000.
The results are expressed on an "as conditioned" basis. These may be expressed on a dry matter basis using the appropriate moisture result.

Normative References:

1.American Society for Testing and Materials (ASTM)
D 1193-77-Standard Specifications for Reagent Water.
Version 1977.

2. Health Canada Test Method. T-115.
Determination of Tar, Water, Nocotine and Carbon Monoxide
in Mainstream Tobacco Smoke, 1999-12-31.
Health Canada – Official Methods.

Sr. no	Product Name	Eugenol ug/g	
		Eugenol 1	Eugenol 2
1	Sanket 999 Jarda + Sanket No. 1 Supari Mix	71.83	74.93
2	Moolchand Superb Jarda +Moolchand Superb Supari	303.06	300.33
3	Shimla Jarda + Shimla Supari Mix	875.67	867.3
4	Goa 1000 Zarda + Goa Supari	96.89	92.78
5	Gutkha Pan Parag	1164.95	1122.4
6	Gutkha Manikchand	405.94	403.65
7	Click Eucalyptus	< 0.00005	< 0.00005
8	Baba Zarda 120	20348.8	20261.1
9	Dentobac Creamy Snuff	25373.53	25706.13
10	Lime Mix - Miraj Tobacco	13.97	12.82
11	Shahin Mishri	6345.45	6094.77
12	Dabur Red Tooth Powder	6648.43	6606.2
13	Baidhyanath Red Tooth Powder	1220.55	1250.61
14	Gai Chhap Zarda	< 0.00005	< 0.00005
15	Raja Khaini	< 0.00005	< 0.00005
16	Gutkha Tulsi Mix	273.73	265.51
17	IPCO Creamy Snuff	165.56	161.22
18	Kuber Gutkha	1439.14	1370.72
19	Vimal Gutkha	8.91	9.38
20	Tuiber Tobacco Water	41.72	42

307

7k. **Determination of Sorbic Acid**

Summary:

This method estimates the amount of Sorbic Acid by reversed phased high performance liquid chromatography (HPLC) and UV detection. External standards are used in this method.

Preparation of Standards:

Weigh 100 g of Potassium Sorbate into 100 ml volumetric flask.
Dilute to volume with Type I water.
This is the Primary Stock Standard Solution.

Prepare different working standards ranging the sorbate concentration from 0.0 ug/ml to 100 ug/ml. (0, 5, 10, 25, 50 and 100 ug/ml).

Sorbic Acid calibration standards are prepared afresh every five working days which are stored at 4 °C until analysed.
20 ul of each standard is injected into HPLC and analysed.
A calibration curve is prepared by plotting concentration of Sorbic Acid vs. peak area.
Determine response factor from calibration curve.

Sample Generation:

Weigh accurately 1g finely chopped (20 mesh) tobacco into a 50 ml glass beaker.
Add 30 ml hot (50 °c) Type I water to the sample and sonicate for 30 minutes at 50 °c.
Centrifuge at 1200 rpm for 10 min and filter the aliquote.
Decant the water into a 100 ml standard flask.
Similarly extract another 1g of tobacco and collect the extract resulting from 2g of tobacco.
Allow to cool and make the volume to 100 ml.
Mix well, filter and transfer the aliquot into a test tube for HPLC analysis.

**** Estimated time of extraction for one sample is one and half-hour.**

Sample Analysis:

Chromatographic Conditions:

Column Temp: 30 °c.
Mobile Phase : Solvent A – Methanol, filter and degas.
Solvent B – 2 litres of 1% IPA adjusted to pH 2.3 with phosphoric acid.
Sample wash: Solvent A.

Mobile phase : Gradient.
20 ul of each sample is injected onto HPLC.

**** Estimated time for analysing each sample: 35 min.**

Calibration and Calculations:

A calibration curve is plotted with concentrations vs respective peak areas.

$$\text{Sorbitol : (g/g)} = \frac{\text{Peak area}}{\text{Resp. Factor}} \times \frac{\text{ml of solution}}{\text{Wt of Tobacco}}$$

Normative References:

1) American Society for Testing and Materials D 1193 – 77. Standard specification for Reagent water, Version 1977.

2) Health Canada Test Method T – 115, 1999 – 12 – 31.

Sr.no	Product Name	Sorbic Acid ug/g	
		1	2
1	Sanket 999 Jarda + Sanket No. 1 Supari Mix	< 0.00005	< 0.00005
2	Moolchand Superb Jarda +Moolchand Superb Supari	< 0.00005	< 0.00005
3	Shimla Jarda + Shimla Supari Mix	< 0.00005	< 0.00005
4	Goa 1000 Zarda + Goa Supari	< 0.00005	< 0.00005
5	Gutkha Pan Parag	< 0.00005	< 0.00005
6	Gutkha Manikchand	< 0.00005	< 0.00005
7	Click Eucalyptus	< 0.00005	< 0.00005
8	Baba Zarda 120	0.59	0.53
9	Dentobac Creamy Snuff	1315.43	1284.42
10	Lime Mix - Miraj Tobacco	< 0.00005	< 0.00005
11	Shahin Mishri	< 0.00005	< 0.00005
12	Dabur Red Tooth Powder	< 0.00005	< 0.00005
13	Baidhyanath Red Tooth Powder	< 0.00005	< 0.00005
14	Gai Chhap Zarda	< 0.00005	< 0.00005
15	Raja Khaini	< 0.00005	< 0.00005
16	Gutkha Tulsi Mix	< 0.00005	< 0.00005
17	IPCO Creamy Snuff	< 0.00005	< 0.00005
18	Kuber Gutkha	< 0.00005	< 0.00005
19	Vimal Gutkha	< 0.00005	< 0.00005
20	Tuiber Tobacco Water	< 0.00005	< 0.00005

71. Determination of Triacetin

Extraction: Weigh 2 g of the tobacco sample in a flask and add to it 150 ml aq. 0.5 H2SO4. Steam distill this mixture. Collect the distillate in a flask under approximately 25 ml of Distilled water. Collect approximately 200 ml of the distillate. Transfer the distillate to a 500 ml separating funnel and add to it 50 ml of methylene chloride. Shake the separating funnel. Drain off and collect extracted methylene chloride fraction into a 250 ml conical flask. The extraction is carried for two more times, thus collecting total of 150 ml of the extract. This 150 ml extract is evaporated to 1 ml. This l ml extract is taken for the analysis in Gas Chromatograph.

Gas Chromatograph Configuration:

Gas Chromatograph:	Chemito 8610.
Injector:	Splitless mode.
Column:	BP 5 ; Fused silica capillary column.
Detector:	Flame Ionization Detector (FID)
Channel	A, 1 Volt full scale.
Range:	12
Atten.:	8
Auto Zero:	On.
Carrier :	He at 40.0 psi, flow+ 1.3 ml / minute @ 70 degree C.

Gas Chromatograph Operating Condition:

Makeup gas:	Nitrogen; 25 ml/min.
Injector:	220 degree C.
Detector:	250 degree C.
Start Temp.:	70 degree C; Hold for 2 minutes.
Rate:	5 degree C/min to 220 C; Hold for 3.0 min.
Total Run Time:	35.00 minutes.

Estimated time for analysis: - 45 minutes.

Calculation: A calibration curve of Triacetin is prepared by plotting the concentration of the standards versus the respective peak area.

Calculations:

$$\text{Triacetin ug / g} = \frac{\text{Area of Sample}}{\text{Area of standard}} \times \frac{\text{Conc. of Standard}}{1} \times \frac{\text{ml of Extract}}{\text{Wt. of Sample}}$$

Sr. no	Product Name	Triacetin ug/g	
		1	2
1	Sanket 999Jarda + Sanket No. 1 Supari Mix	<0.0001	<0.0001
2	Moolchand Superb Jarda +Moolchand Superb Supari	0.04	0.06
3	Shimla Jarda + Shimla Supari Mix	0.06	0.05
4	Goa 1000 Zarda + Goa Supari	<0.0001	<0.0001
5	Gutkha Pan Parag	<0.0001	<0.0001
6	Gutkha Manikchand	0.033	0.036
7	Click Eucalyptus	<0.0001	<0.0001
8	Baba Zarda 120	0.01	0.03
9	Dentobac Creamy Snuff	<0.0001	<0.0001
10	Lime Mix - Miraj Tobacco	<0.0001	<0.0001
11	Shahin Mishri	<0.0001	<0.0001
12	Dabur Red Tooth Powder	0.021	0.024
13	Baidhyanath Red Tooth Powder	<0.0001	<0.0001
14	Gai Chhap Zarda	0.31	0.28
15	Raja Khaini	0.033	0.038
16	Gutkha Tulsi Mix	<0.0001	<0.0001
17	IPCO Creamy Snuff	<0.0001	<0.0001
18	Kuber Gutkha	0.034	0.036
19	Vimal Gutkha	<0.0001	<0.0001
20	Tuiber Tobacco Water	<0.0001	<0.0001

7m. Determination of Sodium Propionate

Preparation of extraction solution:

Take 35 g of $CaCl_2$ and dissolve it in about 1 litre of Dist. Water. Add 0.54 ml of Conc.H_2SO_4. Make the total volume to 2 liters.

Extraction:

Weigh 10 g of the tobacco sample in 125 ml flask. Add 20 ml of the aqueous extraction solution. Moisten the tobacco on rotary shaker until all the solution is absorbed by tobacco. Add 80 ml of methanol. Seal the flask with the parafilm. Shake the sample flask for 30 minutes. Let the sample sit for 1 hour. Shake the sample again for 30 seconds. Decant liquid into centrifuge tubes. Centrifuge at low speed. Take 2 ml of the supernatant and add 2 ml methanol to it. Mix thoroughly for 10 seconds. Centrifuge at medium speed. Take the supernatant for analysis on Gas Chromatograph.

Estimated time for extraction: - 2 hours per sample.

Sample Analysis – Gas Chromatography :

Gas Chromatograph Configuration:

Injector:	Splitless.
Detector :	Flame ionization (FID)
Column:	BP 5 ; fused silica capillary column.
Carrier:	Heat 12.0 psi; flow=2.3 ml/min. @ 70 degree C.
Makeup gas:	Nitrogen gas; 25 ml / minute.

Gas Chromatograph – Operating Condition:

Injector:	225 degree C.
Detector:	230 degree C.

Column Oven Temperature Profile:

Start Temp.:	70 degree C	Hold for two minutes.
Rate: 7.5 deg. C/minute to 155 deg. C .		Hold for 3.07 minutes.
Rate: 7.5 deg. C/minute to 205 deg. C.		Hold for 4.0 minutes.
Total Run time:	25 minutes.	

Calculations: A calibration curve of Sodium Propionate is prepared by plotting the concentration of the standards versus the respective peak area.

Calculations:

$$\text{Na-propionate ug / g} = \frac{\text{Area of Sample}}{\text{Area of standard}} \times \frac{\text{Conc. of Standard}}{1} \times \frac{\text{ml of Extract}}{\text{Wt. of Sample}}$$

Sr. no	Product Name	Na-propionate ug/g	
		1	2
1	Sanket 999Jarda + Sanket No. 1 Supari Mix	<0.0001	<0.0001
2	Moolchand Superb Jarda +Moolchand Superb Supari	0.35	0.37
3	Shimla Jarda + Shimla Supari Mix	<0.0001	<0.0001
4	Goa 1000 Zarda + Goa Supari	<0.0001	<0.0001
5	Gutkha Pan Parag	<0.0001	<0.0001
6	Gutkha Manikchand	<0.0001	<0.0001
7	Click Eucalyptus	0.004	0.005
8	Baba Zarda 120	<0.0001	<0.0001
9	Dentobac Creamy Snuff	<0.0001	<0.0001
10	Lime Mix - Miraj Tobacco	<0.0001	<0.0001
11	Shahin Mishri	<0.0001	<0.0001
12	Dabur Red Tooth Powder	0.44	0.46
13	Baidhyanath Red Tooth Powder	<0.0001	<0.0001
14	Gai Chhap Zarda	<0.0001	<0.0001
15	Raja Khaini	0.0007	0.0005
16	Gutkha Tulsi Mix	0.0002	0.0003
17	IPCO Creamy Snuff	0.0003	0.0005
18	Kuber Gutkha	1.01	1
19	Vimal Gutkha	<0.0001	<0.0001
20	Tuiber Tobacco Water	<0.0001	<0.0001

7n. Estimation Procedure for Humectants (Glycerol, Propylene Glycol and Triethylene Glycol)

Extraction: Weigh 4 g of tobacco sample in a 250 ml conical flask. Add 50 ml warm (50 degree C.) double distilled water into the flask. Cover the n\mouth of the flask with parafilm. Mix on a wrist action rotary shaker for 60 minutes. Sit for 30 minutes. Decant the clear supernatant into the sample bottle. (Centrifuge if necessary) Proceed to analyse the glycols on Gas Chromatograph.

Chromatographic conditions:

Chromatograph :	Model Chemito – 8610.	
Injector:	Split with split flow 15 ml/min.	
Column:	BP5, Capillary column, 50 m X 0.22 mm X 1.0 um.	
Detector:	Flame Ionisation Detector.	
Attenuation:	2, Range 10.	
Autozero :	On.	
Carrier:	Helium	30 ml / min.
	Air:	333 ml/min.
	Hydrogen	420 ml/min.

Temperature Programme:

Oven Temp.:	110 degree C.
Time:	1 min.
Rate:	8.0 degree / min. to 220 degree C. , hold for 2 min.
Total Run Time:	17 minutes.
Injector Temp:	250 degree C.
Detector Temp:	250 degree C.
Polarity:	Negative.
Back off:	Negative.
	X 10.

Identification & Quantification: Locations of the peaks for Glycerol, Propylene Glycol and Triethylene Glycol were ascertained by running the standards of each of the glycol individually. Standards: Standards of different known concentrations of each of the glycol were run and the calibration curves of the concentration against peak area were plotted.

Calculations: Individual Hemectant (Glycerol or Propylene Glycol or Triethylene Glycol)

$$\text{Concentration ug / g} = \frac{\text{Area of sample}}{\text{Area of standard}} \times \frac{\text{Conc. of Standard}}{1} \times \frac{50}{4}$$

Sr.no	Product Name	Triethylene glycol µg/g		Propylene glycol µg/g		Glycerol µg/g	
		TEG 1	TEG 2	PG 1	PG 2	GLY 1	GLY2
1	Sanket 999 Jarda + Sanket No. 1	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
2	Moolchand Superb Jarda +Moolchand	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
3	Shimla Jarda + Shimla Supari Mix	651.38	647.53	<0.0001	<0.0001	<0.0001	<0.0001
4	Goa 1000 Zarda + Supari	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
5	Gutkha Pan Parag	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
6	Gutkha Manikchand	<0.0001	<0.0001	211.77	214.84	<0.0001	<0.0001
7	Click Eucalyptus	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
8	Baba Zarda 120	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
9	Dentobac Creamy Snuff	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
10	Lime Mix - Miraj	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
11	Shahin Mishri	1174.81	1120.94	<0.0001	<0.0001	<0.0001	<0.0001
12	Dabur Red Tooth Powder	6250.61	6270.26	5870.08	5774.16	<0.0001	<0.0001
13	Baidhyanath Red tooth powder	316.75	322.69	<0.0001	<0.0001	<0.0001	<0.0001
14	Gai Chhap Zarda	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
15	Raja Khaini	269.45	262.56	<0.0001	<0.0001	<0.0001	<0.0001
16	Gutkha Tulsi Mix	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
17	IPCO Creamy Snuff	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
18	Kuber Gutkha	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
19	Vimal Gutkha	<0.0001	<0.0001	382.5	370.69	<0.0001	<0.0001
20	Tuiber Tobacco	2399.72	2321.42	<0.0001	<0.0001	<0.0001	<0.0001

7o. Determination of Moisture Content

Accurately weigh and record the weight of an appropriately labeled, dry 20 ml glass vial with airtight cap.

Transfer the tobacco (2g) into the pre-weighed 20 ml glass vial with airtight cap.

Accurately weigh and record the total weight of the capped vial with tobacco.

Place the samples in the oven at 110°c with the caps loosened to allow the moisture to be driven off from the tobacco.

After a minimum of 24 hours, remove the vials and tighten the caps immediately to prevent re-absorption of moisture from the air. Keep the samples for 2 hours in a desiccator for cooling.

Accurately weigh and record the total weight of the capped glass vial with tobacco after heating and calculate the % Moisture content.

% Moisture content = weight of tobacco and glass vial – weight of tobacco and glass vial X $\frac{100}{2}$
(Weight before heating) (Weight after heating)

Sr.No	Product Name	Moisture Content on percentage basis
1	Sanket 999 Jarda + Sanket Supari	7.72
2	Moolchand Superb Jarda + Moolchand Supari	7.47
3	Shimla Jarda+ Shimla Supari Mix	5.03
4	Goa 1000 Zarda + Goa Supari	6.53
5	Gutkha Pan Parag	4.99
6	Gutkha Manikchand	4.86
7	Click Eucalyptus	16.87
8	Baba Zarda 120	11.25
9	Lime Mix - Miraj Tobacco	24.34
10	Shahin Mishri	10.15
11	Dabur Red Tooth Powder	5.74
12	Baidhyanath Red Tooth Powder	5.24
13	Gai Chhap Zarda	11.33
14	Raja Khaini	24.52
15	Gutkha Tulsi Mix	5.29
16	Kuber Gutkha	5.64
17	Vimal Gutkha	7.97

8. Conclusions, recommendations and limitations

Substantive quantities of nitrosamines, BaP and heavy metals exist in most smokeless tobacco products. Nicotine contents are very high in some and lower in others. It is possible that those with lower nicotine content are targeted towards children; as "starter" products. It is alarming that Red Tooth powders which are not marketed as tobacco products also contain substantive quantities of nicotine.

These findings underscore the need for intensive efforts to prevent men women and children from using any smokeless tobacco product.

It is recognized that the currently marketed tobacco products have not been subjected to adequate regulation. All smokeless tobacco products should be subjected to review based on procedures applicable to other consumer products intended for human consumption. The incorporation of non-tobacco ingredients into smokeless tobacco products should also be regulated, for their potential for harm independently or by interaction with tobacco. Health warnings and labelling should reflect the known adverse health effects of the smokeless tobacco product.

The findings in this report are subject to at least two limitations. First, the analysis did not use a sales-weighted or representative sample of all brands or manufacturers; the products tested were 20 leading products. Second, the findings for any specific brand could have been affected by factors unique to the sample delivered to each city surveyed, such as the retailers' duration and conditions of storage (e.g., humidity and temperature) and manufacturing dates.

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319

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Annex-1: Details of smokeless tobacco brands tested:

No	PRODUCT NAME	BATCH	Date of purchase	place of purchase
1	Sanket 999 Jarda + Sanket No 1 Supari Mix	J J	22-Oct 2003	Mumbai
2	Moolchand Superb Jarda+ Moolchand Superb Supari	004, 006 batch 006	22-Oct 2003	Mumbai
3	Shimla Jarda+ Shimla Supari Mix	MSY MSY	22-Oct 2003	Mumbai
4	Goa 1000 zarda+ Goa supari	A-9 A-9	22-Oct 2003	Mumbai
5	Gutka Pan parag		8-Nov 2003	Gujarat
6	Gutka Manikchand	B	8-Nov 2003	Gujarat
7	Click Eucalyptus	351090	19-Oct 2003	Bangalore
8	Baba zarda 120	Barcode no.89018370406068	4-Nov 2003	Mumbai
9	Dentobac	Barcode no>8904027801041	22-Oct 2003	Mumbai
10	Lime mix - Miraj tobacco	AA9	22-Oct 2003	Mumbai
11	Shahin mishri	RC No.DMJ/CH-24/2/95	22-Oct 2003	Mumbai
12	Dabur red tooth powder	2432	22-Oct 2003	Mumbai
13	Baidhyanath red tooth powder	1423-1416-1552	22-Oct 2003	Mumbai
14	Gay chap tobacco	6	22-Oct 2003	Mumbai
15	Raja khaini	Regn. No. ADUPG810FXM002	22-Oct 2003	Mumbai
16	Gutka Tulsi mix	08CI23	22-Oct 2003	Gujarat

17	IPCO creamy snuff	Regn. No.AAEFA6022AXM001 JULY02 Regn. No.AAEFA6022AXM001 FEB03 Regn. No.AAEFA6022AXM001 JUNE03	8-Nov 2003	Gujarat
18	Kuber gutka	0.8	8-Nov 2003	Gujarat
19	Vimal gutka		8-Nov 2003	Gujarat
20	Tuiber tobacco water			

322

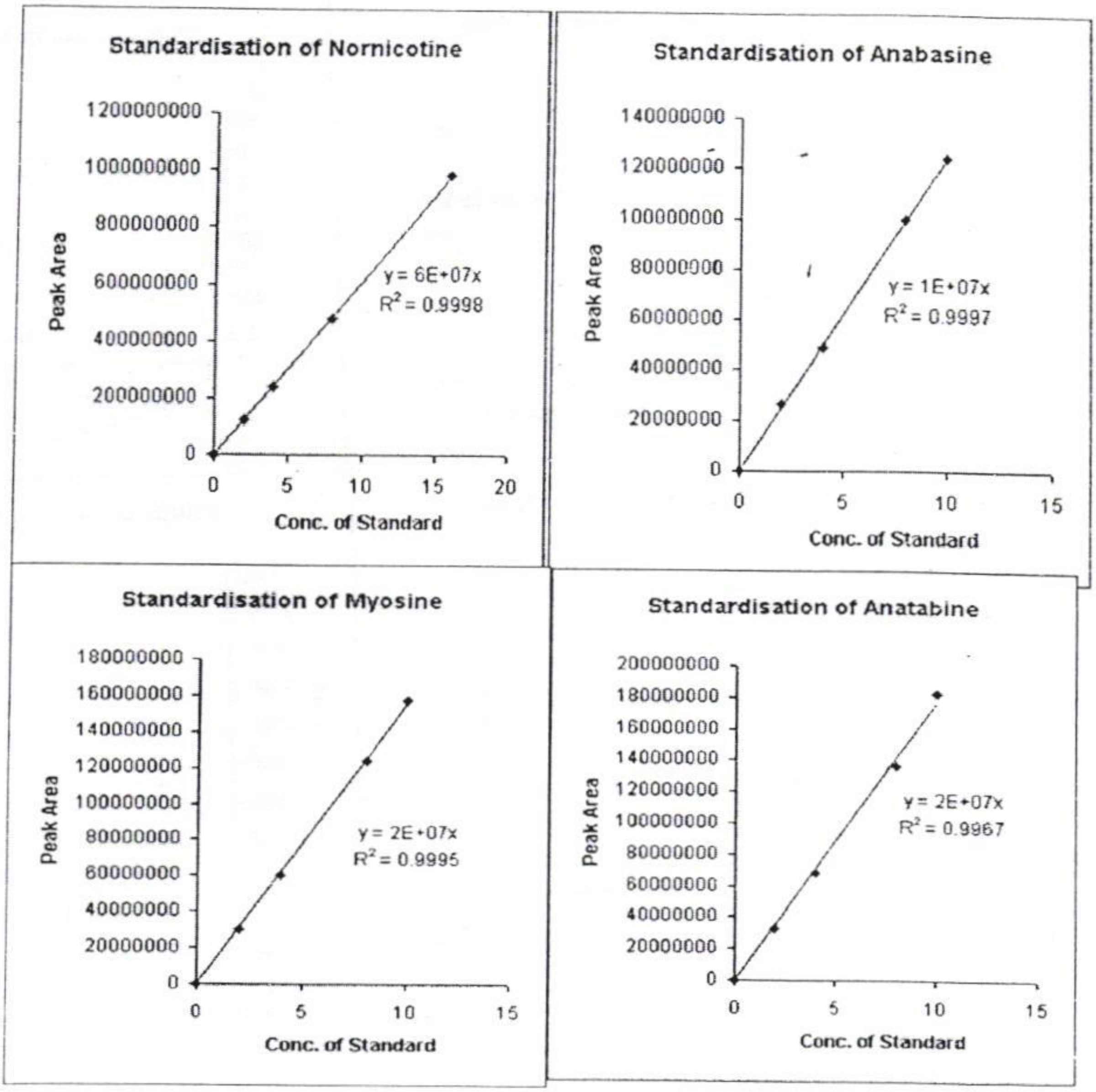
Annex-2: Techniques used for the Measurements of chemical constituents of Smokeless Tobacco

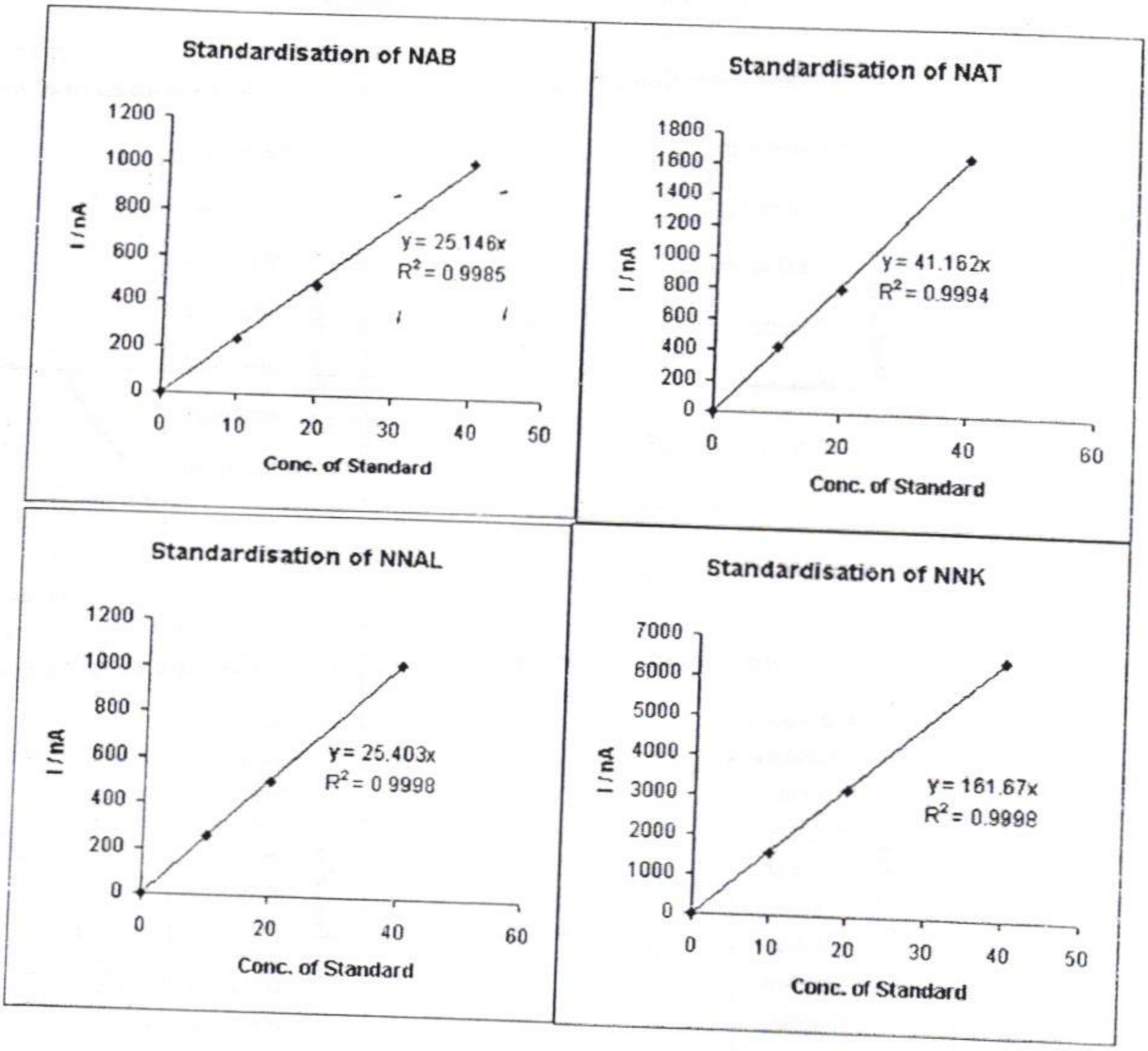
Name of Instruments	Make of Instruments	Detectors	Column	Tobacco Chemicals
Gas Chromatograph Dual Port	Toshnival Instrument (India) ltd. Model no. 8610.	Flame Ionization Detector (FID)	Capillary Column (BP-5) 50 m X 0.22 I.D. X 1.0 um.	Glycerol, Propylene Glycol, Triethylene Glycol. Benzo(a)pyrene Triacetin Sodium Propionate
			Packed Column (3% ov-101)	Alkaloids: Nicotine
		Thermal Ionization Detector (TID)	Capillary Column (BP-5) 50 m X 0.22 I.D. X 1.0 um.	**Alkaloids:** Nornicotine, Anabasine, Myosmine, Anatabine.
Electro Chemical Trace Analyser. Polaragraphic & Voltammetric Techniques.	EG&G Instruments Princeton Applied Research. Model no. 303A/394/305	Techniques: Differential Pulse Anodic Stripping Voltametric (dpasv) Differential Pulse Cathodic Stripping Voltametric (dpcsv) Differential Pulse square Voltametric (dpsv)		**Heavy Metals:** Nickel, Lead, Cadmium, Chromium, Arsenic, Selenium.
		Differential Pulse Polorography (DPP)	**Electrolyte:** 0.1 % Hcl	**Nitrosamines:** N-nitrosonornicotine, 4-(N-nitrosomethylamino)-1-(3-pyridyl)-1-butanone, N-nitrosoanatabine, N-nitrosoanabasine.

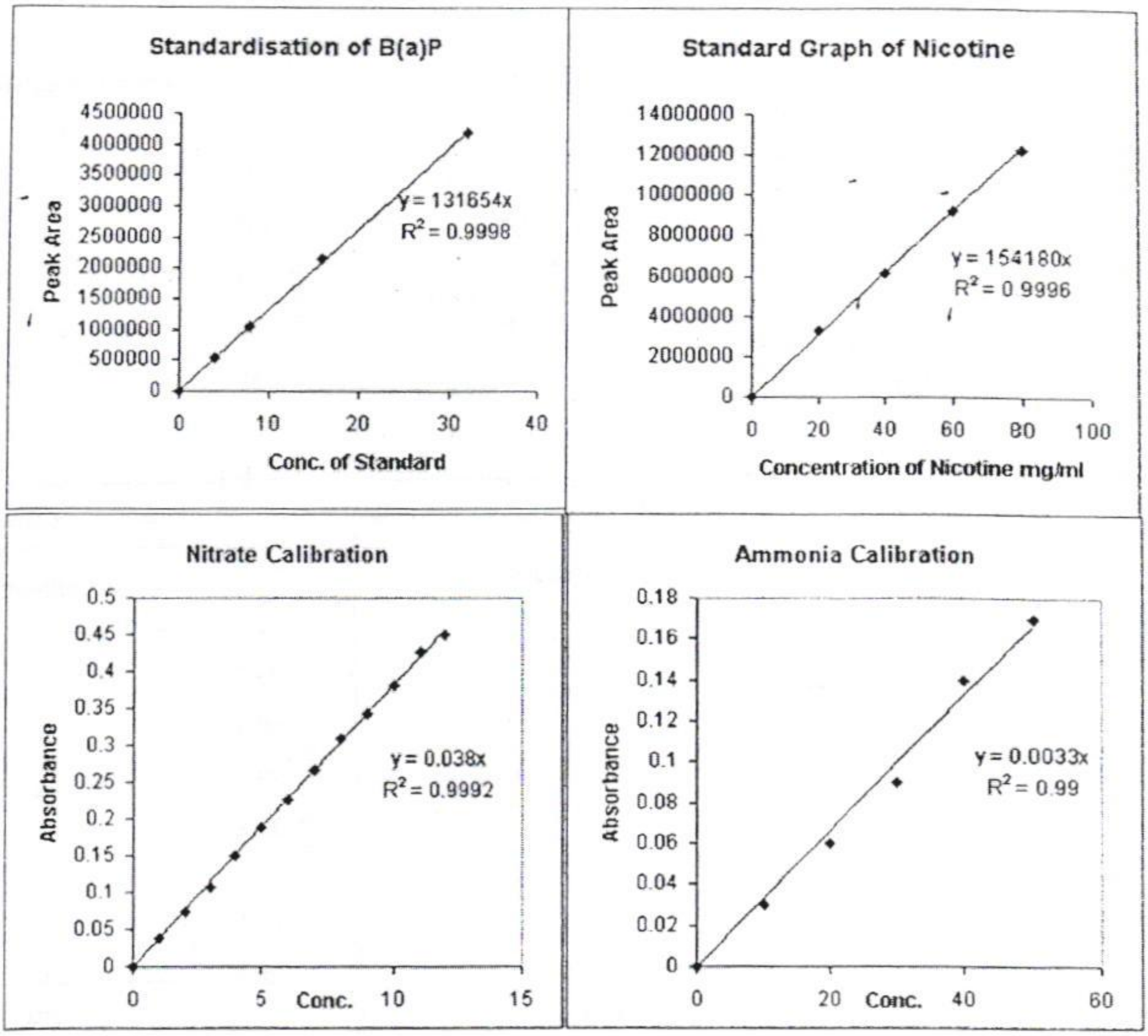
High Performance Liquid Chromatograph	Hitachi, Merck : L-6220/L-7400/L-7350	Liquid – Liquid Phase	C-18 column	Sorbic Acid, Eugenol [2-Methoxy-4-(2-propenyl)-phenol]
Double beam Ultra-Violet Spectrophotometer	Toshnival Instrument -(India) Ltd. Spectrascan Model no: 2600		**Wavelength:** 420nm 550nm	Ammonia Nitrate.
Digital Mercury Analyser with Vapour Generating system	Electronics Corporate of India. Model no: MA 5840 MS 500.			Mercury
pH meter	Testronix Model no: 511			pH value
Titrimeteric Method				Magnesium Carbonate ($MgCo_3$)

324

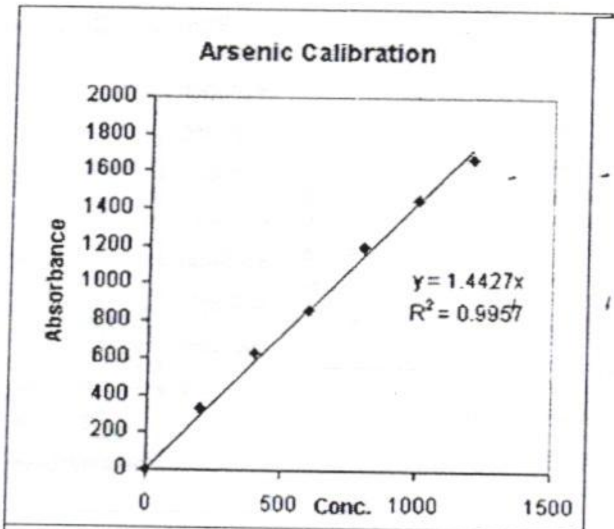
Annex-3: Calibration curves used for estimations:

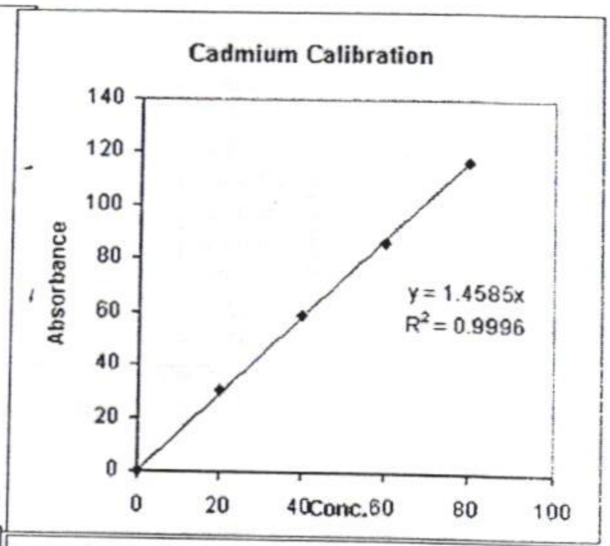


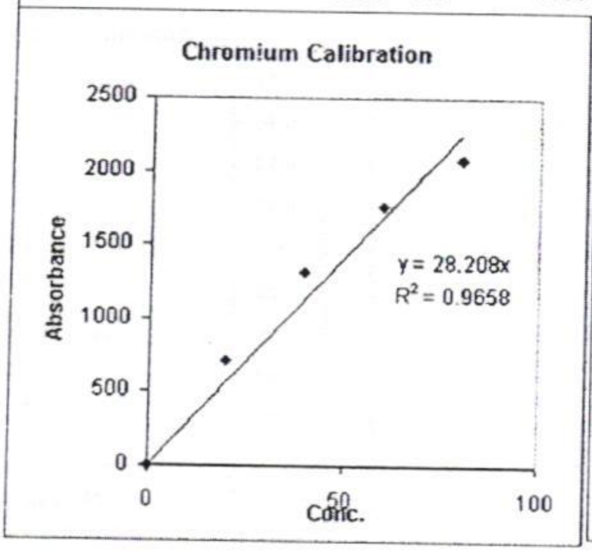

Standardisation of NAB
y = 25.146x
R² = 0.9985
I / nA
Conc. of Standard
Standardisation of NAT
y = 41.162x
R² = 0.9994
I / nA
Conc. of Standard
Standardisation of NNAL
y = 25.403x
R² = 0.9998
I /nA
Conc. of Standard
Standardisation of NNK
y = 161.67x
R² = 0.9998
I / nA
Conc. of Standard

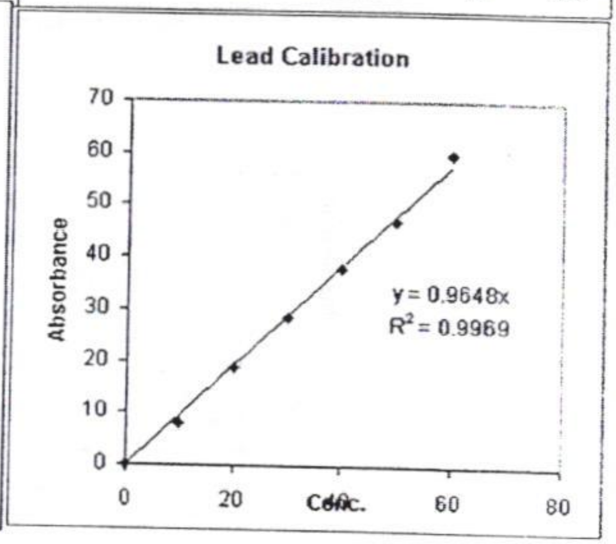

Standardisation of B(a)P
Peak Area
Conc. of Standard
y = 131654x
R^2 = 0.9998
Standard Graph of Nicotine
Peak Area
Concentration of Nicotine mg/ml
y = 154180x
R^2 = 0.9996
Nitrate Calibration
Absorbance
Conc.
y = 0.038x
R^2 = 0.9992
Ammonia Calibration
Absorbance
Conc.
y = 0.0033x
R^2 = 0.99

327

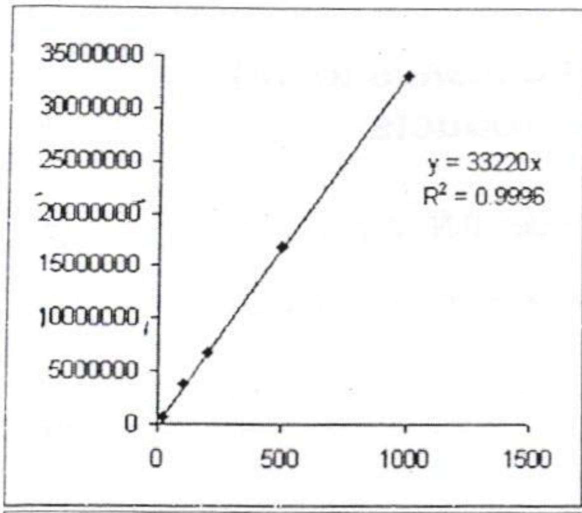

Arsenic Calibration
Absorbance
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
500
Conc.
1000
1500
y = 1.4427x
R² = 0.9957

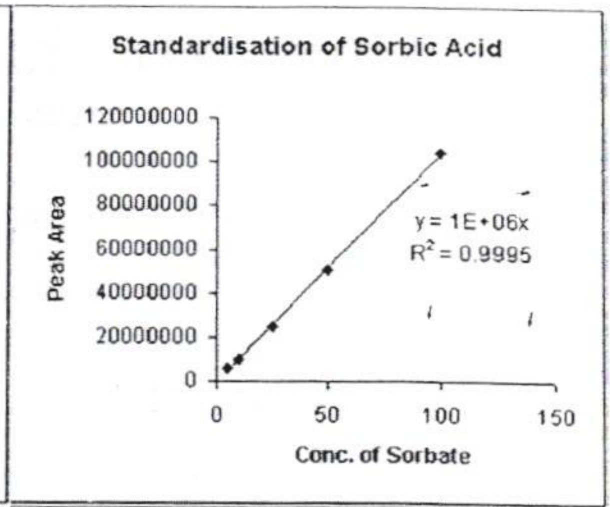

Cadmium Calibration
Absorbance
140
120
100
80
60
40
20
0
0
20
40
Conc.
60
80
100
y = 1.4585x
R² = 0.9996

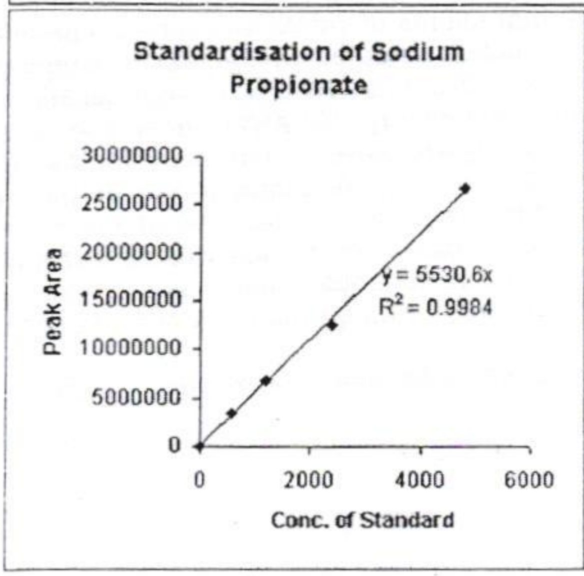

Chromium Calibration
Absorbance
2500
2000
1500
1000
500
0
0
50
Conc.
100
y = 28.208x
R² = 0.9658

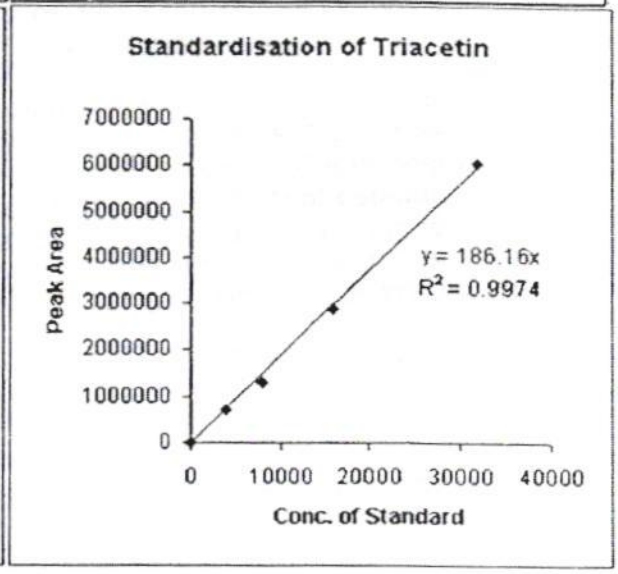

Lead Calibration
Absorbance
70
60
50
40
30
20
10
0
0
20
40
Conc.
60
80
y = 0.9648x
R² = 0.9969

328


35000000
30000000
25000000
20000000
15000000
10000000
5000000
0
0
500
1000
1500
y = 33220x
R^2 = 0.9996


Standardisation of Sorbic Acid
120000000
100000000
80000000
60000000
40000000
20000000
0
Peak Area
0
50
100
150
Conc. of Sorbate
y = 1E+06x
R^2 = 0.9995


Standardisation of Sodium Propionate
30000000
25000000
20000000
15000000
10000000
5000000
0
Peak Area
0
2000
4000
6000
Conc. of Standard
y = 5530.6x
R^2 = 0.9984


Standardisation of Triacetin
7000000
6000000
5000000
4000000
3000000
2000000
1000000
0
Peak Area
0
10000
20000
30000
40000
Conc. of Standard
y = 186.16x
R^2 = 0.9974

ANNEXURE - 7

Research Article
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Determination of Toxic Metals in Indian Smokeless Tobacco Products

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This study targets the lesser-known ingredients of smokeless tobacco products, i.e., the toxic metals, in Indian brands. The metals selected in the study included lead (Pb), cadmium (Cd), arsenic (As), copper (Cu), mercury (Hg), and selenium (Se). The differential pulse anodic stripping voltammetry (DPASV) technique was used for estimating the metals Pb, Cd, and Cu; square wave voltammetry for As; and the cold vapor atomic absorption technique for Hg. The resulting levels of the metals were compared to the daily consumption of the smokeless tobacco products. It was observed that almost 30% of gutkha brand samples exceeded the permissible levels of metals Pb and Cu, when compared to the provisional tolerable intake limits determined by the FAO/WHO. The reliability of data was assured by analyzing standard reference materials.

KEYWORDS: smokeless tobacco, metals, lead, cadmium, arsenic, copper, mercury

INTRODUCTION

The tobacco plant (*Nicotiana tabacum*) is widely known for its leaves, which are smoked, chewed, or sniffed for various effects. It is well documented that the addiction of tobacco comes from the chemical nicotine[1], which is harmful to humans. Tobacco contains over 19 known carcinogens and at least 30 metallic compounds, comprising heavy metals[2,3,4]. Harmful effects on human health are associated with exposure to the heavy metals lead (Pb), cadmium (Cd), mercury (Hg), arsenic (As), selenium (Se), and nickel (Ni). These metals have been extensively studied[5] and their effects on human health have been regularly reviewed by international bodies, such as the World Health Organization (WHO). These heavy metals are found in the atmosphere as well as many man-made sources, and they do not have any metabolic function, as such, in the body[6].

In India, a very popular form of tobacco is the smokeless tobacco (commonly known as gutkha, zarda, khaini, and others) consisting of a mixture of tobacco and other constituents. In addition to nicotine, the major groups of carcinogens in smokeless tobacco products (STPs) include nonvolatile tobacco-specific nitrosamines (TSNA), *N*-nitrosamine acids, and other constituents. Reports of toxic metals in cigarettes[7,8] and tobacco[9] led us to study their presence and accumulation in smokeless tobacco variants[10]. The concentration of these metals in humans depends on the daily intake of smokeless tobacco. Marketed STPs vary considerably in form and content of toxicants, including

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332

nicotine, and thereby in associated health effects, such as increased heart rate, an increased risk in pregnancy, increased premature fetal death, and SIDS (Sudden Infant Death Syndrome). It has been reported by the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) in 2008[11] that aqueous and organic extracts of American and Swedish moist snuff and Indian chewing tobacco cause mutations and chromosomal damage in bacterial and mammalian cell cultures. Increased micronuclei formation in oral epithelial cells as evidence of chromosomal damage in oral cancer patients due to STP use has been reported[12,13].

The role of copper (Cu) in submucous fibrosis *in vitro* has been shown earlier[14] and it was noticed that Cu in gutkha may be responsible for the fibrosis in mouth cavities. Early symptoms of chronic Cu poisoning include precancerous oral lesions (leukoplakia-small white patches) and sores in the mouth or tongue, followed by oral submucous fibrosis and difficulty in opening the mouth fully. Lead is particularly dangerous for the younger age group, as chronic exposure resulting in the lowering of the IQ and its poisoning effect on the brain may not be reversible[4,15,16]. Arsenic exposure can cause skin pigmentation and cancer problems, ulcerations of the mouth, low hemoglobin, leukemia, acute renal failure, seizures, and nerve damage[17], and it is also a potential carcinogen[18]. Excessive doses of Cd are known to cause lung and bone damage, and increased blood pressure[3] and causation of cardiovascular disease[19,20,21].

Our study targeted seven different groups of STPs for determination of a total of eight metals, namely Pb, As, Cu, Se, Cd, Ni, chromium (Cr), and Hg. On analysis, it was found that the smokeless tobacco contained considerable levels of metals like Pb, As, Cd, and Cu, which if consumed in excess would prove harmful for consumers.

METHODOLOGY

Sample Collection

Indian STPs were purchased from retail stores in Mumbai. The date of purchase, name of manufacturer, company, and manufacturing date were recorded. Twenty-five forms of different brands of STPs were collected from 10 outlets in various parts of the city. Samples of the same brand were mixed together to obtain a representative sample of that product. Brand names have not been disclosed in this paper due to legal requirements. The products collected for analysis represented the commonly used brands, such as the popular gutkha, zarda, khaini, and mishri, which are chewing tobacco products that have become more popular, especially among teenagers and young adults in many states of India. Other tobacco-containing products were also selected that included creamy snuff and Dentifrice (Dantmanjan). One earlier pharmacokinetic study on mishri (a form of STP) use by women reported that 0.5–1 g of mishri was applied to teeth and retained in the mouth for 10–15 min or longer[22].

Sample Pretreatment

All samples were ground to 20-mesh size with a grinder and kept in cleaned polythene bags and stored in desiccators. One gram of sample was taken for specific analysis and pretreated as per the standard procedure given below for different metals.

A. Pb, Cd, As, Se, Ni — Wet acid digestion method: a known quantity of sample (1 g) was taken in a clean borosilicate beaker. The sample was wet digested with 3 ml of concentrated nitric acid (AR or GR grade) and 2 ml perchloric acid by slow heating. The solution was evaporated to near dryness. It was ensured that the residue obtained after digestion was free from organic matter, which otherwise act as impurities in metal analysis. The white residue was reconstituted using 10 ml of supporting electrolyte. This sample was further analyzed on the voltammeter, an instrument

333

known for its sensitivity up to nanogram level. This routine analytical method is well known for its minimum detection level for samples having a low concentration of the analyte.

B. Hg — Bethge's apparatus method: 1 g of ground sample, 4 ml of HNO_3, and 2 ml of H_2O_2 was kept for refluxing for 2 h. This was followed by addition of supporting electrolyte. The sample was then taken for analysis in a cold vapor Hg analyzer.

Sample Analysis

Levels of Pb, Cd, Cr, Ni, Se, and As in the processed samples were estimated by the differential pulse anodic stripping voltammetry (DPASV) technique, and As was estimated by square wave voltammetry using a EG&G (Princeton, NJ) model PARC 394 with static mercury drop electrode (SMDE) assembly (PARC 303) with a PARC 305 stirrer. The measurement procedure was followed as reported earlier[23]. The electrolytes and instrument conditions used for different metals have been summarized in Table 1. Reagent blank samples were subtracted from the corresponding batch of field samples. The minimum detection limit achieved was 0.03, 0.012, 0.01, 0.02, 0.005, 0.0002, and 0.1 ppm for Pb, Cu, Cd, Cr, Ni, Se, and As, respectively. The quality of data was assured by analysis of standard reference materials[24,25]. The recovery was found to be within ±8%. The permissible levels of metals are summarized in Table 2. Mercury metal in the processed tobacco samples was analyzed using a Digital Mercury Analyzer (MA 5840) from Electronic Corporation of India (ECI), employing a cold vapor generating system using the protocol described in our earlier studies[26].

TABLE 1
Instrumental Parameters Employed for Analysis of Heavy Metals during Voltammetry

Metal	E ½ vs. Ag/AgCl	Scan Rate	Pulse Repetition Time	Modulation Amplitude	Supporting Electrolyte Composition	Technique
Pb Cd Cu	−0.42 V −0.6 V −0.02 V	5 mV/sec	0.5 sec	50 mV	0.25% HNO_3	DPASV
Cr	−1.2 V	5 mV/sec	0.5 sec	50 mV	Sodium acetate (0.2 mol/l), diethylenetriamine pentaacetic acid (0.05 mol/l), sodium nitrite (2.5 mol/l)	DPASV
Ni	−0.9 V	2 mV/sec	0.5 sec	50 mV	Double distilled water, 0.02 *M* dimethylglyoxime, ammonia buffer	DPASV
Se	−0.6 V	2 mV/sec	0.5 sec	50 mV	0.2 *M* HCl	DPASV
As	−0.5 V	2 mV/sec	0.5 sec	50 mV	0.1 *M* HCl	Square wave voltammetry
Hg	—	—	—	—	10% HNO_3, stannous chloride	Cold vapor atomic absorption

During the smokeless tobacco analysis, the products were divided into seven main groups and subgroups depending on the form and brands, respectively. Each value was reported as the mean of triplicate analyses, along with the standard deviation (±) as shown in Table 3.

334

TABLE 2
Permissible Intake Levels as per FAO/WHO Recommendations

Metal	Provisional Tolerable Weekly Intake (µg/kg/week)	Per Day Intake (µg/kg/day)	For a 60-kg Individual (µg/day)	Ref.
Pb	25	5	300	FAO/WHO
As	15	3	180	FAO/WHO
Cd	3.5	0.2–1	30	WHO/JECFA
Cu	500	100	600	FAO/WHO

RESULTS AND DISCUSSION

In India, the consumption of smokeless tobacco is widespread because it is inexpensive, widely available, heavily advertised, and has complete social acceptance, unlike smoking. Nicotine content, toxicants like TSNAs, PAHs, alkaloids, aldehydes, and more have been studied by many[27], so in this study we targeted the determination of metals in the STPs. Recent studies have reported levels of toxic metals in STPs such as snuff and Alaskan iqmik[28], but the research on metals in Indian smokeless tobacco brands is uncommon[7]. Similarly, the use of voltammetry for metals in cigarette tobaccos has been reported earlier[29]. Dobrowolski and Mierzwa reported a comparative analysis of the metals in tobacco using two different techniques involving atomic absorption spectrophotometry[30].

The metal analysis of smokeless tobacco has yielded very useful information about the indirect intake of heavy metals. In these products, the levels of Pb, As, Cd, and Cu exceeded the average daily intake values of consumption. Exposures to each of these were calculated using an average consumption of 10 pouches per day based on survey reports. According to the GYTS (Global Youth Tobacco Surveys) and NSS (National Service Scheme) Unit of TISS (Tata Institute of Social Sciences) Mumbai India 1998, the survey shows that among students, addiction to the following forms of tobacco intake was cigarettes (smoking), 10.6%; tobacco chewing, 6.7%; paan masala, 9.9%; and gutkha, 9.6%. Of those who took these products, very few were addicted to a single product — 15% of those who smoked, 2% of those who ate paan masala, 13% of those who ate gutkha, and 14% of those who chewed tobacco in other forms. Paan masala/gutkha addiction was found in both rural and urban areas[31]. The average daily intake was calculated as shown below.

Daily intake (µg/day) = Metal concentration in gutkha sample taken for analysis × Weight of gutkha sample taken for analysis (pouch weight) × Daily intake of pouch (10 pouches per day)

Several food products in India have recommended limits for some heavy metals; however, although STPs are classified under foods for regulatory purposes, the limits for metals have not been specified. Therefore, the daily intake of these elements was compared with the provisional tolerable weekly intake (PTWI) and the proposed maximum permissible level suggested by the Food and Agriculture Organization /World Health Organization (FAO/WHO), as shown in Table 2.

- **Lead** — The FAO/WHO established a PTWI of Pb in adults and children as 25 µg/kg/week[32,33]. According to the Joint FAO/WHO Expert Committee on Food Additives (JECFA)[33], the accumulation of Pb in the body was based on net absorption of Pb — 40% from dietary sources, 10% from food and drinking water, and up to 50% from inhalation of Pb compounds. This implies that at an intake of 5 µg/kg bw/day, retention of Pb in the body leads to an increased blood Pb level, thereby impacting the hematic and immune system. It was found that in four brands, A5, A7, A8, A9 from group A (gutkha), the Pb level touched or exceeded this permissible range, as shown in Table 3, when an average 10 pouches were consumed per day.

335

TABLE 3
Observed Levels of Heavy Metals in STPs with (±) Standard Deviation

Smokeless Tobacco Forms	Pb		As		Cd		Cu	
	µg/g	µg/day*	µg/g	µg/day*	µg/g	µg/day*	µg/g	µg/day*
A. Gutkha								
A1	14.9 ± 0.01	149.0	0.11 ± 0.01	1.1	0.13 ± 0.01	1.3	30.5 ± 0.02	305.0
A2	0.13 ± 0.02	1.3	0.57 ± 0.04	5.7	0.17 ± 0.00	1.7	36.1 ± 0.02	361.0
A3	0.25 ± 0.01	2.5	1.09 ± 0.02	109.0	0.08 ± 0.00	0.8	14.7 ± 0.02	146.0
A4	0.03 ± 0.01	0.3	0.13 ± 0.01	1.3	0.01 ± 0.01	0.1	14.7 ± 0.02	147.0
A5	68 ± 0.03	680.0	0.13 ± 0.01	1.3	3.2 ± 0.02	32.0	282 ± 0.02	2820.0
A6	0.95 ± 0.02	9.5	3.5 ± 0.02	35.0	0.01 ± 0.01	0.1	17 ± 0.02	170.0
A7	29.8 ± 0.04	298.0	0.12 ± 0.01	1.2	0.01 ± 0.01	0.1	272 ± 0.02	2720.0
A8	23.8 ± 0.02	238.0	0.13 ± 0.01	1.3	0.01 ± 0.01	0.1	237 ± 0.02	2370.0
A9	33.3 ± 0.01	333.0	0.14 ± 0.01	1.4	0.01 ± 0.01	0.1	656 ± 0.02	6560.0
A10	0.03 ± 0.01	0.3	0.34 ± 0.05	3.4	0.19 ± 0.00	1.9	14.7 ± 0.02	147.0
A11	0.15 ± 0.00	1.5	0.68 ± 0.05	6.8	0.07 ± 0.00	0.7	14.7 ± 0.02	14.70
A12	0.19 ± 0.01	1.9	0.26 ± 0.05	2.6	0.11 ± 0.01	1.1	25 ± 0.02	250.0
A13	0.15 ± 0.00	1.5	0.14 ± 0.01	1.4	0.01 ± 0.01	0.1	17 ± 0.02	170.0
B. Zarda								
B1	0.53 ± 0.00	5.3	0.37 ± 0.02	3.7	0.23 ± 0.00	2.3	17.7 ± 0.02	177.0
B2	0.96 ± 0.03	9.6	0.39 ± 0.04	3.9	0.50 ± 0.00	5.0	18.7 ± 0.02	187.0
C. Creamy Snuff								
C1	0.13 ± 0.00	1.3	0.79 ± 0.07	7.9	0.07 ± 0.00	0.7	7.7 ± 0.02	77.0
C2	0.59 ± 0.01	5.9	0.6 ± 0.07	6.0	0.15 ± 0.01	1.5	7.7 ± 0.02	77.0
D. Dentifrice (Dantmanjan)								
D1	5.04 ± 0.07	50.4	0.2 ± 0.07	2.0	0.23 ± 0.02	2.3	7.7 ± 0.02	77.0
D2	4.91 ± 0.07	49.1	0.13 ± 0.04	1.3	0.18 ± 0.01	1.8	4.7 ± 0.02	47.0
E. Khaini								
E1	0.33 ± 0.03	3.3	0.14 ± 0.02	1.4	0.04 ± 0.00	0.4	.012 ± 0.02	0.12
E2	0.31 ± 0.03	3.1	0.11 ± 0.03	1.1	0.03 ± 0.01	0.3	.013 ± 0.01	0.13
F. Mishri								
F1	0.30 ± 0.01	3.0	0.81 ± 1.00	8.1	0.11 ± 0.00	1.1	8.7 ± 0.02	87.0
F2	0.21 ± 0.01	2.1	0.79 ± 0.02	7.9	0.10 ± 0.01	1.0	8.2 ± 0.02	82.0
G. Others								
G1	0.16 ± 0.02	1.6	0.83 ± 0.07	8.3	0.07 ± 0.00	0.7	8.7 ± 0.02	87.0
G2	0.16 ± 0.02	1.6	0.82 ± 0.07	8.2	3.1 ± 0.01	31.0	8.6 ± 0.01	86.0

* Per day levels calculated considering a consumption of minimum 10 pouches per day.

- **Arsenic** — In 1990, the JECFA set the As level to 2.1 µg/kg bw/day. PTWI for As according to the FAO/WHO in adults is 15 µg/kg/week[32,34,35,36]. According to this level, brand A3 from group A was found to contain toxic levels of As, as shown in Table 3.
- **Cadmium** — Cd was found below the permissible level in all groups, as shown in Table 3, except from Group A and G, brands A5 and G2, respectively. According to WHO-JECFA[33,37], the recommended value of Cd is 3.5 µg/kg bw/week for adults. Considering the accumulation property and the long biological half-life of Cd, a level of 0.2–1 µg/kg bw/day has been set[32,37]. This equals 30 µg Cd/day for a 60-kg body weight individual. The absorption

336

following oral exposure of Cd is likely to depend on physiological status, such as age and levels of Fe, Ca, and Zn stored in the body. According to IPCS 1992[19], ingested Cd from daily food and water is about 12–25 μg, from which the actual absorbed amount of Cd is 0.6–1.3 μg/day, and total inhalatory intake from the atmosphere is 0.15 μg/day of which the actual absorbed amount of Cd is 0.04 μg/day.

- **Copper** — Cu is an essential and beneficial element in human metabolism. Its recommended daily intake, based on essentiality, is about 0.5 mg/kg bw/day, i.e., 500 μg/kg body weight per day according to FAO/WHO[38,39]. The Cu levels were found to be higher in four brands: A5, A7, A8, and A9 of Group A — 282, 272, 237, and 656 μg per pouch as shown in Table 2. As per earlier studies, the average daily exposure from air, food, and water for a person weighing 70 kg and drinking 1.5 l of water per day, eating 1.5 kg of food per day, and inhaling 20 m^3/day is 0.01–0.06 μg/kg, 31.4 μg/kg, and 3.77 μg/kg body weight per day, respectively[40]. The role of Cu in gutkha for causing submucous fibrosis has been of concern among dentists.

The metals Ni, Se, Hg, and Cr were found to be negligible, and therefore not reported in the results. The source of heavy metals in smokeless tobacco may be due to atmospheric absorption by tobacco plants[41]. A number of factors influence the actual level of elements found in plants that include type of plant tissue, level of elements in soil, soil and leaf residues resulting from application of metal-containing pesticides, insecticides[42], and soil amendments including fertilizers and municipal sludge[43]. It also depends on the distance of the plant from the source of the element, the season, the climatic condition, and the foliar uptake from settled aerosols[6]. Also, it is possible that the source of metals may be due to the addition of various ingredients as shown in Table 4. Certain spices, such as mint, saffron, etc., used in the flavoring of STPs might also contribute to the heavy metal content[44].

TABLE 4
Common Ingredients Used for Flavoring of Tobacco

S. No.	Name	Ingredients
1	Gutkha	Areca nut, catechu, tobacco, lime, saffron, flavoring agent, saccharine, mint. Held in the mouth and chewed.
2	Zarda	Loose leaves boiled in water with lime and spices to evaporation; the residual particles are then dried and colored with vegetable dye.
3	Creamy Snuff	Fire cured tobacco; after the initial curing process, the leaves undergo fermentation process, then are enriched with flavor additives, including spices.
4	Tooth Powder	Tobacco, clove oil, glycerin, menthol, spearmint, camphor.
5	Khaini	Mixture of tobacco, lime, menthol, or aromatic spices.
6	Mishri	Powdered form of roasted tobacco.
7	Other tobacco	Mixture of tobacco, lime, menthol, or spices.

To summarize, the gutkha brands tested had significant levels of metals as compared to other groups of smokeless tobacco in the range: Pb (0.03–68 μg/g), Cd (0.01–3.2 μg/g), As (0.1–3.5 μg/g), and Cu (0.012–656 μg/g). This study emphasizes the fact that some STPs have heavy metals above permissible limits prescribed by the WHO. This study was also instrumental for the policy makers in order to impose a temporary ban on the sale of the popular brand gutkha in Maharashtra, a state in India.

35

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338

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339

Annexure - O

सत्यमेव जयते

Ministry of Health and Family Welfare
Government of India

GLOBAL ADULT TOBACCO SURVEY
GATS INDIA 2009-2010

EXECUTIVE SUMMARY

IIPS
(Established in 1956)
Capacity Building for a Better Future

International Institute for Population Sciences
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340

EXECUTIVE SUMMARY

The Global Adult Tobacco Survey India (GATS India) is the global standard for systematically monitoring adult tobacco use (smoking and smokeless) and tracking key tobacco control indicators. Global Adult Tobacco Survey India was carried out in all 29 states of the country and 2 Union Territories of Chandigarh and Puducherry, covering about 99.9 percent of the total population of India. The major objectives of the survey were to obtain estimates of prevalence of tobacco use (smoking and smokeless tobacco); exposure to second-hand smoke; cessation; the economics of tobacco; exposure to media messages on tobacco use; and knowledge, attitudes and perceptions towards tobacco use.

The Ministry of Health & Family Welfare (MoHFW), Government of India, designated the International Institute for Population Sciences (IIPS), Mumbai, as the nodal agency for conducting GATS in India. Technical assistance was provided by the Centers for Disease Control and Prevention (CDC), the World Health Organization (WHO), the Johns Hopkins Bloomberg School of Public Health, and Research Triangle Institute International (RTI International).

GATS India was conducted in 2009–2010 as a household survey of persons age 15 and above. A nationally representative probability sample was used to provide national and regional (North, West, East, South, Central and North-East) estimates by residence (urban and rural) and gender and state estimates by gender. The survey was designed to produce internationally comparable data on tobacco use and other tobacco control indicators using a standardized questionnaire, sample design, data collection and management procedures. GATS India was the first nationwide survey in which electronic handheld devices were used for data collection and management. A total of 69,296 interviews were completed among which 33,767 and 35,529 were of males and females respectively. Out of all completed interviews, 41,825 interviews were conducted in rural areas and 27,471 interviews in urban areas. The overall response rate was 91.8 percent which ranged from the highest of 99.2 percent in Tamil Nadu to the lowest of 80.1 in Arunachal Pradesh.

Tobacco use

GATS India revealed that more than one-third (35%) of adults in India use tobacco in some form or the other. Among them 21 percent adults use only smokeless tobacco, 9 percent only smoke and 5 percent smoke as well as use smokeless tobacco. Based on these, the estimated number of tobacco users in India is 274.9 million, with 163.7 million users of only smokeless tobacco, 68.9 million only smokers, and 42.3 million users of both smoking and smokeless tobacco. The prevalence of overall tobacco use among males is 48 percent and that among females is 20 percent. Nearly two in five (38%) adults in rural areas and one in four (25%) adults in urban areas use tobacco in some form. Prevalence of smoking among males is 24 percent whereas the prevalence among females is 3 percent. The extent of use of smokeless tobacco products among males (33%) is higher than among females (18%).

The prevalence of tobacco use among all the states and Union Territories ranges from the highest of 67 percent in Mizoram to the lowest of 9 percent in Goa. Prevalence of tobacco use in Arunachal Pradesh, Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Odisha, Sikkim, Tripura, Assam and West Bengal is higher than the national average. In most of the states/UTs, the prevalence of both smoking and smokeless tobacco use among males is higher than among females with exceptions in Puducherry, Tamil Nadu, Meghalaya, Tripura and Mizoram, where prevalence of smokeless tobacco is higher among females than males. More than 75 percent of tobacco users, both smokers as well as users of smokeless tobacco are daily users of tobacco. In India, *khaini* or tobacco-lime mixture (12%) is the most commonly used smokeless tobacco product, followed by gutkha, a mixture of tobacco, lime and areca nut mixture (8%), betel quid with tobacco (6%) and applying tobacco as dentifrice (5%). The prevalence of each of the smokeless tobacco products, except dentifrice, is higher among males than females. Among smoking tobacco products, bidi (9%) is used most commonly followed by the cigarette (6%) and the hookah (1%).

Among both males and females, the prevalence of cigarette smoking is higher in urban areas but the prevalence of all other smoking products is higher in rural areas. The prevalence of each of the smokeless tobacco product is higher in rural than urban areas, however, gutkha is almost equally prevalent in both urban and rural areas.

On an average a daily cigarette smoker in India smokes 6.2 cigarette sticks per day, and a daily bidi smoker smokes 11.6 bidi sticks per day. One-fourth of daily cigarette smokers smoke more than 10 cigarettes per day, and more than half of the daily bidi smokers smoke more than 10 bidis per day.

The mean age at initiation of daily tobacco use for tobacco users age 20–34 years is 17.8 years. The mean age at initiation of smoking as well as use of smokeless tobacco among users of respective products age 20-34 years is 17.9 years. Two in every five daily tobacco users age 20–34 had started using tobacco daily before attaining the age of 18. The quit ratio for smoking (defined as former smokers among ever daily smokers) is 13 percent, while the quit ratio for use of smokeless tobacco use (defined as former users of smokeless tobacco among ever daily users of smokeless tobacco) is 5 percent. Three in five (60%) daily tobacco users use tobacco within 30 minutes of waking up in the morning.

Tobacco Cessation

Nearly two in five smokers (38%) and users of smokeless tobacco (35%) made an attempt to quit respective tobacco use in the past 12 month period prior to the survey. Among smokers, males and females equally reported (38% of males and 39% of females) that they made a quit attempt. Among smokeless tobacco users fewer females (29%) made a quit attempt compared to males (39%). There is considerable variation in quit attempts across states/UTs. For smoking it ranges from 12 percent in Delhi to 55 percent in Andhra Pradesh. For users of smokeless tobacco it ranges from 8 percent in Delhi to 54 percent in Madhya Pradesh.

Among those smokers who made a quit attempt, 9 percent used counselling and 4 percent used pharmacotherapy for cessation. However, 26 percent used other methods of cessation such as traditional medicines and other products. Among users of smokeless tobacco 8 percent used counselling to quit smokeless tobacco and 22 percent used other methods. Among 47 percent of smokers who had visited a health care provider in the past 12 months, a little more than half (53%) were asked by the health care provider if they smoked and 46 percent were advised to stop smoking. Among 47 percent of users of smokeless tobacco who visited a health care provider in the last 12 months prior to the survey, little more than one-third (34%) were asked by the health care provider whether they used smokeless tobacco and only 27 percent were advised to stop such use.

Second-hand smoke

GATS India shows that 52 percent of adults were exposed to second-hand smoke (SHS) at home. In rural areas 58 percent and in urban areas 39 percent were exposed to SHS at home. The SHS exposure at home ranged from the highest of 97 percent in Mizoram to the lowest of 10 percent in Tamil Nadu. Exposure to SHS in indoor workplaces who usually work indoors or both indoors and outdoors was 30 percent. The exposure to SHS was highest (68%) in Jammu & Kashmir and lowest in Chandigarh (15%). Among those who visited different public places within 30 days prior to the survey, 29 percent were exposed to SHS in any of the public places; 18 percent on public transport, 11 percent in restaurants, 7 percent in Government buildings and 5 percent at the health care facility. Exposure to SHS at any public place ranged from the highest of 54 percent in Meghalaya to the lowest of 11 percent in Chandigarh. Half of the adults (51%) who had visited restaurants during the 30 days prior to the survey had seen a designated non-smoking area in the restaurant, and 16 percent observed smoking in such an area. There was a large variation across the states/UTs in the proportion of adults who saw a designated non-smoking area in the restaurant. It varied from 17 percent in Mizoram to 89 percent in Delhi. Similar variation in observing smoking in non-smoking area was also noted. It varied from 3 percent in Chandigarh to 41 percent in Sikkim.

Economics

About half of all cigarette (51%) and bidi (49%) smokers and users of smokeless tobacco products (55%) purchased tobacco products from stores[1]. Kiosks[2] were next common points of purchase. Thirty-one percent cigarette smokers, 39 percent bidi smokers and 32 percent smokeless tobacco users purchased tobacco products from kiosks, which included roadside paan shops. More than half (59%) of cigarette smokers purchased just two brands of cigarettes and over three-fourth (76%) of cigarette smokers purchased one of five most preferred brands. However, only about one-fifth of bidi smokers purchased bidis of one of the five most preferred brands. On an average, a daily cigarette smoker incurred an expenditure of ₹ 399.20 per month on cigarettes and a daily bidi smoker ₹ 93.40 per month on bidis. Monthly expenditure on cigarettes in urban areas (₹ 469.00) is higher than in rural areas (₹ 347.50), but monthly expenditure on bidis in urban areas (₹ 92.50) is slightly lower than rural areas (₹ 98.00). Monthly expenditure on cigarettes ranged from the lowest of ₹ 181.70 in Jharkhand to the highest of ₹ 1264.90 in Arunachal Pradesh. Monthly expenditure on bidis was lowest in Bihar (₹ 42.70) and highest in Rajasthan (₹ 147.80).

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[1] A place where products and supplies, such as food, clothing, daily use commodities are offered for sale, a shop.

[2] A small booth, bookstall or a cubicle from which cigarettes, newspapers, and sweets are sold. In India these are generally found at the airports, railway platforms or cinema halls to sell products.

Media

A little more than half (52%) of adults in India noticed anti-cigarette information on any media/location during the last 30 days prior to the survey. A relatively higher proportion of adults noticed anti-bidi information (61%) and anti-smokeless tobacco information (66%). The anti-tobacco information noticed by adults varied widely across states for different products. The proportion of adults who noticed anti-cigarette information ranged from 91 percent in Chandigarh to 36 percent in Bihar. The proportion of adults who noticed anti-bidi information ranged from 92 percent in Chandigarh to 31 percent in Assam. Similarly, a proportion of adults who noticed anti-smokeless tobacco information was highest in Chandigarh (93%) and lowest in West Bengal (39%). Majority of cigarette smokers (71%), bidi smokers (62%) and users of smokeless tobacco (63%) noticed health warnings on packages of the respective products. Among those who noticed health warnings on packages, 38 percent of cigarette smokers, 29 percent of bidi smokers and 34 percent of smokeless tobacco users thought of quitting such products because of warning labels on the respective packages of tobacco products. Among all adults, 28 percent noticed some form of advertisement or promotion of cigarettes, 47 percent noticed some advertisement or promotions of bidis and 55 percent noticed some advertisement or promotion of smokeless tobacco products.

Knowledge, attitudes and perceptions

Half (49%) of adults in India are aware that smoking causes stroke and less than two-thirds (64%) believe that smoking causes heart attack whereas, a large proportion (85%) believes that smoking causes lung cancer. Across all states/UTs, highest proportion of adults in Mizoram reported that smoking causes stroke (79%), heart attack (92%) and lung cancer (98%) whereas the lowest proportion of adults in Arunachal Pradesh reported it (34%, 37% and 78% respectively).

Recommendations

In view of the high prevalence of tobacco use in the country, there should be a national effort to prevent any further increase in the prevalence of tobacco use, especially among the vulnerable groups such as females, youth and children. There should also be targeted programmes addressing different types of tobacco use and different user groups with special focus on cessation. There is a need to further strengthen the implementation of Cigarettes and Other Tobacco Products (Prohibition of Advertisement and Regulation of Trade and Commerce, Production, Supply and Distribution) Act, 2003, at national, state and sub-state levels. Establishment of a comprehensive implementation and regulatory structure at the national and state level is required. Tobacco control strategies need to be mainstreamed with other national health programmes, within the overall framework of the National Rural Health Mission (NRHM). The multifaceted nature of tobacco problem in India calls for greater involvement and investment of various stakeholder ministries/departments, e.g. Human Resource Development (Education), Finance, Agriculture, Labour, Commerce, Rural Development, Information & Broadcasting, Women & Child, etc., in addition to the Ministry of Health & Family Welfare, as also the Panchayati Raj Institutions, academic/public health institutions, civil society groups, media, etc.

The progress under the National Tobacco Control Programme (NTCP) launched in 2007-08 needs to be carefully evaluated at the end of the 11th Five Year Plan (2007-12) and a comprehensive NTCP should be expanded on a nationwide basis in the 12th Five Year Plan.

Annexure - 11

Respirology (2003) **8**, 419–431

INVITED REVIEW SERIES: TOBACCO AND LUNG HEALTH

Smokeless tobacco and health in India and South Asia

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Smokeless tobacco and health in India and South Asia
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Abstract: South Asia is a major producer and net exporter of tobacco. Over one-third of tobacco consumed regionally is smokeless. Traditional forms like betel quid, tobacco with lime and tobacco tooth powder are commonly used and the use of new products is increasing, not only among men but also among children, teenagers, women of reproductive age, medical and dental students and in the South Asian diaspora. Smokeless tobacco users studied prospectively in India had age-adjusted relative risks for premature mortality of 1.2–1.96 (men) and 1.3 (women). Current male chewers of betel quid with tobacco in case-control studies in India had relative risks of oral cancer varying between 1.8–5.8 and relative risks for oesophageal cancer of 2.1–3.2. Oral submucous fibrosis is increasing due to the use of processed areca nut products, many containing tobacco. Pregnant women in India who used smokeless tobacco have a threefold increased risk of stillbirth and a two- to threefold increased risk of having a low birthweight infant. In recent years, several states in India have banned the sale, manufacture and storage of *gutka*, a smokeless tobacco product containing areca nut. In May 2003 in India, the Tobacco Products Bill 2001 was enacted to regulate the promotion and sale of all tobacco products. In two large-scale educational interventions in India, sizable proportions of tobacco users quit during 5–10 years of follow-up and incidence rates of oral leukoplakia measured in one study fell in the intervention cohort. Tobacco education must be imparted through schools, existing government health programmes and hospital outreach programmes.

Key words: areca, asthma, health policy, hypertension, intervention studies, morbidity, mortality, neoplasms, oral submucous fibrosis, pregnancy outcomes, smokeless tobacco, South Asia.

INTRODUCTION

The Europeans introduced tobacco into South Asia in the 1600s, for pipe smoking and probably also as snuff. The chewing of betel quid (a mixture of the leaf of the *Piper betle* vine, aqueous calcium hydroxide paste [slaked lime], pieces of areca nut [*supari*], and frequently some spices) was a popular habit that had already been integrated into social and cultural life in this region for over a millennium. Believed to have originated in prehistoric times, this practice extends eastwards as far as the South Pacific islands. After its introduction, tobacco soon became a new ingredient in betel quid (*pan*), which has become the most commonly used form of smokeless tobacco, although its use varies in different parts of the world.

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An estimate of the number of betel quid users globally is 600 million.[1] Smokeless tobacco users in India and Pakistan together have been estimated to number 100 million.[2]

Habitual betel quid chewing is commonly practised by men and women in Bangladesh, India, Pakistan and Sri Lanka, while tobacco smoking is much more common among men in these countries compared to women, except for certain small geographic areas.

Countries in South Asia are major producers of tobacco and the region is a net exporter. Current production figures are shown in Table 1. Tobacco leaf production has been increasing steadily for many decades, and has doubled since the 1960s.[3] The increasing demand for tobacco in Bangladesh is being met by imports, especially from India.[4]

About 35–40% of tobacco consumption in India is in smokeless forms, mostly of the species *Nicotiana rustica*, while most smoking tobacco is *N. tabacum*.[6,7] Samples of *N. rustica* have been found to contain higher concentrations of tobacco-specific nitrosamines than *N. tabacum*.[8]

346

Table 1 Current raw tobacco production in selected countries in the year 2002[5]

Major producing countries	Production (metric tonnes) of tobacco leaves
South Asian region	
Bangladesh	37 000*
India	575 000†
Pakistan	85 100*
World	
Brazil	654 250
China	2 400 000*
USA	401 890

*FAO estimate; †unofficial figure.

SMOKELESS TOBACCO USE IN SOUTH ASIA

Smokeless tobacco use in South Asia raises various concerns. It is commonly used and increasingly so, especially as new forms of smokeless tobacco have been emerging over the last few decades, enticing new consumers.[9] Increasing use has been reported not only among men, but also among such vulnerable groups as children, teenagers, women of reproductive age and by immigrants of South Asian origin wherever they have settled. In India, per capita smokeless tobacco consumption has increased among the poor between 1961 and 2000 in both rural and urban areas.[10] Lately, a European company has begun marketing one of its smokeless tobacco products in India. This review attempts to highlight these issues and the concern for the health consequences.

Forms of smokeless tobacco

In South Asia, the use of smokeless tobacco is common. The various forms are chewed, sucked or applied to teeth and gums.[11,12] Generally sun- or air-cured smokeless tobacco can be used by itself in unprocessed, processed or manufactured form. It can be used with lime, with areca nut or in a betel quid (*pan*) (Fig. 1). The use of unprocessed tobacco, the cheapest form, varies in different parts of India. It is sold as bundles of long strands in Kerala or as leaf tobacco (*hogesoppu*) in Karnataka. *Kaddipudi* are cheap 'powdered sticks' of raw tobacco stalks and petioles, used in Karnataka. Sometimes this powder is formed into bricks or blocks mixed with jaggery (solid molasses) and water. *Gundi*, also called *kadapan*, is a mixture of coarsely powdered tobacco with coriander seeds, other spices and aromatic, resinous oils, popular in Gujarat, Orissa and West Bengal. *Kiwam* or *qiwam*, used mainly in north India and Pakistan, is a thick paste of boiled tobacco mixed with powdered spices such as saffron, cardamom, aniseed and musk, and is also available as granules or pellets. A commercial mixture of tobacco, lime and spices is *zarda*. It is typically flavoured with cardamom and saffron and often

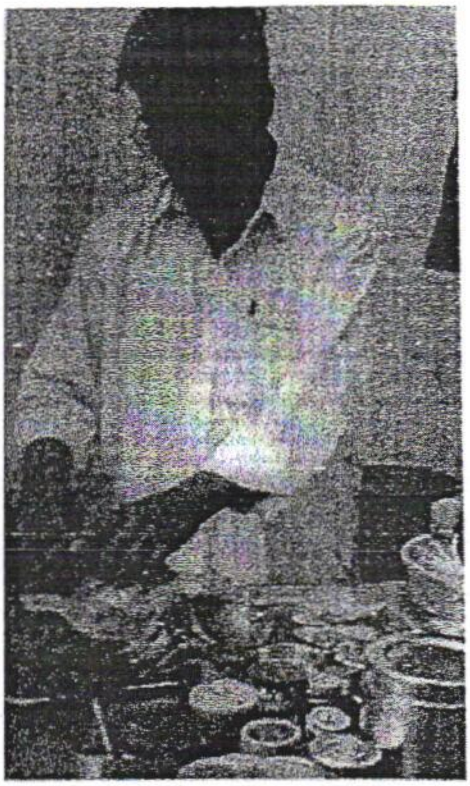

Figure 1 A *pan* seller outside a major railway station in Mumbai, India.

chewed in betel quid, and is popular in north India, Pakistan and Bangladesh.

Pattiwala is sun-dried, flaked tobacco with or without lime, used mainly in Maharashtra and several north Indian states. A similar preparation popular in northern areas is *khaini*, a mixture of tobacco and lime generally made by the user but now available ready made in sachets as well. *Khaini* is placed in the mandibular or labial groove and sucked slowly for 10–15 min, occasionally overnight.

In India there are several smokeless tobacco preparations incorporating areca nut and slaked lime. *Mainpuri* tobacco, taking its name from a district in the northern state of Uttar Pradesh, contains finely cut areca nut, camphor and cloves. *Mawa*, popular among teenagers especially in Gujarat, contains thin shavings of areca nut with some sun-dried tobacco and slaked lime. A similar product used in Maharashtra is called *kharra*.

Gutka, a dry preparation commercialized since 1975, containing areca nut, slaked lime, catechu, condiments and powdered tobacco, was originally available custom-mixed from *pan* vendors. For the last couple of decades, *gutka* has been available in several brands. A similarly packaged mixture without tobacco, often with an identical brand name, is called *pan masala*. These products have become very popular especially among teenagers and young adults in many states of India, as shown by a number of surveys, both published and unpublished, in Gujarat, Maharashtra, Bihar and Punjab (Fig. 2).

347

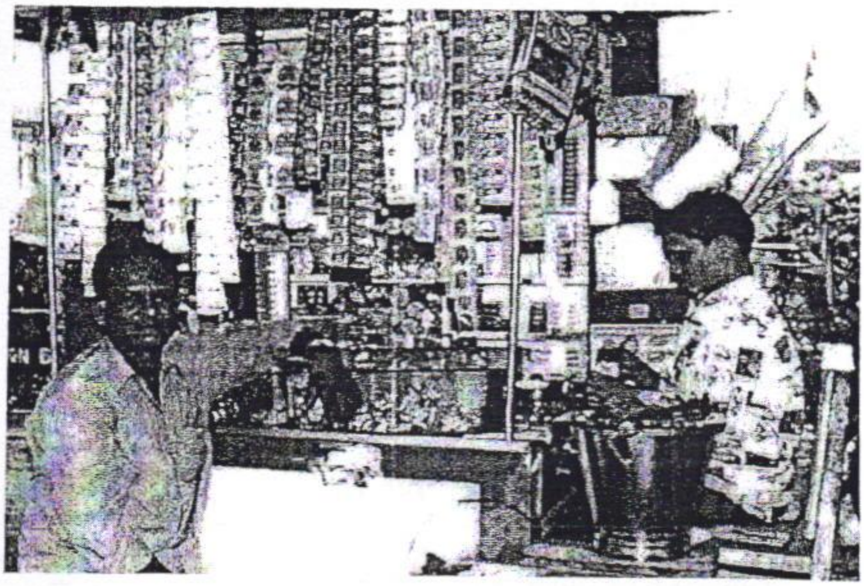

Figure 2 Smokeless tobacco seller on a busy road near a marketplace in Mumbai, India.

Products containing tobacco and areca nut together are highly addictive. Having begun to experience the public health impact of these products and having been warned by tobacco control experts about the high carcinogenicity of *pan masala* and *gutka*, three state governments (Tamil Nadu, Andhra Pradesh, Maharashtra) have taken the initiative to ban the sale of these products. The loopholes in the law however, are being well exploited. For example, substitutes such as '*supari* mix' packets, containing areca nut, lime, spices and condiments are sold with a free packet of chewing tobacco, in the form of *zarda* or *khaini*. None of these products are individually banned, but a user can mix the two packets to create his own '*gutka*'.

Dry snuff (*tapkeer*) was once commonly used nasally, but is now used mainly orally. Other dry tobacco products are used to clean the teeth. For example, dried forms of smokeless tobacco, such as *mishri*, *bajjar* and *gul*, are mainly used in Goa, Maharashtra, Gujarat and eastern parts of India. These are frequently prepared at home by roasting coarsely cut tobacco on a griddle and then powdering it. Such products are widely used by the poorer classes, especially by women, and tend to be used many times a day, due to their addictive properties. *Gudakhu* is tobacco paste made with molasses and is sold in small bottles. Creamy snuff or tobacco toothpaste, an industrially manufactured product advertised as being an antibacterial, is popular in western parts of India (Fig. 3).

Naswar or *Niswar*, used widely in Afghanistan and Pakistan, is a mixture of powdered tobacco, slaked lime, and indigo and can be home made or available commercially. In Pakistan, *naswar* is tobacco flavoured with cardamom and menthol. *Nass*, a mixture used in Pakistan, Iran and the Central Asian Republics contains local tobacco, sometimes only partially cured, ash, cotton or sesame oil and in some areas, lime. It is placed either under the tongue or in the lower labial groove.

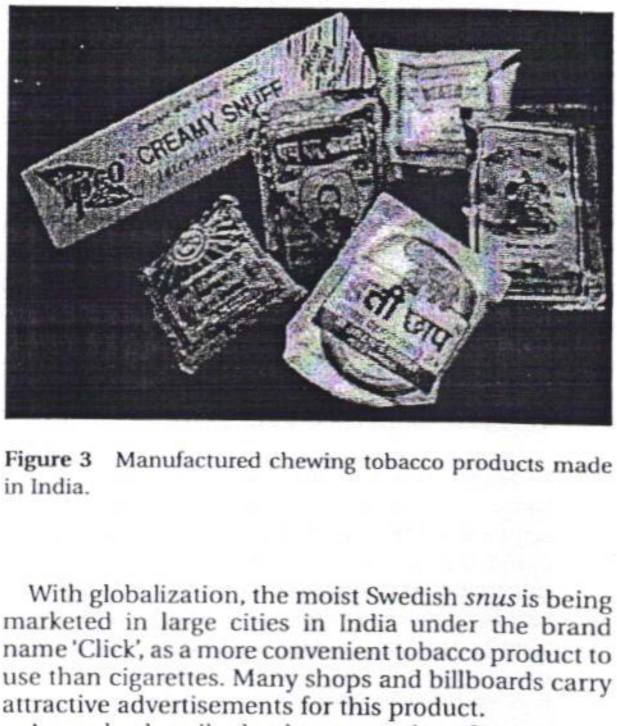

Figure 3 Manufactured chewing tobacco products made in India.

With globalization, the moist Swedish *snus* is being marketed in large cities in India under the brand name 'Click', as a more convenient tobacco product to use than cigarettes. Many shops and billboards carry attractive advertisements for this product.

A newly described tobacco product for oral use is tobacco water (*tuibur* or *hidakphu*) i.e. water through which tobacco smoke has been passed, which is used for gargling in Manipur and Mizoram states in India.

Prevalence of smokeless tobacco habits

In some parts of India, such as the states of Bihar and Maharashtra, smokeless tobacco use is more common than smoking. Apart from regional preferences due to differing socio-cultural norms, the preference for smokeless tobacco is inversely related to education and income.[13]

Table 2 Distribution of basic types of tobacco habits in seven areas of India

Area	Male users (% total men)			Total users	Female users (% total women)			Total users
	Chew or apply	Smoke	Mixed		Chew or apply	Smoke	Mixed	
Mainpuri, Uttar Pradesh[15]	21	41	20	82	9	11	1	21
Bhavnagar, Gujarat[16]	9	56	6	71	15	*	*	15
Ernakulam, Kerala[16]	14	45	22	81	38	1	1	39
Srikakulam, Andhra Pradesh[16]	4	70	7	81	3	64	*	67
Singbhum, Bihar[16]	17	50	14	81	26	5	2	33
Darbhanga, Bihar[16]	28	24	26	78	7	41	4	51
Pune, Maharashtra[17]	53	6	2	62	49	*	*	49
Goa[18]	3	61	5	69	23	24	2	49
Mumbai (urban), Maharashtra[13]	46	14	10	69	57	*	*	57.5
Trivandrum (urban), Kerala[19]	27	56	nr	83	26	2	nr	28

*Prevalence < 0.5%; nr, not reported.

In countries of South Asia, particularly India, traditional values do not favour smoking by the young or by women, but there is no such taboo against using smokeless tobacco. Thus, most women who use tobacco use it in smokeless forms. Tobacco use, in whatever form, generally begins during adolescence.

Awareness of the hazards of smokeless tobacco use is very low in rural populations. On the other hand, many believe tobacco, smoked or smokeless, has medicinal value for curing or palliating common discomforts such as toothache, headache, and stomach ache. This leads to advice for initiating tobacco use from adults to other non-users, even children.

In India it has been estimated that roughly one-third of women and two-thirds of men use tobacco in one form or another.[14] In prevalence surveys in eight rural areas of India, smokeless tobacco use was 3–53% among men and 3–49% among women (Table 2). Also, in these areas 2–26% of men and 0–4% of women practised both smoking and smokeless tobacco habits.[15–18]

In a study from the large metropolitan city of Mumbai[13] the prevalence of tobacco use was 57.5% among women (Table 2), almost solely in smokeless form (57.1%). Among men, 69.3% used tobacco, including 45.7% in smokeless form. The proportion of tobacco users who both smoked and used smokeless forms was nearly 10%.

In a surveyed population 35 years of age or older in a northern suburb of Trivandrum, Kerala, where residents were mostly of lower socio-economic status, chewing habits were practised by 26.8% of men ($n = 25\,453$) and 26.4% of women ($n = 34\,441$) (Table 2). These habits consisted mainly of chewing betel quid with tobacco.[19]

In Bangladesh, 20–30% of women in rural areas are estimated to use smokeless tobacco.[20] In Turkmenistan, 12% of the population has been reported to use *nass*.[14]

In a survey in Karachi, Pakistan, conducted in 1980, about 21% of men and 12% of women chewed tobacco in some form. Excluding those who chewed tobacco by itself and including those who chewed *pan* without tobacco, about 30% of men and 30% of women chewed betel quid.[21]

Other countries where many habitual betel quid chewers add tobacco to their quid include Indonesia, Thailand, Cambodia, the Philippines and the US territory of Guam. The practice is also found wherever South Asians have emigrated, such as in South Africa, Malaysia, Singapore, Australia, New Zealand, the UK and the USA.[11] The easy availability of the areca nut and chewing tobacco in Australia and New Zealand suggests that there are significant groups in these countries at risk of developing oral cancer.[22,23]

In several studies of immigrant communities of Bangladeshi origin in the UK, over 80% of the adults surveyed, both male and female, chewed betel quid regularly. The majority of the women incorporated tobacco (as leaf or zarda) in the quid, while under half of the men did. Burnt tobacco leaves were used as dentifrice by 20% of the women studied.[24–27] In a study in which 42% of adults used betel quid, an interesting finding was that the traditional method of betel-quid chewing was being replaced with readily available processed areca nut and tobacco products.[28]

Acquisition of smokeless tobacco habits and habit prevalence among youth

The acquisition of tobacco habits occurs mainly at young ages and according to patterns of product preference established among adults. In a small study, one-third to one-half of children under the age of 10 years in three rural areas of India (Gujarat, Tamil Nadu and Karnataka) had experimented with smokeless tobacco or smoking, imitating parents, grandparents, other elders in the family, or peers.[29] In a study encompassing the entire state of Goa,[30] 6271 school children aged 5–10 years from 73 village schools, about 13.4% of boys and 9.5% of girls used tobacco, mostly as smokeless tobacco (*mishri* or tobacco toothpaste, followed by chewing), and family members were most influential in this regard.

349

Acquisition of tobacco habits was studied in a 10-year follow-up of Indian villagers aged 15 years and over, conducted during 1966–1977, in three diverse rural areas (Ernakulam, Kerala; Srikakulam, Andhra Pradesh and Bhavnagar, Gujarat). About 3.5% of the non-users, mainly in the lower ages, acquired tobacco habits for the first time, reflecting the already established area-wide patterns of chewing or reverse smoking for women and smoking for men.[31] Almost all males who acquired a habit were in the lowest age group studied (15–34 years), although some females in the middle age group (35–54 years) acquired a habit as well.

It is popularly perceived that the chewing of betel quid with tobacco is becoming a less common habit in India and that it is more confined to the elderly. Yet younger generations have readily taken up the use of mixtures of areca nut and tobacco. Some evidence for such a trend was gathered during a survey carried out in Bhavnagar, Gujarat. The prevalence of *mawa* use rose from 4.7% in 1969, mainly among older women, to 19% in 1993–1994 mainly among younger generations.[32,33]

Still more evidence for a trend toward use of tobacco and areca nut products by youth has been gathered in several recent studies. In a survey of 95 boys and girls in the 8th and 9th grades of a small town private school in Gujarat, 16% of boys used *gutka*. In a village community in Gujarat, 72% of males under 26 years of age used tobacco, mainly bidis and *gutka*, and 50% of females used tobacco in the forms of *gutka* and tobacco toothpaste. Approximately one-eighth of 476 high school students in the 10th to 12th standards in Patna, Bihar, used *pan masala*.[34] Despite the tradition of low tobacco use in Punjab, in a recent survey of 100 rural school-going teenagers in five villages, two-thirds of respondents reported using *gutka* regularly.[35]

The use of sweetened areca nut, betel quid or both, among 74.2% of 160 school children aged 4–16 years in a fishing community in Karachi,[36] could conceivably make them more likely to use smokeless tobacco products in future.

In a survey of 1200 students from junior and degree colleges in Maharashtra, 9.9% took *pan masala*, and 9.6% chewed *gutka*.[37]

Surveys conducted among medical and dental students in Patna, Bihar, India have revealed high levels of tobacco use, especially smokeless forms, such as *khaini* and *gutka*. Chewing of *pan masala* is also common. Current use was higher among senior students, even though their awareness was much higher; this is believed by the researchers to be due to the students being already addicted before learning of the associated diseases. Assessment of the use of tobacco and areca nut products among medical and dental students is important because of the impact of the example they will set for their patients as future caregivers and the unlikely prospect that they would counsel their patients against using tobacco, a major determinant of oral health status.[38,39]

A disturbing parallel to the use of tobacco in betel quid and the increasing popularity among teenagers of areca nut and tobacco mixtures in South Asia comes from some of the Pacific islands, such as Palau. There, betel-quid chewing has been nearly universal for some time. Throughout Palau, single chews, which are sold in many retail stores, consist of half a tender green areca nut, some lime, a piece of pepper leaf and half a cigarette, all wrapped in aluminium foil. A study conducted in Palau in 1995 on a purposive sample of 1110 residents aged 5–74 years in Koror and Airai states, with an age structure similar to that of the whole population, found that 55% of children aged 5–14 years chewed a quid containing areca nut, and that 77% of 15–24-years-olds and over 80% of most other age groups chewed it. Tobacco was added to the quid by 65–96% of the respondents in the different age groups (83% in the total sample), and by 87% of chewers in the youngest age group (5–14 years). The two youngest age groups (5–14 and 15–24 years) rarely used betel leaf in the quid.[40]

RISKS OF MORTALITY AND MORBIDITY DUE TO SMOKELESS TOBACCO

Mortality

Smokeless tobacco use in South Asia is believed to be a significant contributor to excess mortality. The evidence is available from three cohort studies.

A large cohort study in Mumbai showed elevated relative risks of death for both male and female users of smokeless tobacco (mainly in the forms of *mishri* and betel quid). Interim results were based on 5–6 years of follow-up of 52 000 persons, with 114 980 person years for female and 57 890 for male smokeless tobacco users. The age-adjusted relative risk for smokeless tobacco users compared with non-tobacco users among men was 1.22, and for women it was 1.35, with a suggestion of a dose–response relationship for daily frequency of use. Risks for smokers were somewhat higher, with the relative risk of death for male smokers being 1.63 (1.39 for cigarettes and 1.78 for bidi), with a clear dose–response relationship for daily smoking frequency. There were too few women smokers to be able to estimate their risks.[41]

In an earlier cohort study in Ernakulam, Kerala on a cohort of 10 287 individuals aged 15 years and over, who were followed for 10 years, the relative risk of death for men who were chewers (mainly *pan* with tobacco) was 1.2 (not significant), and among women chewers it was 1.3 ($P < 0.05$), while for men who smoked (mainly bidi) the relative risk was 1.5, with $P < 0.05$.[42]

In another cohort study in Srikakulam district, Andhra Pradesh, 10 169 persons were followed for 10 years. The predominant habit was reverse chutta smoking but there were some tobacco chewers among the men with 41 deaths recorded during 1460 person-years of observation, giving an age-adjusted relative risk of 1.96.[43]

It can be concluded from the above studies that the age-adjusted relative risk of mortality for users of smokeless tobacco, like that of smokers, is elevated compared to that of non-tobacco users.

Morbidity

The major health consequences associated with smokeless tobacco use in South Asia include cancers of several sites (e.g. the upper respiratory and digestive tracts), and poor reproductive outcomes. There are some research results on the impact of smokeless tobacco on blood pressure and cardiac disease. In addition, use of areca nut, often chewed with tobacco, can predispose to diabetes mellitus and aggravate asthma. Epidemiological evidence from selected studies on the relationship of smokeless tobacco use with various diseases is summarized below.

Cancers

In India, the number of newly diagnosed tobacco-related cancers has been estimated at approximately 250 000 out of a total of 700 000–900 000 new cancers diagnosed each year.[44] Tobacco-related cancers account for about one-third of all cancers in Bangladesh, India, Pakistan and Sri Lanka.[14]

In men in India, lung cancer is the commonest cancer among all registered cancers in the six population-based registries (Bangalore, Barshi, Bhopal, Chennai, Delhi and Mumbai), but when cancers at all oral sites are combined—oral cavity, tongue and lip—oral cancer vies for first place with lung cancer in four registries.

Oral cancers: Oral and pharyngeal cancers have a high incidence in South Asia, even among women.[45] In this area, the oral use of smokeless tobacco is considered the predominant risk factor for these cancers, especially oral cancer.

In an evaluation of epidemiological studies on the carcinogenic risk to humans of tobacco habits other than smoking, the IARC Working Group concluded that there was sufficient evidence that the habits of chewing betel quid containing tobacco and tobacco mixed with lime were carcinogenic to humans.[11] Since then, nine case-control studies from India and one from Pakistan on cancers of the oral cavity have provided fresh evidence of the oral cancer risk to chewers of betel quid with tobacco. In six of the studies from India, relative risks of oral cancer for men who were current chewers of *pan* with tobacco compared to non-chewers varied from 1.8 (95% CI: 1.2–2.7) to 5.8 (95% CI: 3.6–9.5). In contrast, for men who were current bidi smokers the relative risks varied from non-significant to around 2.[46–51] Relative risks of oral cancer for women who currently chewed *pan* with tobacco varied from 30.4 (95% CI: 12.6–73.4) to 45.9 (95% CI: 25.0–84.1).[48,49] The odds ratio for men who currently chewed areca nut without tobacco compared to non-chewers was 1.7 in one study.[51]

Relative risks of oral cancer in men, stratified by habit as 'ever' chewers and 'never' chewers or smokers, were reported in three studies conducted in Trivandrum, as 6.1 for tongue and floor of the mouth (95% CI: 3.3–11.4), 8.75 for gingiva (among non-drinkers only; 95% CI: 3.6–21.5) and 14.3 for buccal and labial mucosa (95% CI: 8.2–24.8).[52–54] In a study from Pakistan, the likelihood of people who had ever been chewers of *pan* with tobacco developing oral cancer was 8.4 times (95% CI: 2.3–30.6) and without tobacco 9.9 times (95% CI: 1.8–55.6) greater than that of never-chewers, after adjustment for oral submucous fibrosis, ever cigarette smoking, alcohol drinking and other chewing habits.[55]

Significant dose–response trends were observed for frequency of chewing per day in all 10 studies, and for duration of habit in seven of them. Retention of the quid overnight, analysed in another study, showed a 36-fold increased risk.[56]

In a case series study from Bangladesh, the site of origin of the majority of the lesions corresponded with the site maximally exposed to betel quid, usually in the buccal mucosa.[57] A case series study from Myanmar indicated a clear association of oral cancer with betel-quid chewing.[58]

Use of tobacco with lime was identified as a definite risk factor for oral cancer. Two large hospital-based case-control studies from India and Pakistan, reported two- and 14-fold increases in the risk of oral cancer. The study from Pakistan and another case-control study from the Kazakh Soviet Socialist Republic showed highly elevated risks of oral cancer in users of *nass* as well as *naswar*. However, all these studies lacked adjustment for smoking and betel-quid habits.[11] In a recent study from Pakistan, the odds ratio for ever chewers of *naswar* developing oral cancer was 9.5 (95% CI: 1.7–52.3) after adjustment for ever cigarette smoking, alcohol drinking and other chewing habits.[55]

In one study of oral cancer from India, current users of nasal snuff had a relative risk of 3.9 ($P < 0.05$) for cancer of the gingiva.[52]

Due to a lack of reported studies, the IARC Working Group had stated that there was inadequate evidence that oral use of *mishri*, and *gudakhu* are carcinogenic in humans. Not much further published evidence has emerged since then.[11]

Oropharyngeal cancers: Three case-control studies of oropharyngeal cancers (ICD-9 code 146) reported only non-significant relative risks for tobacco chewers (mainly betel quid), but highly elevated and significant relative risks for smokers (5.6–18.4) after adjustment for chewing.[47,51,59] A significant relative risk of 1.74 (95% CI: 1.25–2.43) was found for oropharyngeal cancer in men who chewed betel quid with tobacco, after adjusting for smoking and alcohol comsumption, in one study.[50] A significant dose–response for the frequency and duration of chewing was reported in another study.[51]

Laryngeal cancers: One case-control study from India showed a highly significant relative risk of laryngeal cancer for occasional pan-tobacco chewing, but not for having 'ever' had the habit of chewing.[59] Smoking posed a much greater risk for cancer of the larynx.[59,60]

Oesophageal cancers: Five case-control studies from India were available for analysis. In three case-control studies of oesophageal cancer, significant odds ratios for tobacco chewers (generally betel quid) varied from 2.1 to 3.2 in multivariate models.[50,61,62] In two other studies of oesophageal cancer, only insignificant odds ratios for tobacco chewing (mostly betel quid) were found.[63,64] In one of these studies, the adjusted odds ratio for the lower third of the oesophagus for chewers was 6.6 ($P < 0.001$).[61] Two case-control studies found a dose–response relationship for oesophageal cancers with chewing of areca nut/betel quid with or without tobacco.[50,64] The study from Assam[65] found highly elevated risks for the use of fermented areca nut, *tamol*, with any form of tobacco (7.1 for men and 3.6 for women). Smoking was also found to pose elevated risks for oesophageal cancers in the available studies.

Oral submucous fibrosis

Oral submucous fibrosis (OSF) is a debilitating, potentially cancerous oral condition, caused primarily by chewing areca nut and its mixtures, as demonstrated by numerous epidemiological studies and other corroborative evidence.[66] The condition may sometimes extend beyond the mouth to the oesophagus.[67] The intense marketing of industrially manufactured products containing areca nut and tobacco has considerably increased the occurrence of OSF in the Indian population. In three recent case-control studies (in Bhavnagar, Gujarat; Nagpur, Maharasthra; and New Delhi) over 70% of the cases were under 35 years of age.[68–70] In two studies from India, in which frequency and duration of chewing were analysed, frequency of chewing rather than the total duration of the habit was directly related to OSF[69,70] but in one study from Pakistan duration of the habit was also significant.[71] *Pan masala* chewers developed the condition in about half the time compared to quid users (betel quid, areca quid), with 75% of the *pan masala* chewers developing the disease within 4.5 years and quid chewers in about 9.5 years. The absence of betel leaf in *pan masala* and the proportionately higher dry weight of areca nuts may be responsible for the earlier development of OSF in *pan masala* chewers.[70] Tobacco as an ingredient in some areca nut mixtures is not a causative factor for OSF, but is responsible for a higher occurrence of OSF due to increased addiction and concurrent use of areca nut.

OSF is well established as a condition with high malignant potential and is considered irreversible. In a cohort study of 12 212 tobacco users in Ernakulam, Kerala, patients with OSF followed up for an average of 6.0 years showed a relative risk of developing oral cancer of 397.3 compared to those with no oral lesions but with tobacco habits.[72] The suspicion that increased occurrence of OSF in the younger age groups would lead to an earlier development of oral cancer from OSF was confirmed by the demonstration of a significant increase in the incidence of oral cancer in the Ahmedabad population-based cancer registry data. A comparison of the age-specific incidence rates of mouth cancer (ICD 143–5) during 1983–1987 and 1995 shows that the incidence had significantly increased in the younger population (< 50 years). Since tongue cancer (ICD 141) did not show a similar increase, and OSF typically involves the mouth (inner cheek) more than the tongue, it was concluded that the increase in mouth cancer incidence was real. Urgent public health measures are required to curb this new but avoidable epidemic.[73]

Hypertension and blood lipid profile

There is some evidence that smokeless tobacco is a risk factor for hypertension and adverse blood lipid profile, although perhaps to a lesser extent than smoking. A study of Assam tea garden workers found that consumption of locally prepared alcohol, intake of extra salt and the habit of using *khaini* increased the risk of hypertension.[74] Another study found statistically significant increments in heart rate and blood pressure following the chewing of betel quid with tobacco for 15–30 min, while no significant differences were found after chewing betel quid without tobacco.[75]

A study comparing serum lipid profile in 30 smokers, 30 tobacco chewers and 30 controls without any tobacco habit found that high-density lipoprotein-cholesterol was lower in both smokers ($P < 0.01$) and tobacco chewers ($P < 0.001$) than in the controls; it also found that both smokers and tobacco chewers had higher values for total cholesterol, low-density lipoprotein cholesterol, very low-density lipoprotein-cholesterol and triglycerides, as compared to the no habit group. Thus smoking and tobacco chewing both demonstrated comparable adverse effects on lipid profile and could increase cardiovascular risk.[76]

Adverse effects on pregnancy

Adverse reproductive outcomes from smoking during pregnancy have been well documented. There is some evidence that the same relationship may hold for smokeless tobacco use as well. Studies from India have shown a nearly threefold increase in stillbirths[77] and a 100–400 g decrease in birthweight, in offspring of women who applied or chewed tobacco during pregnancy.[77,78] Odds ratios varying from 2 to 3 have been found for low birthweight in infants born to mothers using smokeless tobacco.[79–81] Other associations included an average increase in placental weight of 66 g in tobacco chewers (mostly tobacco with lime)[82] and increased male foetus wastage, compared to non-users.[77,79]

Asthma

Asthma patients who chew betel quid with or without tobacco may find their condition aggravated by the arecoline from areca nut, which induces the contraction of bronchiolar smooth muscle by means of its acetylcholine-like (parasympathetic) actions.[83]

EXISTING REGULATORY STRUCTURES

In the South Asian region, like everywhere else, existing tobacco control legislation focuses more on cigarettes.[34] Legislation in India began with the promulgation of the Cigarette Act 1975 (Regulation of Production, Supply and Distribution), requiring manufacturers to add statutory health warnings in English ('Cigarette smoking is injurious to health') to cigarette packages and advertisements, and prohibiting tobacco advertising through government-controlled electronic media and publications. In 1990, the Government of India issued an Executive Order prohibiting smoking in all healthcare establishments, government offices, educational institutions, air-conditioned railway cars, buses, suburban trains, etc. In June 1999, Indian Railways, operating under the Government of India, banned the sale of tobacco on railway platforms. In September 2000, the Government amended the Cable Network Rules and banned television advertisements for tobacco.

In order to curb the use of tobacco in India, there was a long-standing demand for comprehensive legislation on the advertisement, sale and use of tobacco in the country. The Cigarettes and Other Tobacco Products Bill 2001,[84] which has incorporated several strategies for tobacco control, addressing all types of tobacco products, became an Act after passage through both houses of Parliament in April 2003 and assent by the President in May 2003. The new Cigarettes and Other Tobacco Products Act, 2003 prohibits direct advertising in all media and sports sponsorship by tobacco companies. It also prohibits smoking in public places to protect non-smokers, especially children, from environmental smoke. It disallows the sale of tobacco in any form to persons under 18 years and within 100 yards of educational institutions. Clear health warnings in local languages and in English have been made mandatory on all packages, with a pictorial warning of a skull and cross-bones. Also, the tar and nicotine content of cigarettes have to be specified on the packages. Issues of enforcement will have to be tackled next, and this will require the strong voice of prominent and knowledgeable citizens, including health professionals.

Since 1987 in India, beginning with the state of Maharashtra, a few other states (Goa, Delhi) have taken their own initiatives to prevent smoking and spitting in government premises and on railway platforms and have conducted educational campaigns against tobacco use. Prohibition of the sale of tobacco products within 100 metres of educational institutions and on railway platforms has been passed by some states.

Recently, beginning with Tamil Nadu in 2001, banning orders have been issued in several more states against the sale, manufacture and storage of *gutka*, and in some states other forms of chewing tobacco and *pan masala* as well. Similar initiatives have been taken by several other state governments but industry opposition through the courts has forced these states to modify the ban or postpone its implementation until the Supreme Court reaches a decision.

The intent of legislation can be reinforced by health education of the public and communities on the dangers of tobacco use. The potential for this is discussed in the next section.

THE POTENTIAL FOR EFFECTIVE HEALTH EDUCATION

The public have little knowledge about the dangers of chewing betel quid or any form of smokeless tobacco. Researchers in India have demonstrated the feasibility and efficacy of anti-tobacco education for the community in high tobacco-chewing areas through controlled intervention studies.[85,86]

Intervention studies

Tobacco habits are widely prevalent in Kerala in the form of bidi smoking and betel-quid (*pan*) chewing. Overall, tooth-related problems (48%) and peer-group influence (38%) were reported to be common initiating factors for tobacco use in Ernakulam district. There was an inverse relationship between the levels of education and the use of tobacco.[87]

A large controlled prospective intervention trial for primary prevention of oral cancer was conducted in three areas in India. These included the district of Ernakulam (Kerala), and two other areas. Results are presented here for Ernakulam district, which had the highest proportion of tobacco chewers who predominantly chewed betel quid with tobacco.

The intervention cohort, at baseline, in Ernakulam District consisted of 12 212 tobacco users 15 years of age and older in the intervention group and there were 6075 subjects in a non-concurrent control cohort.[85] Both cohorts were interviewed about their tobacco use by trained investigators, and subjects were examined for the presence of oral lesions by dentists and subjected to 10 annual follow up examinations.

In the intervention cohort at baseline, 66% of men were bidi smokers, 6% were cigarette smokers, 16% were chewers (mostly betel quid with tobacco) and 12% had multiple habits. Among women tobacco users, 92% were chewers. The percentages were somewhat similar in the control cohort. At baseline, the prevalence of leukoplakia was 2.9% in the intervention cohort and 2.7% in the control cohort.[88]

In the intervention villages, social scientists provided personal communication on tobacco habits using photographs and pictorial booklets and addressed the factors that can influence continuation of tobacco use. Two documentary films were made with the involvement of the local people to reinforce the messages imparted during home visits. The first film imparted information on the relationship between tobacco use and oral cancer and the second one addressed the reasons for initiation and tips on tobacco cessation. Cinema slides, posters, folk dramas, radio programs and newspaper articles were also used, with content based on feedback received from the field. At the request of the population, cessation camps were conducted, with group discussions on problems faced in cessation and possible solutions, as well as a few days of regular daily counselling of individuals. Ten annual follow-up surveys were conducted after the baseline survey, covering a 10-year period for the intervention cohort during

Table 3 Stoppage of tobacco chewing habits in intervention and control cohorts in Ernakulam District during 10 years of follow up

Interval	Intervention %	Control† %
1 year[88]	2.7	nr
5 years[89]	10.2 (men)	nr
	14.9 (women)	nr
	13.9 (all)[91]	4.2 (all)[91]
8 years[90]	13.0 (men)	1.0 (men)
	18.0 (women)	6.0 (women)
10 years[85]	15.1 (men)	2.3 (men)
	18.4 (women)	7.8 (women)

nr, not reported.
†Minimal intervention.

Table 4 Annual age adjusted incidence rates per 1000 of leukoplakia in tobacco (betel quid) chewers in intervention and control cohorts in Ernakulam District over 10 years of follow-up

Interval	Intervention	Control†	Odds ratio
5 years[89]	22.6 (men)	44.6 (men)	nr
	6.2 (women)	33.5 (women)	
8 years[90]	3.5 (men)	7.4 (men)	nr
	4.8 (women)	6.2 (women)	
10 years[85]	3.3 (men)	5.2 (men)	0.63*
	2.0 (women)	4.6 (women)	0.45*

*$P < 0.05$.
nr, not reported.
†Minimal intervention.

1977–1988. In the control cohort (1966–1977), no active programme of health education was undertaken, but during the surveys, the dentists routinely explained the association of tobacco use with oral cancer and advised against tobacco use, more forcefully so if the individual had a precancerous lesion.

Results for 1 year, 5 years, 8 years and 10 years of follow-up were reported (Table 3). After 1 year of follow up, 2.7% of the intervention cohort had stopped and 6.5% had reduced their chewing habits. The rate of regression of leukoplakia among those who had stopped or reduced their tobacco use was 5.3%, which was significantly higher than the rate (1.1%) in those who did not change or increased their tobacco use.[88]

After 5 years of follow up, the percentage stopping their tobacco use (of every type) was higher in the intervention cohort compared to the control cohort: 3% in the control group versus 9% in the intervention cohort, but for chewers in particular, 10.2% of men and 14.9% of women chewers in the intervention cohort had stopped. Furthermore, the reduction in tobacco use by continuing users was much higher in the intervention cohort than in the control group.

For chewers after 5 years, the age-adjusted incidence rate of leukoplakia per 1000 men was 44.6 in the control cohort versus 22.6 in the intervention cohort, and 33.5 versus 6.2 among women (Table 4). The rate ratio for the protective effect of the intervention against leukoplakia ranged from 0.19 to 0.51 in women and men chewers, respectively.[89]

Intervention was helpful to all categories of tobacco users but was more helpful to men and chewers (mainly betel quid with tobacco), especially those with habits of long duration. In a multiple logistic regression analysis of the first 5 years of intervention data, the odds ratio calculated for quitting tobacco use by men who had chewed tobacco for 11 or more years was 240.1 for the intervention relative to the control cohort.[91]

By the end of 10 years, 15.1% of men and 18.4% of women tobacco chewers in the intervention cohort had discontinued their tobacco use, as compared to 2.3% and 7.8% in the control cohort. The reduction in the daily frequency of overall tobacco use was higher in the intervention than in the control cohort. The relapse rates were much lower in the intervention cohort than in the control cohort. The overall incidence of leukoplakia in the control group was 40% higher (Table 4) than in the intervention cohort and the differences in observed and expected incidence rates of leukoplakia among tobacco users of all types were statistically significant ($P < 0.05$).[85,92]

In a detailed analysis of the effect of cessation of tobacco use, it was shown that it led to a substantial fall in the incidence of leukoplakia. The incidence ratios between those who stopped their habits and all others ranged from 0.15 to 0.81 in different gender and tobacco use groups. For female chewers this was 0.31 and for male chewers it was 0.81. The fact that all ratios were below unity implied a reduced risk of oral cancer after cessation of tobacco use, since oral leukoplakia demonstrated a high premalignant potential.[72,92]

The educational intervention was helpful in reducing the use of tobacco, in increasing quit rates and decreasing relapse rates. Spontaneous regression rates of oral precancerous lesions were higher among individuals who reported stopping or reducing their tobacco use compared to those who did not. The incidence rates of oral precancer were lower in the intervention cohort than in the control cohort. This study was felt to have demonstrated the feasibility and practicality of primary efforts in preventing oral cancer in rural India.

Another educational intervention, in the Kolar District of Karnataka, India, was carried out by specially trained primary health centre (PHC) workers in the government system, in one experimental and two control areas with similar populations. The PHC workers performed the baseline habit prevalence survey in the three areas and provided anti-tobacco education of the community in the experimental area. They performed a repeat survey after 2 years and a final survey after another 3 years. Health education methods included screening of films, exhibits, and personal contact with a display of photographs of the harmful effects of tobacco. Results after the final survey showed that in the experimental area, the decline in the prevalence of tobacco use (compared with the baseline) was 10.2% in males and 16.3% in females. The quit rates in men and women in the intervention cohort were 26.5% and 36.7%, respectively, compared to 1.1% and 1.5% in a control cohort.[86]

In the state of Goa, 4th and 5th grade students in 46 villages in the northern and central zones were taught how to communicate anti-tobacco information to their parents and to the community. Quit rates of 8.9% among men and 11% among women were observed after about 1.5 years from baseline.[30]

Mass media intervention

As a special project during 1990, educational information about the use of tobacco was broadcast on All India Radio (the only radio medium at that time), through 30 Sunday morning episodes in 16 languages from 84 stations. Community surveys (without comparison groups) conducted in Karnataka and Goa to evaluate the broadcasts showed that about 30% of the potential audience listened to the programmes in both states. In Karnataka, nearly 6% of tobacco users reported quitting the habit, as did 4.3% in Goa. In addition, about one-third of tobacco users intended to quit and another third had reduced their consumption.[93]

Educational messages, materials, and related issues

Methods of communication used in the Ernakulam intervention study included personal communication, films, posters, newspaper articles, folk dramas, radio programmes, exhibits, group meetings and cessation camps. The study experience showed that the health messages should be personally relevant to the consumer, and tailored to his/her beliefs and lifestyle, including the prevalent tobacco habits in the area.[94] Some of the main messages were as follows: (i) tobacco cannot cure toothache, but can cause oral cancer; (ii) tobacco can harm the heart and make you die earlier; (iii) tobacco use during pregnancy may harm your child; (iv) chewing tobacco can cause cancer of the food pipe; (v) betel quid can aggravate asthma; (vi) those who have given up tobacco have said that the discomforts do not last long; (vii) children are more likely to use tobacco if their parents do; (viii) tobacco use is harmful to health and is expensive (part of the expense is in treating the diseases it causes. Money saved—health gained); and (ix) parents who die prematurely due to tobacco use deprive their children of social support.

ACTION NEEDED NOW

There is a paucity of educational materials on smokeless tobacco. Keeping in mind the high quality of tobacco advertising that commands the attention of the public, skilled commercial artists should be motivated to work with health professionals and health authorities in preparing such materials which must be attractive, with simple language and unequivocal meaning, incorporating messages about all forms of smokeless tobacco and smoking.[95] Anti-tobacco education must be imparted through schools, hospital outreach programmes, existing government health programmes such as maternal and child health programmes and routine home visits, using suitable materials.

In view of the available knowledge about the damaging effects on health caused by tobacco, it should follow that medical and health-related conferences be made tobacco free, including all venues attached to the conference, and this should apply to all participants, staff, advertisers and volunteers.[96] If these conferences and meetings clearly enunciate and adhere to specific tobacco control policies, this would help to raise awareness about tobacco control issues and the seriousness of tobacco control among participants and non-participants connected with the event. The International Union Against Cancer (UICC) has already adopted these guidelines for all conferences, meetings or workshops that it sponsors or that are held under UICC auspices. Specific guidelines for such a policy are outlined in the UICC Tobacco Control Fact Sheet No. 20.[97]

There is a lot of indirect advertising still tolerated in healthcare settings in the form of advertisements in magazines left in patient areas. One suggestion for tackling this problems comes from an organization in the USA called, Doctors Ought to Care. Each tobacco advertisement should be crossed out with a black marker and a notice displayed on the cover debunking the claims of glamour and machismo associated with tobacco use and declaring that tobacco destroys health, makes one poorer and leads to premature death.[96]

When doctors examine patients of South Asian origin, it is not enough to ask them about smoking habits, but they should also be asked about whether they use smokeless tobacco. Health professionals in areas with South Asian immigrants should become aware of the effects of betel-quid chewing. The tell-tale staining of gums and teeth can alert an observant practitioner.

Outreach programmes from hospitals can educate the community about the dangers of tobacco and the signs of tobacco-related cancer. Such a programme, conducted through a large cancer hospital over the last several years, approximately doubled the outpatient attendance for oral examination and the number of oral precancers seen.[34] As the programme develops, it has been attracting tobacco users (smokers and smokeless) to its cessation programme.

Children are a potentially powerful motivating force for health and against tobacco use. Because personal communication is very effective for tobacco cessation and children communicate personally with their parents, they can be very effective in changing tobacco use behaviour. Hence school and community programmes to raise tobacco awareness among children are recommended.

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Ahmedzullo - 1

Patterns and distribution of tobacco consumption in India: cross sectional multilevel evidence from the 1998-9 national family health survey

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Abstract

Objective To investigate the demographic, socioeconomic, and geographical distribution of tobacco consumption in India.

Design Multilevel cross sectional analysis of the 1998-9 Indian national family health survey of 301 984 individuals in 92 447 households in 3215 villages in 440 districts in 26 states.

Setting Indian states.

Participants 301 984 adults (≥ 18 years).

Main outcome measures Dichotomous variable for smoking and chewing tobacco for each respondent (1 if yes, 0 if no) as well as a combined measure of whether an individual smokes, chews tobacco, or both.

Results Smoking and chewing tobacco are systematically associated with socioeconomic markers at the individual and household level. Individuals with no education are 2.69 times more likely to smoke and chew tobacco than those with postgraduate education. Households belonging to the lowest fifth of a standard of living index were 2.54 times more likely to consume tobacco than those in the highest fifth. Scheduled tribes (odds ratio 1.23, 95% confidence interval 1.18 to 1.29) and scheduled castes (1.19, 1.16 to 1.23) were more likely to consume tobacco than other caste groups. The socioeconomic differences are more marked for smoking than for chewing tobacco. Socioeconomic markers and demographic characteristics of individuals and households do not account fully for the differences at the level of state, district, and village in smoking and chewing tobacco, with state accounting for the bulk of the variation in tobacco consumption.

Conclusion The distribution of tobacco consumption is likely to maintain, and perhaps increase, the current considerable socioeconomic differentials in health in India. Interventions aimed at influencing change in tobacco consumption should consider the socioeconomic and geographical determinants of people's susceptibility to consume tobacco.

Introduction

Consumption of tobacco is a major risk factor for mortality.[1] Recent shifts in global tobacco consumption indicate that an estimated 930 million of the world's 1.1 billion smokers live in developing countries,[2] with 182 million in India alone.[3] By 2020 tobacco consumption has been projected to account for 13% of all deaths in India.[1 4]

Smoking is not only associated with lung cancer[5] but is also linked to cardiovascular diseases, tuberculosis, and chronic respiratory diseases.[6] Although 20% of total tobacco consumption in India is through cigarette smoking,[1] bidis (handrolled cigarettes that contain unprocessed tobacco) and hookahs are alternatives, with bidi smoking accounting for 40% of total tobacco consumption.[1 3] Tobacco is also consumed, especially in India and South East Asian countries, through chewing (for example, paan masala, gutka, and mishri).[7 8] Chewing tobacco is a risk factor for oral cancers.[7] The annual incidence of oral cancer in men in India is estimated to be 10 per 100 000.[9] Regardless of how tobacco is consumed, its adverse influence on disease and mortality among individuals and populations is clear.

Importantly, however, the distribution of tobacco consumption is not uniform. Tobacco consumption is often found to be disproportionately higher among lower socioeconomic groups.[10] However, barring a few local studies,[11] little systematic investigation has been done into how tobacco consumption is socioeconomically and geographically distributed in India. The gaps in tobacco consumption need to be examined to see which people are most likely to consume tobacco and which areas are more likely to have higher tobacco consumption. Such analyses are critical for designing policies and interventions aimed at achieving overall reductions in tobacco consumption at the population level and at reducing the inequalities in susceptibility to consume tobacco.

We investigate how tobacco consumption (in its smoking and smokeless form) is distributed across a range of demographic and socioeconomic markers at individual and household level in India. Conditional on this distribution we also estimate the extent to which the prevalence of tobacco consumption varies between localities, districts, and states.

Methods

Sources of data

The analysis was based on a representative, cross sectional 1998-9 national family health survey of

See *Editorial* by Samarasinghe and Goonaratna

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359

Table 1 Descriptive information on the individual sample considered for the analytical multilevel models from the 1998-9 Indian national family health survey, showing the frequency of different exposure variables along with the counts and prevalence of tobacco smoking, chewing, and smoking and chewing across different exposure variables. Values are numbers (%) of study participants for each variable

Variable	Participants	Smoking	Chewing	Smoking and chewing
Living environment				
Large city	38 930 (12.9)	5 340 (13.7)	6 101 (15.7)	9 744 (25.0)
Small city	20 189 (6.7)	2 524 (12.5)	3 029 (15.0)	4 817 (23.9)
Town	42 304 (14.0)	6 380 (15.1)	7 633 (18.0)	11 985 (28.3)
Village	200 561 (66.4)	41 448 (20.7)	46 743 (23.3)	72 950 (36.4)
Sex				
Female	149 939 (49.7)	5 091 (3.4)	19 472 (13.0)	23 170 (15.5)
Male	152 045 (50.3)	50 601 (33.3)	44 034 (29.0)	76 326 (50.2)
Marital status				
Married or cohabiting	221 391 (73.3)	46 792 (21.1)	49 629 (22.4)	79 958 (36.1)
Single	53 416 (17.7)	4 876 (9.1)	6 857 (12.8)	9 799 (18.3)
Widowed	24 121 (8.0)	3 490 (14.5)	6 178 (25.6)	8 556 (35.5)
Divorced or separated	3 056 (1.0)	534 (17.5)	842 (27.6)	1 183 (38.7)
Religion				
Hindu	231 498 (76.7)	41 755 (18.0)	48 316 (20.9)	75 321 (32.5)
Muslim	35 304 (11.7)	7 537 (21.3)	6 601 (18.7)	12 104 (34.3)
Christian	19 125 (6.3)	4 798 (25.1)	5 718 (29.9)	8 238 (43.1)
Other	15 762 (5.2)	1 545 (9.8)	2 795 (17.7)	3 727 (23.6)
Missing	295 (0.1)	57 (19.3)	76 (25.8)	106 (35.9)
Social caste				
Other caste	118 978 (39.4)	18 863 (15.9)	18 578 (15.6)	32 227 (27.1)
Scheduled caste	48 350 (16.0)	10 399 (21.5)	11 174 (23.1)	17 862 (36.9)
Scheduled tribe	36 735 (12.2)	9 124 (24.8)	13 075 (35.6)	17 857 (48.6)
Other backward caste	83 598 (27.7)	14 510 (17.4)	17 612 (21.1)	26 688 (31.9)
No caste or missing	14 323 (4.7)	2 796 (19.5)	3 067 (21.4)	4 862 (33.9)
Education				
Illiterate	115 704 (38.3)	22 635 (19.6)	27 740 (24.0)	42 412 (36.7)
Primary school	50 456 (16.7)	12 241 (24.3)	13 093 (25.9)	20 764 (41.2)
Secondary school	87 649 (29.0)	16 059 (18.3)	16 893 (19.3)	27 232 (31.1)
Higher school	21 741 (7.2)	2 353 (10.8)	2 894 (13.3)	4 471 (20.6)
College	19 952 (6.6)	1 866 (9.4)	2 255 (11.3)	3 555 (17.8)
Postgraduate	6 482 (2.1)	538 (8.3)	631 (9.7)	1 062 (16.4)
Household standard of living index				
Lowest fifth	55 003 (18.2)	13 615 (24.8)	17 102 (31.1)	25 038 (45.5)
Second fifth	56 821 (18.8)	13 225 (23.3)	15 011 (26.4)	23 094 (40.6)
Third fifth	59 569 (19.7)	12 150 (20.4)	13 421 (22.5)	21 352 (35.8)
Fourth fifth	62 409 (20.7)	9 945 (15.9)	10 715 (17.2)	17 710 (28.4)
Highest fifth	68 182 (22.6)	6 757 (9.9)	7 257 (10.6)	12 302 (18.0)
Total	**301 984 (100.0)**	**55 692 (18.4)**	**63 506 (21.0)**	**99 496 (32.9)**

301 984 adults aged 18 and older, from 92 447 households from 26 Indian states.[12] The household data, obtained through an interview based structured questionnaire and answered by an available adult household member, provide a range of demographic and socioeconomic markers on all the members of the household, including information on smoking and chewing tobacco.[12] All households are geographically referenced to the primary sampling unit, district, and the state to which they belong. The primary sampling units (hereafter termed: local areas) are villages or groups of villages for rural areas, and wards or municipal localities for urban areas. The response rate to the survey ranged from 89% to 100%; in 24 of the 26 states it exceeded 94%.

Outcome measures

Our analysis used two dichotomous outcomes, based on the responses to the questions: "Does 'household member' chew paan masala or tobacco?" and "Does 'household member' smoke?" In addition, a combined measure of participants who smoke and chew tobacco was constructed in order to assess the distribution of consuming any tobacco. In our sample the overall prevalence for smoking was 18.4% and for chewing 21.0%; the combined prevalence was 32.9%. Table 1 provides the descriptive characteristics of the outcome and exposure measures in the sample population considered for analysis.

Exposure measures

At the individual level we considered age (treated as continuous variable centred at its mean), sex, marital status, and educational attainment. At the household level we considered caste, religion, and a standard of living index based on material possessions. Caste status was based on the following mutually exclusive classification: scheduled caste, scheduled tribe, other backward caste; other caste; and no caste. "Scheduled caste" and "scheduled tribe" represents population groups identified by India's constitution as being marginal to the mainstream socioeconomic and political processes and, since 1951, are eligible for affirmative action. "Other backward caste" is another grouping of populations that are identified as socially and educationally backward. Since 1990 the other backward castes, while not sharing the constitutional affirmative action rights of scheduled castes and tribes are legally defined and covered by other legislative measures. "Other caste" is a residual category of people who are not scheduled caste or tribe, or other backward caste; "no caste" represents population groups for whom caste is not applicable (Muslims, Christians, or Buddhists, for example) and participants who did not report any caste affiliation in the survey. In general, the "other caste" category is considered to have higher social status, with the government of India designating the scheduled caste or tribe and other backward caste as socially and economically disadvantaged.[12] We divided religious affiliation into four categories: Hindu, Muslim, Christian, and other. We used the consumption and material possessions based on assets to create the standard of living index for households, weighted for the proportion of each possession at the all India level.[13] Since the standard of living index is a constructed measure it does not have an absolute interpretation. Consequently, it is more appropriate to use this measure in categorical, hierarchically ordered fashion. We followed the convention of dividing the population into every fifth of the standard of living index for our analysis. Households were also characterised by whether they were located in a large city (a population of 1 million or more), a small city (population of 100 000 or more but less than 1 million), a town (population of less than 100 000), or villages and rural areas.

Statistical approach

We applied multilevel statistical procedures[14] to model the variation in tobacco consumption according to the different analytical levels.[15] Specifically we estimated the effect of the demographic and socioeconomic markers on tobacco consumption ("fixed parameters") and the variations in tobacco consumption in local areas, districts, and states that are not accounted for by individual and household demographic and socioeconomic markers. We calibrated a five level binary logistic model with a nested structure: 301 984 individuals (level 1) in 92 447 households (level 2) in

360

3215 local areas (level 3) in 440 districts (level 4) in 26 states (level 5). To calibrate models, we used the marginal quasi-likelihood (MQL) approximation with first order Taylor linearisation procedure. Model estimates are maximum likelihood based, derived by using the iterative generalised least squares algorithm, as implemented within the *MLwiN* program, version 1.10.0006.[16]

Results

Table 2 presents the odds ratios along with the 95% confidence interval derived from the fixed part of a multiple multilevel regression model calibrated for tobacco smoking, chewing, and smoking and chewing.

Smoking and demographic and socioeconomic markers

Age was positively associated with the probability of smoking; for a 10 year change in age the odds ratio related to smoking increased by 1.16. Men were considerably more likely to smoke than women (odds ratio 19.69). Marital status was also predictive of smoking: single, widowed, and divorced or separated people were less likely to smoke (odds ratios 0.32, 0.88, and 0.93, respectively), although the association was weak and imprecisely estimated for divorced and separated people. We also observed religion-based differences: Christians and the residual category of "other religion" were less likely to smoke than Muslims or Hindus. Caste status was also associated with smoking: in comparison to the other caste (the reference category), the scheduled tribe and scheduled caste were more likely to smoke. We observed a strong gradient between education and smoking, with the odds of being a smoker approximately three times higher in the educationally worst off group (illiterate people) than in the educationally best off group (people with postgraduate education). We observed a similar gradient between household standard of living and smoking, with individuals in the lowest fifth having an odds ratio of 2.5 of being smokers (compared with the highest fifth). The prevalence of smoking was greater in rural areas (odds ratio 1.19) and towns (odds ratio 1.14) than in large cities.

Chewing and demographic and socioeconomic markers

Age was positively associated with chewing (odds ratio 1.14 for a 10 year change), and men were more likely to chew than women (odds ratio 3.27). Single people were less likely to chew, but both widowed and separated or divorced people were more likely to chew than married people. Muslims were more likely to chew (odds ratio 1.15) and Christians and other religions less likely to chew (odds ratios 0.76 and 0.85, respectively) compared with Hindus. Scheduled caste and scheduled tribe groups were more likely to chew (odds ratios 1.15 and 1.11, respectively) than other caste. We observed a strong gradient between education and chewing; the odds of chewing in the educationally worst off group was 1.84 times that of people with postgraduate education. A similar household standard of living gradient became apparent for chewing: the odds of chewing in the lowest fifth was nearly twice that of the highest fifth. Chewing prevalence did not differ substantially between different types of urban and rural areas.

The pattern in demographic and socioeconomic inequalities for smoking and chewing combined was similar to those observed for the separate analysis of smoking and chewing. In general the socioeconomic gap in combined tobacco consumption was smaller than for smoking alone and larger than for chewing alone.

Distribution of tobacco consumption across local areas, districts, and states

Table 3 provides the variance estimates for each of the levels for two models—the first does not account for age, sex, marital status, education, religion, caste, household standard of living and urban or rural status; the second does account for these demographic and socioeconomic markers. The variance estimates in table 3 show that socioeconomic markers at the individual and household level do not entirely explain the differences in the prevalence of smoking, chewing, and their combined prevalence by local areas, districts

Table 2 Odds ratios with 95% confidence intervals from the fixed part of a multivariable five level binomial logit model that is calibrated for tobacco smoking, chewing, and smoking and chewing, conditional on random effects at the level of state, district, local area, and household

	Smoking	Chewing	Smoking and chewing
Age (years)	1.16 (1.15 to 1.16)	1.14 (1.13 to 1.15)	1.23 (1.22 to 1.23)
Living environment			
Large city*	1.00	1.00	1.00
Small city	1.06 (0.94 to 1.19)	0.91 (0.81 to 1.02)	1.02 (0.92 to 1.14)
Town	1.14 (1.03 to 1.26)	0.97 (0.88 to 1.07)	1.12 (1.02 to 1.22)
Village	1.19 (1.08 to 1.31)	0.92 (0.84 to 1.01)	1.09 (1.00 to 1.18)
Sex			
Female*	1.00	1.00	1.00
Male	19.69 (19.20 to 20.19)	3.27 (3.21 to 3.32)	8.53 (8.37 to 8.70)
Marital status			
Married or cohabiting*	1.00	1.00	1.00
Single	0.32 (0.31 to 0.33)	0.55 (0.53 to 0.56)	0.36 (0.36 to 0.37)
Widow	0.88 (0.85 to 0.92)	1.20 (1.16 to 1.24)	1.01 (0.98 to 1.05)
Divorced or separated	0.93 (0.84 to 1.03)	1.23 (1.14 to 1.32)	1.20 (1.11 to 1.30)
Religion			
Hindu*	1.00	1.00	1.00
Muslim	1.03 (0.98 to 1.08)	1.15 (1.11 to 1.20)	1.15 (1.10 to 1.20)
Christian	0.88 (0.82 to 0.94)	0.76 (0.72 to 0.81)	0.76 (0.72 to 0.81)
Other	0.54 (0.50 to 0.58)	0.85 (0.80 to 0.90)	0.66 (0.63 to 0.70)
Missing	0.77 (0.55 to 1.08)	0.95 (0.71 to 1.27)	0.80 (0.60 to 1.08)
Social caste			
Other caste*	1.00	1.00	1.00
Scheduled caste	1.16 (1.12 to 1.20)	1.15 (1.11 to 1.18)	1.19 (1.16 to 1.23)
Scheduled tribe	1.27 (1.20 to 1.33)	1.11 (1.06 to 1.16)	1.23 (1.18 to 1.29)
Other backward caste	1.03 (0.99 to 1.06)	1.00 (0.98 to 1.03)	1.01 (0.98 to 1.04)
No caste or missing	1.07 (1.00 to 1.14)	0.96 (0.91 to 1.01)	0.98 (0.92 to 1.03)
Education			
Postgraduate*	1.00	1.00	1.00
College	1.22 (1.12 to 1.33)	1.16 (1.08 to 1.24)	1.18 (1.10 to 1.26)
Higher school	1.40 (1.29 to 1.53)	1.30 (1.21 to 1.40)	1.38 (1.29 to 1.48)
Secondary school	1.99 (1.84 to 2.15)	1.54 (1.44 to 1.65)	1.85 (1.74 to 1.98)
Primary school	2.56 (2.36 to 2.77)	1.73 (1.62 to 1.85)	2.37 (2.21 to 2.53)
Illiterate	2.94 (2.71 to 3.19)	1.84 (1.72 to 1.97)	2.69 (2.51 to 2.87)
Household standard of living index			
Highest fifth*	1.00	1.00	1.00
Fourth fifth	1.43 (1.37 to 1.48)	1.30 (1.25 to 1.34)	1.43 (1.38 to 1.47)
Third fifth	1.78 (1.71 to 1.85)	1.49 (1.44 to 1.55)	1.76 (1.70 to 1.82)
Second fifth	2.14 (2.05 to 2.24)	1.67 (1.61 to 1.74)	2.10 (2.02 to 2.18)
Lowest fifth	2.43 (2.32 to 2.55)	1.90 (1.82 to 1.97)	2.54 (2.44 to 2.64)

*Reference categories in each of the categorical exposure variable. The reference category is a 40 year old, postgraduate, married Hindu woman, belonging to the "other caste" group and to the highest fifth (quintile) of household standard of living index and who lives in a large city. For this group the predicted probability of smoking and chewing was 0.8% and 6.4%, respectively, and the combined probability 4.4%.

361

Table 3 Variance estimates from a five level binomial logit model, before and after adjusting for demographic and socioeconomic markers of individuals or households, at the level of the state, district, local areas, and household, for tobacco smoking, chewing, and smoking and chewing

	Smoking		Chewing		Smoking and chewing	
Levels	Before*	After†	Before*	After†	Before*	After†
Level 5: states	0.243	0.452	0.726	1.010	0.326	0.613
Level 4: districts	0.063	0.102	0.148	0.146	0.057	0.082
Level 3: local areas	0.151	0.132	0.151	0.128	0.124	0.106
Level 2: households	0.045	0.839	0.480	0.652	0.158	0.560
Dispersion	0.859	0.667	0.725	0.665	0.839	0.772

Note: All variance variables were significant at the 0.001 level.
*Gives the variance estimates at different levels before accounting for demographic and socioeconomic markers of individuals or households.
†Gives the variance estimates at different levels after accounting for demographic and socioeconomic markers of individuals or households.

and states. The differences between those geographical areas (especially at state level) increased once account was taken of the composition of the population residing in them. After accounting for individual or household demographic and socioeconomic markers, the bulk of the remaining variation lies at the household and state level. The other spatial levels of local areas and districts seem to matter less. Although the patterning of the multilevel variation was not substantially different across smoking, chewing, and smoking and chewing, the exact magnitude varied: the variation between states was largest for chewing, followed by smoking and chewing, and smoking.

Table 4 Odds ratios for smoking, chewing, and smoking and chewing for the different Indian states, based on the state level residuals estimated from a five level multiple binomial logit model

		Smoking		Chewing		Smoking and chewing	
States	Sample size	Odds ratio	Rank	Odds ratio	Rank	Odds ratio	Rank
Andhra Pradesh	11 668	0.90	15	0.47	6	0.59	6
Assam	10 531	0.80	12	2.62	23	1.71	22
Bihar	21 260	0.61	6	1.42	18	0.78	13
Goa	5 397	0.67	9	0.52	10	0.54	3
Gujarat	12 514	0.63	7	0.74	13	0.66	9
Haryana	9 317	1.72	21	0.36	3	0.70	11
Himachal Pradesh	10 460	1.43	20	0.35	2	0.59	5
Jammu	10 595	2.26	23	0.31	1	0.76	12
Karnataka	14 580	0.61	5	0.65	12	0.63	8
Kerala	10 055	0.79	11	0.51	9	0.59	4
Madhya Pradesh	21 853	0.66	8	1.26	17	0.91	16
Maharashtra	19 488	0.35	1	1.43	19	0.87	15
Manipur	5 547	2.04	22	2.33	22	2.28	23
Meghalaya	3 519	2.44	24	1.26	16	2.61	24
Mizoram	4 335	8.11	26	29.83	26	18.43	26
Nagaland	2 961	0.94	16	1.83	20	1.01	18
Orissa	15 072	0.46	2	2.70	24	1.44	20
Punjab	10 232	0.54	3	0.39	4	0.35	1
Rajasthan	21 815	0.97	17	0.49	7	0.61	7
Sikkim	4 074	0.76	10	1.95	21	1.45	21
Tamil Nadu	15 118	0.57	4	0.50	8	0.48	2
West Bengal	14 891	1.09	18	0.82	14	0.94	17
Uttar Pradesh	29 489	0.88	14	1.05	15	0.86	14
New Delhi	9 222	1.13	19	0.54	11	0.70	10
Arunachal Pradesh	4 045	0.85	13	4.09	25	2.72	25
Tripura	3 946	2.45	25	0.43	5	1.05	19

The model additionally included the demographic and socioeconomic markers of individuals or households in the fixed part and variance component at the level of households, local areas, districts, and states, in addition to the dispersion variable.
The reference point for the calculation of the state odds ratios is the all India log of the odds of smoking, chewing, and smoking and chewing.

Table 4 presents the predicted odds ratio for the different states after taking demographic and socioeconomic markers into account, using the all India prevalence as a reference. For smoking, Maharashtra has the lowest odds ratio (0.35); for chewing, Jammu (0.31); and Punjab for smoking and chewing (0.35). Mizoram has the highest odds ratio for smoking, chewing, and smoking and chewing. The burden of tobacco consumption in India falls disproportionately on Mizoram[17] and the other northeastern states.

Figures 1 and 2 map the unconditional (crude) and conditional (model based) prevalence for combined tobacco consumption. In both maps a "natural break algorithm" was used to divide the states of India into four groups.[18] A strong geographical pattern is evident in the prevalence for tobacco consumption both before (fig 1) and after (fig 2) controlling for demographic and socioeconomic markers at the individual level. In the northeastern states a greater proportion of the adult population smoke and chew tobacco than in the southern and western states of India. As is evident from figure 2, much but not all of the state variation in tobacco consumption observed in figure 1 is accounted for by the differences in the socioeconomic circumstances of the people who live in them and by other variations attributable to households, local areas, and districts.

Discussion

Tobacco consumption in India has a distinct socioeconomic and spatial distribution; the worse off population groups are at greater risk of consuming tobacco. Our analyses show the extent to which tobacco consumption is distributed across population subgroups and across states in India.

Differential socioeconomic and geographical susceptibilities to tobacco consumption

Men are more likely to consume tobacco than women. A strong gradient with regards to education and standard of living is apparent. Higher levels of education and standard of living are inversely related to the probability of smoking and chewing; the gradient is stronger for smoking. The relation between these socioeconomic markers and tobacco consumption is similar to relations observed in developed countries.[10] Further, the caste based differences in tobacco consumption show the persistent effect of caste as a key axis along which health and other wellbeing outcomes are stratified, over and above the adverse effects of low education and an index of material standard of living. In addition, the distribution of tobacco consumption by marital status is contrary to what has been observed in developed countries, where marriage is seen to have a protective effect.[10] Importantly, the large differences observed between states in tobacco consumption, even after controlling for the demographic and socioeconomic markers at individual or household level, highlight the potential importance of the state context in influencing this behaviour.[19]

Limitations of the study

In addition to the general limits to drawing causal inferences based on cross sectional, observational data, one caveat that is pertinent to our analysis relates to the extent to which the observed magnitude of socioeconomic gap reflects "actual" gaps compared with "reporting" gaps, especially since formal and informal social conventions related to tobacco consumption can influence reporting patterns.

Moreover, data were available only on overall tobacco smoking. Differences in the socioeconomic gradient in the use of manufactured cigarettes (higher among people with more education) and bidis (higher among people with less education) have been shown to exist.[11] Smoking bidis is more strongly related to lung and oral cancer than smoking manufactured cigarettes,[20 21] and the preponderance of bidi smoking among less advantaged socioeconomic groups will tend to exacerbate health inequalities.

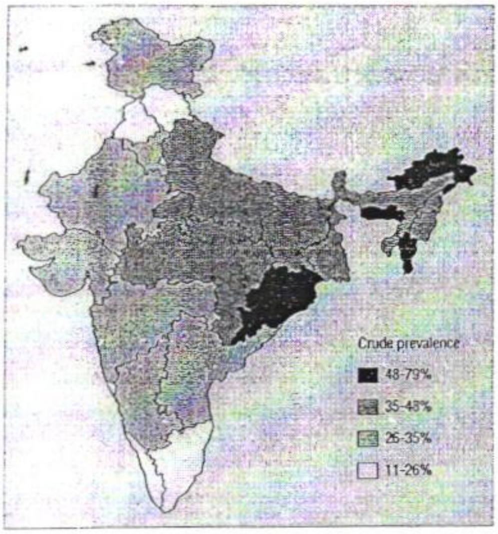

Fig 1 Crude prevalence of adults aged 18 and above who smoke or chew tobacco in 1998-9, by Indian state. The term "crude" means unadjusted prevalence and is computed as number of individuals who smoke and chew tobacco divided by the total number of individuals, in each state, and expressed as percentages

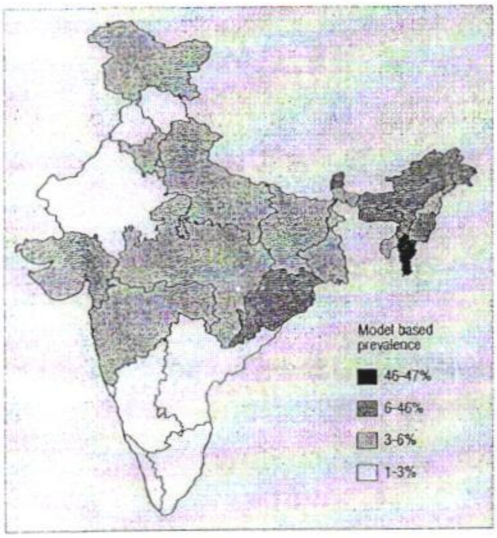

Fig 2 Model based predicted proportion of adults aged 18 and above who smoke or chew tobacco in 1998-9 by Indian state after controlling for demographic and socioeconomic markers at the individual level and for variation in tobacco consumption between households, local areas, and districts. The term "model based" means conditional prevalence and is based on model based, residual, state level differences in smoking and chewing after accounting for between-individual differences in tobacco consumption that are due to age, sex, marital status, caste, religion, education, standard of living, and urban and rural differences, and after taking account of within-state variation attributable to the level of households, local areas, and districts, and expressed as percentages

What is already known on this topic

Tobacco consumption is a key adverse health influence in South Asia in general and India in particular

Little is known about how the consumption of tobacco is distributed in India

What this study adds

Tobacco consumption in India is heterogeneous, with higher prevalence rates observed for population groups with low social caste, education, and standard of living

The prevalence of smoking and tobacco chewing shows marked geographical differences (at the level of villages, districts, and states), even after controlling for the individual and household demographic and socioeconomic markers

States account for the bulk of spatial variation in tobacco consumption

Conclusion

The presence of socioeconomic and demographic gradients in tobacco consumption in India counter the perspective of "poor versus non-poor" that is often adopted when examining health differentials in societies that are labelled as poor or low income. Furthermore, the variations in the prevalence of these risk behaviours by states, even after accounting for the type of individuals and households that reside in these states, show the potential importance of the state context in influencing tobacco consumption. The state of Maharashtra took the first legislative steps to discourage tobacco consumption through prohibitions on use and sale,[22] and this state has the lowest current overall smoking (table 4).

The current large socioeconomic and geographical gap in tobacco consumption in India is likely to feed into substantial, and perhaps increasing, socioeconomic differentials in the health of adults over the future decades. A need exists to document and monitor such inequalities in tobacco consumption in India systematically, to understand their determinants better, and to provide an evidence base for public health interventions that takes account of differences at state level as well as between population groups, in tobacco consumption.

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363

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A memorable call

A house call in Nepal's Himalayas

The young man came into the Himalayan Rescue Association aid post in Manang at midday. He asked me to go and see a man in a nearby village who had been sick since the day before and was unable to move. I stuffed my medical gear into a backpack and followed the man to the horse that he had brought along, and, after a two hour ride, we finally arrived at his village.

We walked through the narrow alleys to the patient's house, where a cow greeted us on the ground floor, and climbed the wooden staircase to the terrace to find a middle aged man lying still on a mattress. Though in agony, he tried to smile on seeing me. The history of his ailment and subsequent physical examination made me think that he had either acute cholecystitis or liver abscess. He looked pretty sick, so I started treatment with intravenous fluids and antibiotics, followed by pethidine, which made him doze off for a while.

He needed an abdominal scan, and the nearest place where it was available was four days' walk away. Helicopter evacuation seemed unfeasible as this is too expensive for most Nepalese. The only viable option was to fly him out from the local seasonal airfield, which was two hours' walk away. After telephone calls to the city, we found out there was a plane flying in tomorrow. This was our best bet. By now it was apparent that my patient needed medical supervision until he could be flown out to the city hospital, and I sent the young man back to the aid post to get extra drug supplies.

STEVE MCCURRY/MAGNUM

Strong winds started in the evening, and it snowed late into the night. This had stopped by the morning, but the whole valley was now covered with thick fog, and it seemed unlikely that the flight would come in. After a few hours, however, the fog started to clear, so we put the patient in a large basket, his legs dangling from two holes in its side, and started carrying him to the airport. The flight came in when we were halfway along the trail. Two of us rushed ahead to ask the pilots to wait, and the party finally made it just as the pilots, impatient to leave, were preparing to take off. To save a few precious minutes, the sick man was lifted over the perimeter fence of the airfield.

A few days later, I got the news that my patient had had liver abscess and was recuperating in a hospital in Kathmandu.

Puncho Gurung *volunteer physician, Himalayan Rescue Association, Nepal*

We welcome articles up to 600 words on topics such as *A memorable patient, A paper that changed my practice, My most unfortunate mistake,* or any other piece conveying instruction, pathos, or humour. Please submit the article on http://submit.bmj.com Permission is needed from the patient or a relative if an identifiable patient is referred to. We also welcome contributions for "Endpieces," consisting of quotations of up to 80 words (but most are considerably shorter) from any source, ancient or modern, which have appealed to the reader.

364

Annexure - 15

Review Article

Indian J Med Res 126, October 2007, pp 300-308

Tobacco use & social status in Kerala

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Health indicators of Kerala State such as infant mortality rate (14/ 1000 live births) and life expectancy at birth (71 yr for men and 76 yr for women) are far ahead of the Indian averages (IMR 58, life expectancy men 62 and women 63) and closer to the developed countries. However, tobacco use prevalence is similar to the national average.

Smoking is the commonest form of tobacco usage among men in the State whereas chewing tobacco is more common among women and children. Tobacco chewing among men is increasing in Kerala probably due to the smoking ban and industry strategy to focus on smokeless tobacco. Tobacco use is significantly more among the low socio-economic (SE) groups compared to the high SE group. Mortality and morbidity attributed to tobacco is higher among the poorest people in the State. Age adjusted cancer rate of oral cavity and lung cancer has been increasing in the State in recent years. Heart diseases among the young people are increasing in the State. Cancer and heart diseases are chronic illnesses which may pull the individual and the entire family below the poverty line.

Tobacco control therefore should be a top priority not only as a health issue but as a poverty reduction issue. Poverty alleviation is one of the major goals of developing economies. No poverty alleviation programme can ignore the potential impoverishment associated with tobacco use. Kerala with a very strong decentralized government has a very good opportunity to address tobacco control as a priority at the grass root level and reduce the impoverishment due to tobacco use.

Key words Chewing - health effects - Kerala - smoking - social status - tobacco

Introduction

Tobacco use is responsible for five million deaths in the world every year and 50 per cent of these deaths occur in the middle age (35-69 yr) population. Mortality attributable to tobacco has been estimated to be one million every year in India[1], projected to 1.5 million by 2020[2]. Deaths due to tobacco use in Kerala have not been estimated. However, considering the similarity of tobacco use prevalence in Kerala and other parts of India, the proportional mortality due to tobacco use in the State will be close to that of India. Based on available data, the annual deaths due to tobacco use in Kerala can be estimated to be close to 24,000.

Kerala is an advanced State in terms of epidemiological transition leading to increasing chronic diseases such as cardiovascular diseases, various forms of cancer, diabetes and chronic obstructive pulmonary disease. Tobacco use is considered to be the major

365

modifiable risk factor for such chronic diseases[3]. Therefore, tobacco control and cessation are an important public health priority in the State. The Framework Convention on Tobacco Control (FCTC) provides a unique window of opportunity for all countries to minimize and avert this alarming public health disaster and protect their citizens from the devastating health, social, environmental, economic consequences of tobacco use and exposure to tobacco smoke[4]. For a State like Kerala, which has been a model for health and development with low cost[5] and with a very strong decentralized government, it should be relatively easy to implement the FCTC to reduce the adverse health impacts of tobacco.

Since tobacco use has been reported to be higher among the poor and less educated people[6], both disease burden as well as economic burden due to tobacco use will disproportionately affect them. The major objective of this paper is to address various aspects of tobacco use, awareness of harmful effects of tobacco and its implications for the poor in Kerala.

Health indicators of Kerala and India

Compared to rest of India, the health status of Kerala is characterized by high levels of education, particularly female education, lower levels of fertility, infant and child mortality and higher levels of life expectancy at birth. Total literacy rate was 90.9 per cent in Kerala compared to 75.6 per cent for India. The difference in literacy levels between Kerala and India was more among women; 87.9 and 54.0 per cent respectively than among men; 94.2 and 75.6 per cent respectively[7]. In 2005, Kerala's infant mortality rate (IMR) of 14 per 1000 live births was less than one fourth of the Indian average of 58[8]. Life expectancy at birth in Kerala was 71 yr for men and 76 yr for women; the corresponding Indian figures were 62 and 63 yr, a difference of nine years for men and 13 yr for women[9]. These indicators of Kerala are closer to the developed nations than its counterparts in India.

However, there are problems for Kerala in some indicators. For example, among the major States of India, Kerala reported the highest rate of suicides in 2005; 27.7/100,000 population compared to the national average of 10.3[10]. Similarly, reported morbidity was also highest in Kerala. In rural area 25.5 per cent of individuals reported some ailment in the previous two weeks of the survey compared to 8.8 per cent for India as a whole. In urban areas the figures were 24 and 9.9 per cent respectively[11].

History of tobacco use in Kerala

Tobacco use in various forms including smoking and chewing has been an integral part of the community life in Kerala for centuries. Historically, in India, tobacco was introduced in Karnataka, the neighbouring State of Kerala, by the Portuguese during AD 1600[12]. A couple of centuries later, the British introduced commercially produced cigarettes and established tobacco production in the country[13]. Traditionally, chewing betel quid with tobacco was more common among the Kerala population irrespective of social class and caste. Among upper caste Hindus of Kerala, *Thamboola charvanam* (betel leaf chewing) was a custom, especially associated with marriage party. Initially betel leaves and pieces of areca nut were the major ingredients of this quid and tobacco was added subsequently. This practice was believed to remove bad breath. Areca nut, though considered not harmful earlier, was later reported to be the fourth psychoactive substance in the world after caffeine, alcohol and nicotine[14].

Beedi (0.2-0.3g of tobacco wrapped in a *temburni* leaf and tied with a small string) smoking was reported as early as 1711 in India[12]. During 1920s and 30s, *beedi* was exported from Kerala to Ceylon (Sri Lanka) and Burma (Myanmar) and to other parts of India such as Mysore and Kudaku in Karnataka State. Local consumption of *beedi* also increased during this period[15]. One of the reasons for increased *beedi* consumption was the call for boycott of imported cigarettes as part of *Swadeshi movement* (movement to boycott foreign goods) that enhanced a shift from cigarettes to beedies[16].

Changing use patterns

In Kerala, smoking and use of snuff is predominantly a male habit while chewing is more or less similar among men and women. In recent years there is an indication that chewing among men is increasing and that of women is decreasing, and smoking among men is showing a tendency to decrease while that in women to increase, although the proportion of women smokers is still very small[17]. The use of *beedi* accounts for the largest proportion (nearly 40%) of tobacco consumption in India[13] and Kerala is not different. Historically, smoking cigarettes was more among people of the high socio-economic class, due to the higher cost of cigarettes compared to *beedi*.

There is a wide variation in ingredients of betel quid, and the most commonly used ingredients in Kerala were betel leaves, areca nut, tobacco and slaked lime. There has been a change in chewing patterns from the traditional betel quid with the introduction of newer products such as *panmasala*, *khaini* (sun dried tobacco and slaked lime) and *gutka* (a generic name for a product that contains tobacco, areca nut and several other substances sold in powdered or granulated form in small sachets). This may be linked with the popular perceptions on tobacco use that smokeless tobacco products are relatively less harmful.

Prevalence of tobacco use among various groups

Adults: Among men in the age group of 15 yr and above the prevalence of current smoking in Kerala was 28 per cent compared to 29 per cent in India as a whole. Among women, current smoking prevalence was 0.4 per cent in Kerala compared to 2.5 per cent in India. With regard to tobacco chewing, 9.5 per cent of Kerala men reported chewing compared to 28.3 per cent in the entire country. The figures for women were 10.5 per cent in Kerala and 12.4 per cent for India as a whole[6,18].

Children and adolescents: In a study among school children aged 12-19 yr, current use of any form of tobacco was reported by 11 per cent of them. The proportion of school students experimented with some form of tobacco was 35 per cent (24% smoking and 11% using smokeless tobacco). The prevalence of current smoking among these children was 8.1 per cent and use of smokeless tobacco was 3.2 per cent. Tobacco use was four times higher among the students who received pocket money, three times higher among those with lower academic performance and three times higher among those whose friends used tobacco compared to their counterparts[19]. A similar finding was reported in a recent study from Delhi and Chennai schools where tobacco use among students in sixth grade was two to four times higher compared to eighth grade students[20].

The prevalence of current tobacco use among male college students in Kerala was 13.6 per cent and overall prevalence of current smoking was 11.7 per cent[21]. More than 37 per cent of the students experimented with some form of tobacco.

Health professionals: The health professionals have a key role in tobacco control, though they have not yet been effectively brought into this area[22]. Recognizing the pertinent role of physicians in promoting reduction of tobacco consumption and enhancing tobacco control in the public health agenda at regional, national and global level, World Health Organization brought out a code of practice to encourage physicians to be role models by quitting and promoting a tobacco free culture[23]. However, 13 per cent of male health service physicians, 15 per cent of male medical college faculty and 14 per cent male medical students in Kerala were reported to be current smokers[24]. As expected, none of the female health service physicians and nursing students reported smoking in the above study. The smoking prevalence among the health professionals and medical students, indeed, was less than the current smoking prevalence of male population in Kerala but significantly higher when compared to the current smoking prevalence among the physicians in the developed world including UK (5%) and the US (3%)[24,25].

Trends in tobacco use in Kerala

There is growing evidence that, globally, over the past two decades the overall smoking prevalence has increased in low and middle income countries while it declined in the high-income countries. The linkages of increasing tobacco consumption and free trade are more explicit as the negotiations on liberalization policies between the US and several Asian countries during the 1980s resulted in an overall increase in demand for tobacco with highest increase in poor countries[26]. Along with the increase in smoking prevalence, over the last three decades of 1970s to 2000, tobacco production also increased by more than double in the developing world compared to the 36 per cent decrease in developed world[27]. Today, India is the third largest country in the world in both tobacco production and consumption. Of the 1.1 billion smokers worldwide, 182 million live in India. Based on the tobacco use prevalence in 2005[17] we have estimated that Kerala had at least four million smokers in that year.

Data on tobacco use prevalence based on a State representative sample at different points in time are limited and not focused entirely on tobacco use. The National Sample Survey Organization (NSS) 1987-1988, and 1993-1994, *Kerala Sastra Sahitya Parishad* (KSSP) 1987 (rural only) and National Family Health Survey (NFHS 2) (1998-99) provided some information on tobacco use. The NSS 1987-1988 survey reported a tobacco use prevalence of 44.6 per cent among men and 13.4 per cent among women in rural Kerala and 1993-1994 survey reported a tobacco use prevalence of 34.6 per cent among men and 6.7 per cent among women showing a decrease in overall tobacco use[28]. The KSSP study in 1987 reported a smoking prevalence of 43 per cent among men aged 15 yr and above[29]. Smoking among women was negligible in this sample although chewing was similar among men (12.47%) and women (12.56%). The NFHS- 2 figures on tobacco use have been already given.

Most of these large studies have limitations because one of the members in the household provided information on all. Therefore, it was reported that in the NFHS-2 study the tobacco use prevalence was underestimated by at least five per cent for smoking among men and 0.5 per cent among women and for chewing by 11 per cent for men and 1.5 per cent for women[30]. Since smoking has some taboo attached to it, there is a possibility of under-reporting by younger men and women of all age groups, even when data were collected from the participants individually. Community based studies, where data collection was done from each of the participants at different points in time, will be a better source of information, to understand trends in tobacco use. Major limitations in comparing tobacco use over different time points include different definitions for current tobacco use, ever tobacco use, not asking about smokeless tobacco, information collected by a single respondent for all members of the household and inclusion of different age groups in the sample.

There are some good community based studies which provided reasonably good data on trends in tobacco use. One of the earlier community based studies from Kerala was reported from Ernakulam district which was part of a multi-centric study. Smoking prevalence in this study was reported to be 22 per cent among men aged 15 yr and above and 0.7 per cent among women. Chewing was reported to be 17 per cent for men and 20 per cent for women. Another 10.3 per cent among men and 0.3 per cent among women reported mixed habit of smoking and chewing[31]. During a 10-year follow up of this study a 5 per cent increase was found in tobacco use[32]. Another study in rural Thiruvananthapuram district in 1990, reported a smoking prevalence of 50 per cent among men[33]. In a large sample study in 1995 consisting of over 110,000 individuals in rural Thiruvananthapuram district reported a current smoking prevalence of 50.1 per cent among men in the age group of 35 yr and above[34]. Chewing was 23.8 per cent among males and 22.2 per cent among females in this study. There is consistency in the findings of these two studies although the later study included individuals above the age of 65 yr also.

The most recent community based study from Thiruvananthapuram district in 2005 reported a current smoking prevalence of 35 per cent among men in the age group of 15-64 yr[17]. In the age group of 35-64 yr the current smoking prevalence was 43.7 per cent. Prevalence of current chewing was 26.2 per cent among men and 6.7 per cent among women. In urban slum prevalence of current chewing was as high as 42 per cent among men and 12.2 per cent among women[17].

In order to understand trends in tobacco use better, one of the methods is the WHO STEPs method of surveillance on risk factors collecting information from 15 to 64 yr with sufficient numbers of males and females in all the 10 yr age groups. In the integrated disease surveillance project of the Government of India, the Indian Council of Medical Research (ICMR) has been given the responsibility of addressing this issue. This is likely to provide useful information on all the major risk factors including tobacco use over a period of time in all the States of India.

Factors associated with tobacco use

In Kerala, tobacco consumption was part of the social relations where, traditionally, tobacco was offered during celebrations including marriage. Raw tobacco was offered as a present when children visit the elderly in many communities in Kerala. However, recently, the trend is changing. Like in many other parts of India, the factors associated with tobacco use are closely linked with age, sex, social class, education and professional status. Although limited, some of the available studies indicate a variety of socio-cultural influences attributable to tobacco use. School going boys, whose fathers were current tobacco users, were two times more likely to use tobacco compared to their counterparts. Boys having friends who were current tobacco users were 2.9 times more likely to use tobacco compared to those whose friends were not using tobacco[21]. Among the college students, those having a tobacco using household member were three times more likely to use tobacco compared to those who did not have any tobacco user in the household. This was consistent with the findings from the study among the south Indian college students in which 'for friendship' was the most common reason cited for smoking[35].

The factors associated with continuation of smoking among the currently smoking male medical college faculty members and health service physicians and medical students of Kerala were largely attributed to enjoyment, 'no need to quit' as they smoked so little according to them which was perceived to be harmless, and to reduce stress. For 29 per cent of the medical college faculty and health service physicians it was psycho-social reason such as 'feeling uncomfortable' if they could not smoke. Only 5.4 per cent of the medical students reported the same[24].

Importantly, there is enough evidence on the linkages of tobacco use and socio-economic factors where both *beedi* smoking and chewing were reported to be higher among low social class compared to high social class. In Kerala this has been reported in a couple of studies. In the KSSP study of 1987 it was reported that among the poor 51 per cent smoked *beedi* compared to 19 per cent in the better off group. With regard to chewing, 21 per cent among the poor group chewed compared to 7 per cent in the better off group. In the NFHS-2 survey among males who had a low standard of linving (SLI) index 43.5 per cent smoked compared to 18 per cent who had a high (SLI) index. Similarly 20.4 per cent of women in low SLI group chewed comapared to 5.3 per cent among the high SLI group.

A similar trend with higher rates of tobacco use among the disadvantaged sections has been consistently reported from the high, middle and low income countries[27]. As a consequence, tobacco related morbidity and mortality are expected to be much higher among lower social strata.

Awareness on harmful effects of tobacco

Although, people of Kerala are aware that tobacco use endangers health, awareness was mostly on the linkages between tobacco use and various cancers. In a study in Thiruvananthapuram district, 46 per cent knew that smoking causes lung cancer while 32 per cent reported that smoking causes or may exacerbate asthma[21]. Only 10 per cent was aware of the relationship between tobacco use and cardiovascular diseases[21]. In a recent study from the same district, the awareness on the associations between tobacco and cardiovascular diseases was 22.5 per cent, an increase of more than double in about eight years[36]. Awareness on tobacco and cancer was 66 per cent, an increase from 46 per cent[36]. Surprisingly, those who reported a linkage between tuberculosis and tobacco use in this study was only 7.3 per cent. In our own study (unpublished data), 64 per cent of diabetes patients reported that smoking will not affect the disease and only 10 per cent reported that smoking causes a lot of aggravation of diabetes. In short, the awareness regarding adverse health effects of tobacco use was largely limited to cancers and hence there is a need for information dissemination focusing on tobacco related diseases especially, cardiovascular diseases and chronic obstructive pulmonary diseases, since these two are the leading causes of death from smoking apart from lung cancer[37]. In addition, the message that tobacco affects almost all organs in the body should be effectively communicated to the entire population.

Health effects of tobacco

The epidemiological studies in recent years have confirmed the harmful effects of tobacco. Tobacco use and exposure are associated with a wide range of debilitating diseases including various types of cancers, coronary heart disease, obstructive pulmonary diseases, peripheral vascular disease, stroke and acid peptic disease[38]. In 2000, globally, the leading causes of death from smoking included cardiovascular diseases (1.69 million deaths), chronic obstructive pulmonary disease (0.97 million deaths) and lung cancer (0.85 million deaths)[37]. The latest US Surgeon General's Report (2004) indicates that smoking harms almost every organ of the body[39]. By 2030, tobacco is projected to be the single biggest cause of death worldwide[40].

Worldwide, tobacco causes nearly five million deaths annually (one in ten adults) with 2.41 million deaths in developing and 2.43 million in developed countries[37]. The death toll is projected to rise to 10 million by 2030 with seven out of ten deaths in the developing world[41].

Tobacco related morbidity and mortality

It has been reported that cigarettes are the cause of death of half of its persistent users and 8 per cent of the world's population will eventually be killed by tobacco[42]. However, *beedi* smoking, which is very common in Kerala, is no less hazardous than cigarettes and smokeless products are also associated with higher morbidity and mortality[43].

According to ICMR, in India in each year tobacco use results in about 160,000 cases of cancer, 4.5 million heart disease 3.9 million chronic obstructive lung diseases[44]. The proportion of cardiovascular disease is rising in the country with a prevalence of 3-4 per cent in the rural areas and 8-10 per cent in urban areas[45]. The cardiovascular diseases in people aged 35-64 yr results in the highest loss in potentially productive years of life in India[45]. India has the highest number of people with diabetes in the world. It was predicted to increase from 31.7 million in 2000 to 79.4 million in 2030[46].

In Kerala, number of patients with cardiovascular diseases is increasing[47]. The diabetes prevalence in the State was as high as 12 per cent[48]. Major tobacco related chronic diseases such as cancers, coronary heart disease, diabetes and COPD in the State are on the rise. The linkages between smoking and TB have been overlooked for a long time[49]. The current burden of chronic non-communicable diseases reflects past exposure to risk factors and the future burden will be determined by the current exposures[3].

Smoking causes half of all male deaths from tuberculosis in India and a quarter of all male deaths from any disease in middle age. A quarter of the cigarette or *beedi* smokers in India would be killed by tobacco at the ages of 25-69 yr losing 20 yr of life expectancy[50]. Similarly, between 1990 and 2000, deaths from coronary heart disease in the country increased from 1.17 to 1.59 million and it was predicted to rise to 2.03 by 2010[51]. Globally, the disability-adjusted life years (DALYs) attributed to tobacco are predicted to rise from under 40 million in 1990 to 120 million by 2020 and the massive increase in overall tobacco consumption in developing countries may cause an increase in the DALYs in these nations[52]. The tobacco related DALYs in India during 1990 was 1.7 million[13]. In terms of overall global burden of disease, India had the second largest proportion of 20.9 per cent after sub-Saharan Africa, but a very small proportion (1.0%) of public health expenditure[52].

In Kerala, data related to morbidity attributable to tobacco are available mostly on cancers. One of the earlier studies on tobacco related morbidity found that Ernakulam district in Kerala, where chewing habit was very high, accounted for nearly half (12) of the total (26) oral cancer cases. The prevalence of leukoplakia and pre-leukoplakia was 1.7 and 2.4 per cent respectively. In the anatomical location of leukoplakia, 64.8 per cent accounted for buccal mucosa[31]. It is important to note that in Kerala chewing practices are more related to placing the tobacco quid in the lower buccal groove. A prospective study by the same team in the 1980s in the same district reported that the annual incidence rate of leukoplakia among 1000 adults was 2.1 for males and 1.5 for females and the rate was highest in the mixed tobacco habits group while lowest in the no tobacco habit group[53].

In a case control study in Kerala it was reported that individuals chewing tobacco ten or more times a day were 15 times more likely to get cancer gingiva compared to non-chewers. Men smoking more than 20 *beedies* per day were 3.2 times more likely and those used snuff were 3.9 times more likely to get gingival cancer[54]. Another study indicated higher risk for cancer of the esophagus for those smoking *beedi* and cigarette[55]. Those who smoked *beedi* for 20 yr had seven times more risk of getting cancer larynx and those who smoked cigarettes for the same duration had five times higher risk compared to non smokers[56].

The findings of a study in three areas of south India including Kerala, reported that chewing and poor oral hygiene explained 95 per cent of oral cancer of the women. Among men, 35 per cent of oral cancer was attributed to a combination of smoking and alcohol and 49 per cent to tobacco chewing[57].

According to the population-based cancer registry in Thiruvananthapuram district, the age adjusted incidence rate of cancers of oral cavity increased from 11.8 per 100,000 males in the year 2000 to 14.1 in 2002 in urban areas. Figures for lung cancer were 7.6 and 8.1 respectively[58].

Studies on tobacco related mortality in rural areas of Kerala and Andhra Pradesh revealed that the age adjusted relative risk for overall mortality for tobacco use by men and women ranged between 1.3 and 1.9 with smokers having higher risks[59].

Implications for the poor

The widespread use of all forms of tobacco during the past couple of centuries indicated that after the advent of tobacco in the early 17th century, the aggressive marketing strategies by the tobacco industry have succeeded in creating a mass market through engineered addiction all over India[12] including Kerala.

The high prevalence of tobacco use among children and adolescents of Kerala and India assumes greater importance to public health, since teens are at a greater risk of nicotine addiction even with low levels of tobacco consumption[60]. This would result in long time use and consequent long-term sufferings from tobacco related diseases and disability.

Once a member of the family is affected by a chronic disease such as cancer, the entire family is likely to be pulled below the poverty line since the cost of health care in Kerala is extremely high and increasing over the years[47]. It has already been reported that tobacco use contributes to impoverishment from hospitalization cost[61]. A large proportion of heart attacks among the young adults is due to tobacco use[62]. Such diseases are destroying the productive lives of poor people. In addition to the direct hospitalization cost due to tobacco related morbidity and mortality, many families loose their major earning member in early life pushing all of the family members into poverty. Since the awareness on the linkages between tobacco and heart diseases and other tobacco related diseases is low particularly among the poor, this needs to be addressed as a priority in the State.

In terms of employment opportunities, *beedi* industry has been one of the agro-based traditional labour intensive industries in Kerala which provided employment for 1,15,546 workers during 1991[63]. The employment opportunities in this industry are coming down drastically. For example, the Kerala Dinesh Beedi Co-operative Society (KDBCS) of Kannur district was one of the important successful victory models for co-operativisation in the employment sector within the State, the country as a whole and possibly for the world[64]. However, the last decade showed a decline in the trends in *beedi* industrial growth in the State. KDBCS, the major employment provider in *beedi* industry in Kerala, was able to provide employment to only 31431 persons in 1994[65] and it declined to 25020 persons in 1999[66].

Today, KDBCS has diversified its production into other areas including food processing. The decline in Dinesh *beedi* sales was mainly due to health education messages, market competition with cigarettes and chewing products, and the ban of smoking in public places by the High Court in Kerala[67]. The goal of KDBCS was to transfer 25 per cent of the workforce within 10 years from tobacco to other products mainly food products[60]. Wages for the workers in the food production section (Kerala Dinesh Foods) equals with those of the *beedi* workers, though the food workers produce less surplus value to the company. The high quality of food products, solidarity from union households and support of the sympathizers in the community give Kerala Dinesh Foods marketing advantages other companies cannot easily undermine[64]. This is a good example which could be emulated in other parts of India and elsewhere.

Costs of tobacco use

Tobacco use induced morbidity and mortality cause considerable economic loss both directly and indirectly. The direct cost is related to the health care and the indirect cost is related to loss of productivity. Although we do not have separate cost calculations for Kerala, it has been argued that, in India, the direct cost of tobacco use including smoking and nonsmoking products excluding the cost of accessories like lighters, matchsticks, *etc.*, to the consumer was between 2 and 3 per cent of the total private final consumption expenditure (PFCE) and between 4 and 6 per cent of the amount spent on food[12]. The total average cost of three major tobacco related diseases in India during the period of 1999 was Rs 277.61 billion. While the total average cost including the loss of income due to absenteeism, institutional service charge and loss due to premature death of a tobacco related cancer case diagnosed in 1990-1991 was Rs. 134,449 and in 1999 it was Rs. 350,000[12]. However, the cost of treating tobacco related disease was more than double than the revenue the government gets from the tobacco industry[68]. Apart from economic cost, the sufferings, physical and emotional distress and the loss due to death of the smokers to their families and society are enormous.

Control initiatives

Kerala has a pioneering role in tobacco control initiatives at various levels including judiciary, academia and non government organizations (NGOs). During 1999, the Kerala High Court brought out a landmark judgment which banned smoking in public places including highways and parks. This was later upheld by the Supreme Court of the country. There are a few tobacco cessation clinics attached to two major hospitals in Thiruvananthapuram.

Conclusion

Tobacco use in Kerala is almost at the same level as rest of India but significantly higher among the poor. Smoking is comparatively low among women compared to men. Tobacco chewing is increasing among men, children and adolescents possibly due to the smoking ban in public places and also tobacco industry strategies to shift their focus to smokeless tobacco products which is not affected by current tobacco control policies. Tobacco use leads to many chronic non-communicable diseases, treatment of which puts economic burden on the people pulling them below the poverty line. Tobacco control therefore should be a top priority not only as a health issue but as a poverty reduction issue. Any poverty alleviation programme cannot ignore the potential impoverishment associated with tobacco use. Kerala with a very strong decentralized government has a very good opportunity to address tobacco control as a priority at the grass root level.

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372

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PHOTOESSAY

Tobacco chewing in India

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In India, tobacco is used in a variety of forms such as smoking, chewing, local applications, drinking and gargling, leading to detrimental health effects such as increased incidence of and mortality from cardiovascular diseases, cerebrovascular diseases, respiratory diseases and cancer, in addition to detrimental reproductive outcomes, dental and oral diseases. Tobacco use, in any form, is more popular in lower socio-economic groups. Betel-quid chewing—a mixture of areca nut, slaked lime, catechu, other spices and condiments rapped in a betel leaf—is a popular, socially accepted, ancient custom and the introduction of tobacco reinforced this practice (Photos 1 and 2). Chewing products are kept all day and sometimes even all night in the buccal sulcus or pouch; usually in the anterior part of the mouth in populations from North India, and in the posterior part among South Indians, colouring the mouth in red (Photo 3). The introduction of commercial pan masala—dehydrated and non-perishable powdered areca nut,

Photo 1 Salesman of betel leaves at the local market

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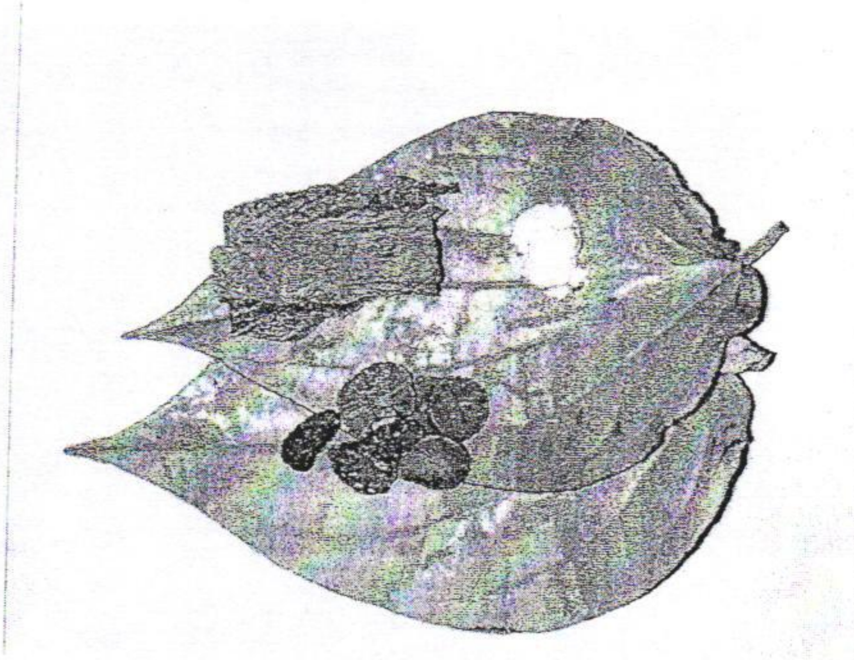

Photo 2 Betel-quid with areca nut, tobacco leaves, lime on betel leaves

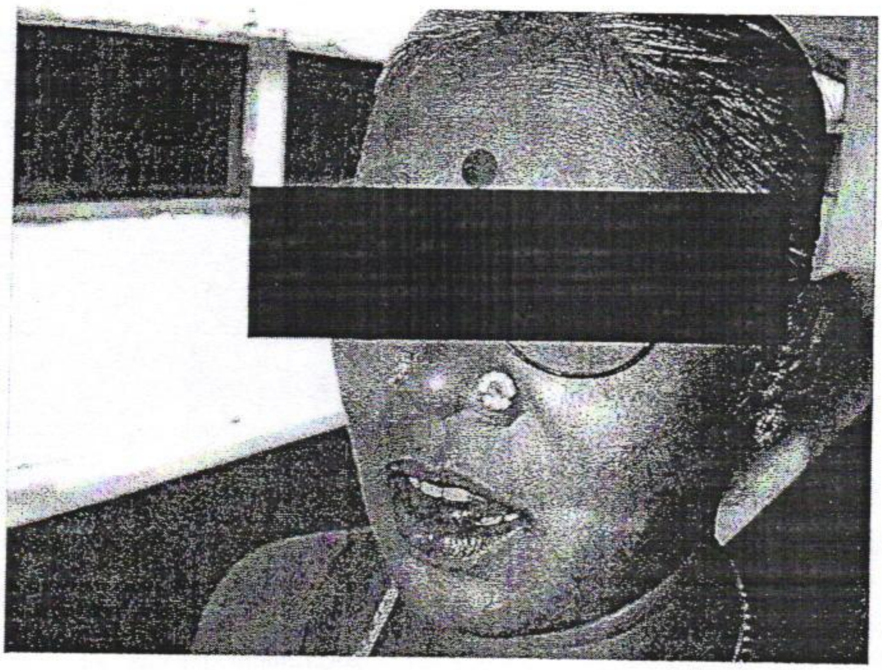

Photo 3 Mouth coloured in red by betel-quid

slaked lime, catechu, cardamom and other flavouring and perfuming agents with or without tobacco available in attractive sachets or tins—has enhanced the sale and use of smokeless tobacco (Photo 4). Cigarette smoking has always been taboo in India and the emergence of cheap and convenient to carry and use preparations of smokeless tobacco, with a longer shelf-life and promoted with aggressive marketing, has lead to a sudden dramatic increase in the habit of chewing tobacco, even among women and children.

The carcinogenic effect of betel-quid and pan masala has lead to one of the highest incidence and mortality

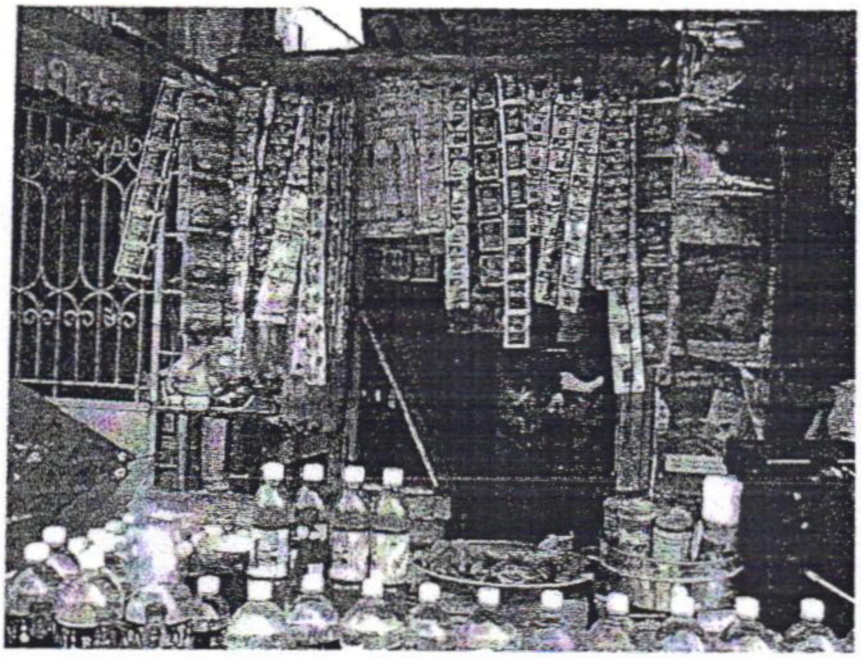

Photo 4 Pan masala shop

Photo 5 Interview by the health worker

rates of oral cancer with 83 000 incidence cases and 46 000 deaths annually in India.[1]

In 1995, a community-based randomized oral cancer screening study to evaluate the efficacy of oral visual inspection in reducing the deaths from oral cancer was implemented in the Trivandrum district, South India.[2,3] Enumeration of households, interview (Photo 5) and oral cancer screening (Photo 6) were carried out through home visits. Incident oral cancers and vital status information were collected through active home visits and through record linkage with the population-based cancer registry or from the government records for death information. Given the fact that tobacco is a major cause of adult morbidity and mortality in India, the battle for tobacco control needs to be continued more strongly through enactment and implementation of legislation and effective community campaigns against tobacco (Photo 7).

Note: The people pictured in this essay gave their consent for their images to be used in the presentation and publication of this research.

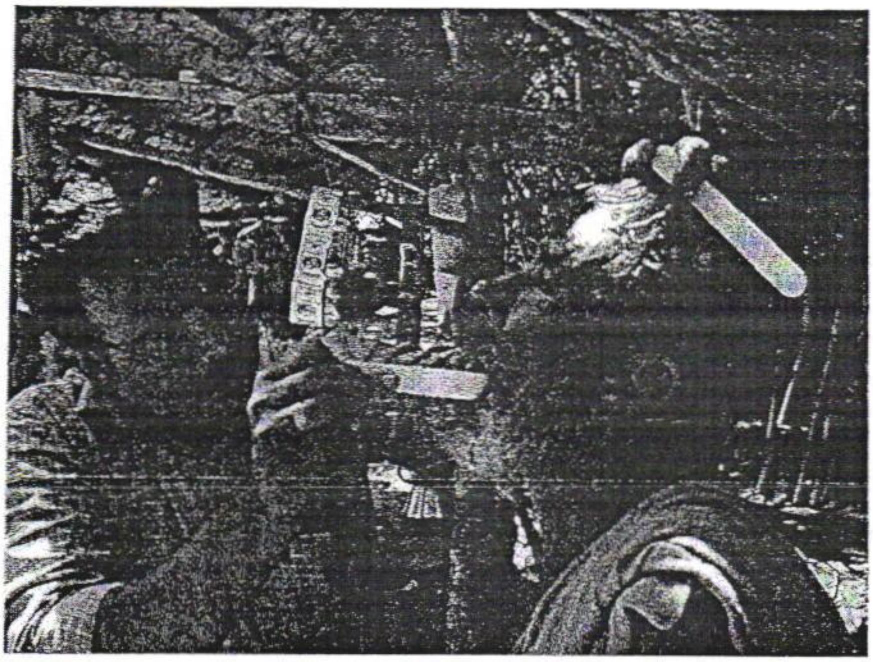

Photo 6 Oral cavity screening on pan masala shop-keeper

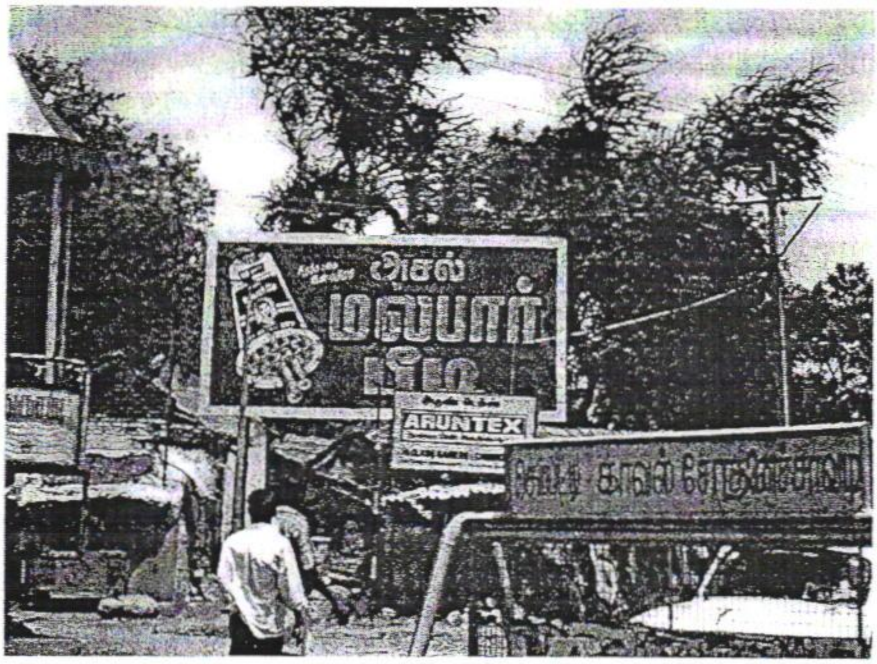

Photo 7 Advertisement of bidi, the local cigarettes

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Social Disparities in Tobacco Use in Mumbai, India: The Roles of Occupation, Education, and Gender

| Glorian Sorensen, PhD, MPH, Prakash C. Gupta, DSc, FACE, and Mangesh S. Pednekar, MSc

Objectives. We assessed social disparities in the prevalence of overall tobacco use, smoking, and smokeless tobacco use in Mumbai, India, by examining occupation-, education-, and gender-specific patterns.

Methods. Data were derived from a cross-sectional survey conducted between 1992 and 1994 as the baseline for the Mumbai Cohort Study (n = 81837).

Results. Odds ratios (ORs) for overall tobacco use according to education level (after adjustment for age and occupation) showed a strong gradient; risks were higher among illiterate participants (male OR = 7.38, female OR = 20.95) than among college educated participants. After age and education had been controlled, odds of tobacco use were also significant according to occupation; unskilled male workers (OR = 1.66), male service workers (OR = 1.32), and unemployed individuals (male OR = 1.84, female OR = 1.95) were more at risk than professionals. The steepest education- and occupation-specific gradients were observed among male bidi smokers and female smokeless tobacco users.

Conclusions. The results of this study indicate that education and occupation have important simultaneous and independent relationships with tobacco use that require attention from policymakers and researchers alike. (*Am J Public Health.* 2005;95:1003–1008. doi:10.2105/AJPH.2004.045039)

Tobacco use in low-income and middle-income countries is predicted to contribute to an increasing share of the global burden of disease in future decades.[1] Eighty-two percent of the world's 1.1 billion smokers now reside in low- and middle-income countries, where, in contrast to declining consumption in high-income countries, tobacco consumption is on the rise.[1] Indeed, the World Health Organization's Framework Convention on Tobacco Control underscores the importance of tobacco control efforts within developing countries as part of a worldwide strategy to reduce the health, economic, and social consequences of tobacco use.[2] Addressing this growing public health problem requires attention to increasing social disparities in patterns of tobacco use. Across high-, middle-, and low-income countries, smoking rates are highest among individuals of low socioeconomic position.[3]

Indicators of socioeconomic position vary across studies; often education, occupation, and income level are used interchangeably to measure socioeconomic position.[4] It is important, however, to examine multiple indicators of socioeconomic position simultaneously if one is to understand their combined impact and thereby provide more complete descriptions of social inequalities in tobacco use. In particular, insufficient attention has been focused on occupational disparities in tobacco use, given the role of occupation in linking education and income as well as its role as a determinant of health in its own right, through hazardous workplace exposures. Indeed, recent analyses of US data indicate that education does not represent a "stand-in" surrogate for occupation, or vice versa; rather, they reflect distinct social constructs making overlapping as well as independent contributions to patterns of tobacco use.[5]

In this study, we examined social disparities in tobacco use in India, where multiple forms of tobacco consumption complicate attempts to reduce its overall impact on public health. It has been estimated that 65% of men use some form of tobacco, including 35% who smoke, 22% who use smokeless tobacco, and 8% who engage in both forms of tobacco use.[6,7] About one third of women use at least one form of tobacco, although rates among women vary considerably by region (from approximately 15% to approximately 65%).[6,7] In general, cigarettes account for an estimated 20% of tobacco consumption; about 50% of tobacco is consumed in the form of *bidis*, that is, traditional, leaf-wrapped unfiltered cigarettes.[8,9]

In previous studies, different patterns have been observed in the educational gradient in tobacco use depending on the type of tobacco used. Whereas overall tobacco use has been shown to be highest among those with the least education, cigarette smoking rates have been shown to increase with increasing education.[10] In India, because of their low cost, bidis are more commonly smoked than cigarettes by individuals of lower socioeconomic position; in turn, cigarettes are more commonly consumed among those with greater financial resources.[10,11] (Bidi smoking has been shown to pose significant health hazards.[12–14]) A similar socioeconomic gradient has been observed for the use of smokeless tobacco, including chewing tobacco, snuff, burnt tobacco, powder, and paste.[7,15]

In general, men in India smoke as well as chew or apply tobacco, whereas women generally chew or apply tobacco, with the exception of the few areas where prevalence rates of smoking among women are high.[7,16] It is estimated that more than 150 million men and 44 million women in India use tobacco in various forms,[14] and approximately 635000 deaths in India are attributed to tobacco each year. Tobacco-related cancers constitute about half of the total cancer incidence among men and about 20% among women.[8]

The purpose of this study was to assess educational and occupational differences in the prevalence of tobacco use, including total tobacco use, bidi and cigarette smoking, and smokeless tobacco use, in a large sample of residents of Mumbai, India. In addition, we sought to assess the joint effects of occupation and education level on tobacco use after con-

378

trolling for other key determinants of use (i.e., gender and age).

METHODS

Baseline data for the Mumbai Cohort Study were collected between 1992 and 1994 in Mumbai (Bombay), India.[17] The overall purpose of this prospective cohort study was to assess mortality associated with tobacco use in Mumbai.

Study Population

Mumbai is a large, densely populated city whose population was approximately 12 million people in 2001.[18] The city is divided into 3 sectors: the main city, the suburbs, and the extended suburbs. This study exclusively focused on the main city. The sampling frame comprised the city's electoral rolls, which are updated via house-to-house visits before each major election. From these rolls, assumed to be relatively complete given that almost all adult residents are entitled to vote, data were derived on the name, age, gender, and address of all individuals older than 18 years. The electoral rolls were organized by geographical areas; sampling was based on the smallest unit, the "polling station," which included 1000 to 1500 eligible voters. Selection of polling stations excluded those involving a large proportion of apartment complexes with high levels of security; results of the pilot data collection indicated the need for this exclusion owing to the difficulty of gaining access to such buildings.

At the selected polling stations, all individuals 35 years or older who were listed on the electoral rolls were eligible to be interviewed. The age cutoff of 35 years was selected as a result of the study's overall goal of studying tobacco-attributed mortality. In selected geographical areas, lists were supplemented to include individuals who were not listed on the electoral rolls but whose residence status was confirmed by a "ration card." These cards, issued by the Bombay Municipal Corporation, serve as a proxy for residence cards and permit access to all city and state governmental services; individuals identified in this manner represented approximately 5% of the overall sample.

Of the individuals approached and invited to participate in the study, the nonresponse rate was less than 1%. It was not possible to contact approximately 50% of the individuals included on the lists as a result of incomplete addresses, houses being demolished, changes of residence, and inaccessibility of residences (often owing to security considerations). A total of 99 598 adults (40 071 men and 59 527 women) were recruited and surveyed. In the analyses presented here, we excluded respondents who reported that they were retired (n = 15 223) or had missing data for occupation (n = 2538). The final sample comprised 81 837 respondents.

Data Collection

The survey was conducted by trained interviewers within participants' households. Hand-held computers were used to record data at the time of the interview. Interviews were conducted in the local languages, including Hindi and Marathi. No surrogate responses were permitted.

Measures

The primary outcome in the present analyses was tobacco use, categorized as follows: (1) having no habit in either the past or present ("never user"), (2) former user (including smoking and use of smokeless tobacco), (3) current smokeless tobacco user (including betel quid, mishri, and creamy snuff), (4) current cigarette smoker, and (5) current bidi smoker (including other forms of smoked tobacco as well, e.g., chilum and hooka). Smokers who also used smokeless tobacco were classified as smokers in these analyses.

Occupation was assessed according to respondents' self-reports. Following the standard Indian classification system, occupations were coded as follows: skilled workers, unskilled workers, traders, service workers, and professionals.[19] Additional categories included unemployed and housewife. Women were considered as housewives unless they were currently employed or looking for employment. Retirees were excluded from the analyses. Education level was classified as illiterate, primary school (up to 5 years of education), middle school (6–8 years of education), secondary school (9–12 years of education), and college (including both some college and attainment of college degree). Gender and age data were also collected.

Data Analysis

Descriptive statistics were calculated for the overall population as well as for men and women separately. Logistic regression was used in conducting multivariate analyses. The response variable, tobacco use, was converted into a dichotomous variable in which current tobacco users (including users of any form of tobacco) were compared with current nonusers. Multivariate analyses of cigarette and bidi smoking were conducted only among men because of the extremely low prevalence (less than 0.5%) of smoking among women. SPSS statistical software (SPSS Inc, Chicago, Ill) was used in analyzing the data.

RESULTS

Sample Characteristics

Men represented about one third of the sample (Table 1). More than 40% of men were employed in service positions, and one third were unskilled workers, whereas a large majority (88%) of women were classified as housewives. Women were generally less educated than men; 45% of women were illiterate, as compared with 11% of men. In addition, only 5% of women had completed secondary school or college, whereas 16% of men had done so. Overall, about a quarter of the participants were between the ages of 35 and 39 years; more than a third were between 40 and 49 years of age.

Tobacco Use Prevalence: Bivariate Analyses

Patterns of tobacco use differed dramatically according to gender (Table 1). While women were less likely than men to have ever used tobacco (26% vs 41%), they were more likely to currently use smokeless tobacco (57% vs 44%). Smoking prevalence rates were 27% among men and, as mentioned, less than 0.5% among women (thus, data on female smokers are not shown separately in Table 1 or described in subsequent analyses). Among male smokers, 12% were cigarette smokers and 15% were bidi smokers. Overall, 2% of the sample members were

37c

TABLE 1—Tobacco Use, by Gender, Occupation, Education, and Age: Mumbai Cohort Study

	Men						Women[a]			
	Total, No. (%)	Never Users, %	Former Users, %	Current Smokeless Tobacco Users, %	Current Cigarette Smokers, %	Current Bidi Smokers,[b] %	Total, No. (%)	Never Users, %	Former Users, %	Current Smokeless Tobacco Users, %
Occupation										
Professional	422 (1.6)	48.1	6.4	26.3	16.4	2.8	293 (0.5)	72.0	1.4	26.6
Trader	2620 (9.7)	37.4	3.4	29.2	16.1	13.9	265 (0.5)	43.0	3.0	52.5
Service	11 605 (42.8)	27.6	1.7	48.9	12.3	9.6	1721 (3.1)	50.2	1.3	48.2
Skilled	2000 (7.4)	28.2	2.7	38.9	12.5	17.8	336 (0.6)	47.0	6.0	46.7
Unskilled	8835 (32.6)	21.6	2.4	44.6	11.4	20.1	3796 (6.9)	35.0	2.3	61.8
Unemployed	1659 (6.1)	18.5	3.6	47.0	11.4	19.6	131 (0.2)	28.2	2.3	66.4
Housewife	...	...	...	...	...	...	48 154 (88.0)	40.5	2.1	57.1
Education										
None/illiterate	3090 (11.4)	11.9	1.7	47.0	7.2	32.3	24 678 (45.1)	25.8	2.3	71.3
Primary	10 090 (37.2)	19.5	2.1	49.7	10.8	17.9	19 773 (36.2)	46.2	2.1	51.5
Middle	9519 (35.1)	31.8	1.8	42.8	14.0	9.6	7358 (13.5)	60.1	1.9	37.9
Secondary	2765 (10.2)	33.3	4.4	40.5	15.3	6.5	2070 (3.8)	74.4	2.3	23.1
College	1677 (6.2)	53.1	4.4	22.9	17.3	2.4	817 (1.5)	89.1	0.7	10.0
Age, y										
35–39	7697 (28.4)	30.1	1.5	42.9	13.3	12.1	13 920 (25.4)	51.9	1.0	46.9
40–44	6447 (23.8)	28.6	1.9	42.8	13.8	13.0	9530 (17.4)	45.1	1.4	53.2
45–49	4962 (18.3)	25.0	1.6	46.0	12.3	15.1	8516 (15.6)	37.7	2.2	59.6
50–54	4036 (14.9)	23.4	2.8	48.2	11.0	14.6	7364 (13.5)	34.6	2.3	62.6
55–59	2554 (9.4)	20.8	3.9	46.6	10.4	18.3	5300 (9.7)	32.7	2.7	64.2
60–64	780 (2.9)	19.5	6.8	40.5	7.9	25.3	4783 (8.7)	32.3	3.0	64.1
65–69	384 (1.4)	19.0	6.0	39.1	10.9	25.0	2609 (4.8)	30.0	4.0	65.5
≥70	281 (1.0)	23.8	8.2	34.9	9.6	23.5	2674 (4.9)	32.2	5.0	62.1
Total	27 141 (100.0)	26.4	2.3	44.4	12.4	14.5	54 696 (100.0)	40.6	2.1	56.9

[a]This group was not categorized separately, because very few women were smokers (less than 0.5%).
[b]Includes all current smokers who were not exclusively current cigarette smokers.

former tobacco users, an indicator of cessation rates.

Among men as well as women, professionals were least likely to have ever used tobacco, whereas unskilled workers and unemployed individuals were most likely to have done so. Use of smokeless tobacco was more common than smoking across all occupational categories. Rates of smokeless tobacco use among women were highest among unskilled workers, those who were unemployed, and housewives. Among men, smokeless tobacco use was especially prevalent among service and unskilled workers and unemployed individuals. Bidi smoking among men followed a similar pattern, with high prevalence rates among unemployed individuals and unskilled workers. In contrast, cigarette smoking was most common among professionals and traders. Self-reported rates of former tobacco use ranged from less than 2% to 6%.

There was a strong gradient in tobacco use according to education level. Among both men and women, the rate of smokeless tobacco was highest among the illiterate and lowest among those with a college education. Among men, the prevalence of bidi smoking was highest among those at low levels of education, but the prevalence of cigarette smoking was highest among those at the highest education levels.

Multivariate Analyses

Table 2 presents gender-specific tobacco use odds ratios comparing current tobacco users, current cigarette smokers, current bidi smokers, and current smokeless tobacco users with individuals reporting no current use of any type of tobacco. Odds ratios according to occupation and education were adjusted for age and the other relevant model variable (i.e., either occupation or education). The reference category for occupation was professional, and the reference category for education was college.

Tobacco use was inversely related to education level across all types of tobacco use. The magnitudes of the odds ratios were especially large among those with no more than a primary school education; in addition, in this subgroup, odds ratios were particularly pronounced among women who used smokeless tobacco and men who were bidi smokers. Relative to participants in the reference edu-

TABLE 2—Adjusted Odds Ratios (and 95% Confidence Intervals) for Various Forms of Tobacco Use (vs No Current Habit), by Education, Occupation, and Gender: Mumbai Cohort Study

	Current Tobacco Users	Current Cigarette Smokers	Current Bidi Smokers[a]	Current Smokeless Tobacco Users
Education				
College	1.00	1.00	1.00	1.00
None/illiterate				
Women	20.95 (16.60, 26.45)	...	...	21.02 (16.63, 26.56)
Men	7.38 (6.36, 8.56)	1.73 (1.39, 2.16)	38.64 (27.38, 54.54)	7.75 (6.55, 9.18)
Primary				
Women	9.12 (7.22, 11.51)	...	...	9.18 (7.27, 11.60)
Men	4.48 (4.00, 5.02)	1.65 (1.41, 1.93)	17.31 (12.46, 24.07)	5.25 (4.59, 6.01)
Middle				
Women	5.45 (4.31, 6.90)	...	...	5.50 (4.34, 6.97)
Men	2.42 (2.16, 2.70)	1.35 (1.16, 1.57)	5.92 (4.26, 8.25)	2.90 (2.54, 3.31)
Secondary				
Women	2.69 (2.09, 3.45)	...	...	2.70 (2.10, 3.48)
Men	2.00 (1.76, 2.27)	1.28 (1.07, 1.53)	3.12 (2.18, 4.46)	2.45 (2.11, 2.85)
Occupation				
Professional	1.00	1.00	1.00	1.00
Skilled				
Women	0.93 (0.64, 1.34)	...	...	0.92 (0.64, 1.34)
Men	1.26 (1.00, 1.58)	1.04 (0.75, 1.43)	2.51 (1.34, 4.71)	1.19 (0.91, 1.56)
Unskilled				
Women	1.26 (0.93, 1.70)	...	...	1.24 (0.92, 1.68)
Men	1.66 (1.34, 2.06)	1.22 (0.91, 1.63)	3.29 (1.77, 6.10)	1.65 (1.29, 2.12)
Trader				
Women	1.05 (0.71, 1.55)	...	...	1.01 (0.68, 1.50)
Men	0.85 (0.68, 1.06)	1.05 (0.77, 1.42)	1.53 (0.82, 2.86)	0.68 (0.52, 0.88)
Service				
Women	1.00 (0.73, 1.36)	...	...	0.99 (0.73, 1.35)
Men	1.32 (1.07, 1.63)	1.08 (0.81, 1.44)	1.39 (0.75, 2.59)	1.48 (1.16, 1.90)
Unemployed				
Women	1.95 (1.18, 3.21)	...	...	1.89 (1.15, 3.12)
Men	1.84 (1.45, 2.33)	1.34 (0.95, 1.87)	3.48 (1.84, 6.58)	1.79 (1.36, 2.36)
Housewife				
Women	1.04 (0.77, 1.39)	...	...	1.03 (0.77, 1.38)
Men	...	...	...	...

[a]Includes all current smokers who were not exclusively current cigarette smokers.

cational category (college), odds ratios for all forms of tobacco use were significantly higher among those in the other educational categories. After adjusting for age and education, we also observed an inverse relationship between cigarette smoking and education (see Table 2).

Although the magnitudes of the relationships were not as large, occupation continued to play an important role in patterns of tobacco use when education and age were controlled. In the case of men, odds ratios for smokeless tobacco use remained statistically significant among unskilled workers, service workers, and unemployed individuals, and the odds ratios for bidi smoking remained significant among unemployed individuals and both skilled and unskilled workers. None of the odds ratios for cigarette smoking were significant. After education level had been controlled, male traders were actually less likely to use smokeless tobacco than were professionals, suggesting an interesting interaction between education and occupation. Among women, after control for education level and age, only the odds ratios for those who were unemployed remained statistically significant.

DISCUSSION

The present results demonstrate the important roles of education and occupation in tobacco use patterns in India. Research in the West has consistently documented a strong socioeconomic gradient in tobacco use, with higher rates of use among those of greater social disadvantage.[4,5,20–22] Indeed, Jarvis and Wardle[23] concluded that, in Western countries, "any marker of disadvantage that can be envisaged and measured, whether personal, material or cultural, is likely to have an independent association with cigarette smoking." Recent evidence documents the same socioeconomic tobacco use gradient in India; tobacco use has been found to be higher among individuals at lower levels of education,[10,11,15,24–27] of lower castes,[15,27] and with lower standards of living.[27,28] (Other research, however, has failed to reveal an association between tobacco use and socioeconomic position.[29])

Education is a powerful correlate of tobacco use patterns.[10] In this study, after adjustment for occupation and age, all forms of tobacco use followed an inverse linear pattern in terms of educational level; similar results have been reported by others.[11,15,27] Odds ratios were alarmingly high among individuals with no more than a primary school education, particularly, as described earlier, women using smokeless tobacco and men smoking bidis. Of note, when we adjusted only for age (data not shown), the direction of the relationship between education and cigarette smoking among men was reversed relative to the bivariate relationships presented in Table 1. Unlike the use of other forms of tobacco, cigarette smoking was most prevalent among the younger groups within this sample; among male participants, age contributed significantly to both education- and occupation-specific odds of cigarette smoking. These findings underscore the importance of adjusting for age in analyses such as those described here.

Our analyses also offer evidence of the independent effects of occupation and education on tobacco use among men; even after control for education, odds ratios for occupation were statistically significant among the most disadvantaged workers in regard to bidi smoking and use of smokeless tobacco. One interesting exception in these occupation-specific results involved the odds of using smokeless tobacco among male traders; although the overall prevalence of smokeless tobacco use was somewhat higher among traders than among professionals, a lower proportion of traders than professionals in each of the various educational groups used smokeless tobacco (data not shown).

Occupation appeared to carry more weight in regard to men's tobacco use than that of women. Because a large proportion of the women in this sample were housewives and 45% were illiterate, it is not surprising that education was a more important indicator of socioeconomic position than current occupation. The "housewife" category provided insufficient information to adequately describe socioeconomic position because it included women living in a range of social and economic circumstances. In addition, education appeared to swamp any influence of occupation among women; for example, the odds of smokeless tobacco use were more than 20 times greater among women who were illiterate than among women with a college education.

Unemployment was a particularly powerful predictor of tobacco use. In the case of all comparisons, even those taking education into account, unemployed individuals were at the highest risk of using tobacco, a relationship that has been reported in other populations as well.[30–34] In addition, unemployment was most strongly associated with bidi use among men (OR = 3.5). Unemployment is an indicator of increased economic disadvantage and associated stressors such as poor housing conditions, unmet needs for food, and potential lack of social connectedness.[23,35] Expenditures on tobacco products have been found to represent a significant portion of the daily incomes of Indian residents in low income categories, including unemployed individuals.[36]

The present findings demonstrate the need, in studies assessing social disparities in tobacco use, to examine occupation and education separately as well as simultaneously. This will allow researchers to gain a more complete understanding of such disparities than might be the case when considering either indicator alone.[5] Others have noted the importance of considering multiple indicators of socioeconomic position in understanding patterns of tobacco use.[5,23,37] Education and occupation are likely to operate through differing pathways. Education is one of the most widely used indicators of socioeconomic position, given that it is easy to measure, applicable to individuals both inside and outside the labor force, and stable across the life course. It has consistently been shown to be a strong correlate of tobacco use, both in India and elsewhere.[5,10,11,15,22,24–26] Nonetheless, it may fail to capture some of the elements of socioeconomic position expressed by occupation; occupation may further indicate one's standing in the community, reveal aspects of the normative environment prevalent within one's occupational "culture," and serve as a marker for the general conditions present at one's workplace.[5,37]

Several caveats must be noted in interpreting our results. For example, our education and occupation data were based on self-reports. In addition, the complexities of obtaining, recording, and coding occupational data can lead to misclassification.[37–40] Furthermore, our occupational categories were combined into broad groupings, which could have contributed to biased estimates in terms of the gradients observed. Nonetheless, these groupings provided greater precision than those used in earlier tobacco use research in India; in these studies, occupation was grouped into even more general categories.[41] We collected data at the individual level, not the household level, and thus our data on socioeconomic position may have been incomplete, particularly in the case of women.[37] Future studies could include other indicators of socioeconomic position, such as caste or different standard of living measures.

In addition, as described earlier, the present data were collected as part of the initial data collection effort in a prospective cohort study; they were not part of a surveillance study designed to assess population prevalence rates of tobacco use. The sample was not a random or representative sample of the population. In particular, we excluded individuals who resided in upper-middle-class and upper-class housing complexes that were not accessible as a result of security issues. Thus, the proportions of individuals in different occupational categories might not have been comparable to the proportions in other cities or in India as a whole. Nonetheless, our findings provide important insight into the interrelationships between education, occupation, and tobacco use. Moreover, although the proportions of different occupation types and the prevalence rates of tobacco use may not have been representative of the general population, it is highly unlikely that the interrelationships observed would have been seriously affected by our sampling methods.

Identifying occupation- and education-specific disparities in tobacco use can provide a useful "signpost" indicating inequities that need to be addressed by policymakers and the broader community through allocation of resources.[42] Our results indicate that tobacco use in India follows a social gradient mirroring that reported for Western countries. If one is to shed light on patterns of disparities, it is important to consider multiple indicators of socioeconomic position, including both education and occupation, as well as gender. Additional research elucidating the differing pathways by which occupation and education may influence tobacco use can inform future policies and other interventions. ■

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Contributors

G. Sorensen conceptualized the analyses presented here and wrote the first draft of the article. P.C. Gupta participated in all aspects of the conceptualization and preparation of the article. M.S. Pednekar conducted all data analyses and participated in the preparation of the article.

Human Participant Protection

This study satisfied all criteria regarding the ethical treatment of human participants, including those formulated by the Indian Council for Medical Research. Participants provided informed consent.

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383

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Original Article

Establishing a model workplace tobacco cessation program in India

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Abstract

Background: Tobacco use is highly prevalent and culturally accepted in rural Maharashtra, India. **Aims:** To study the knowledge, attitude, and practices (KAP) regarding tobacco consumption, identify reasons for initiation and continuation of tobacco use, identify prevalence of tobacco consumption and its relation with different precancerous lesions, provide professional help for quitting tobacco, and develop local manpower for tobacco cessation activities. **Settings, Design, Methods and Material:** The present study was conducted for one year in a chemical industrial unit in Ratnagiri district. All employees (104) were interviewed and screened for oral neoplasia. Their socio-demographic features, habits, awareness levels etc. were recorded. Active intervention in the form of awareness lectures, focus group discussions, one-to-one counseling and, if needed, pharmacotherapy was offered to the tobacco users. **Results:** All employees actively participated in the program. Overall, 48.08% of the employees were found to use tobacco, among which the smokeless forms were predominant. Peer pressure and pleasure were the main reasons for initiation of tobacco consumption, and the belief that, though injurious, it would not harm them, avoiding physical discomfort on quitting and relieving stress were important factors for continuation of the habit. Employees had poor knowledge regarding the ill-effects of tobacco. 40% of tobacco users had oral precancerous lesions, which were predominant in employees consuming smokeless forms of tobacco. **Conclusions:** Identifying reasons for initiation and continuation of tobacco consumption along with baseline assessment of knowledge, attitudes, and practices regarding tobacco use, are important in formulating strategies for a comprehensive workplace tobacco cessation program.

Key words: Tobacco cessation, workplace, focus group discussions, oral screening, health awareness

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INTRODUCTION

Tobacco is one of the leading causes of disease and death in the world. It is responsible for a range of respiratory, cardiovascular, and reproductive tract disorders in addition to cancer of different sites in the body. In India, tobacco consumption is widely prevalent and culturally accepted. India has the highest number of oral cancer cases in the world, with tobacco being popular in smokeless forms as well. It is estimated that in the year 2005, 1,43,963 Indians would have been diagnosed with oral and pharyngeal cancers and 91,029 would have died of the disease.[1]

A tobacco-free policy at work protects nonsmokers from the harmful effects of tobacco smoke. The tobacco user receives positive peer influence from colleagues. As a large part of the day is spent at work, such a policy would help in reducing the frequency of tobacco use. This, however, may not lead to tobacco cessation among tobacco users in the absence of any support for quitting, as tobacco is highly addictive.

The department of Preventive Oncology at the Tata Memorial Hospital (TMH) initiated a workplace tobacco cessation program, considering the several advantages it has over a clinic-based setup. The workplace gives an opportunity to interact with a large number of people simultaneously, study tobacco-related work culture, and provides a stable population for follow-up. Some of the studies from western countries have analyzed the effect of smoke-free policies and different smoking cessation strategies at the workplace. We went a step further, and included both smoking as well as smokeless forms of tobacco in this workplace tobacco cessation program, which was more appropriate for the Indian setting.

384

The slogan for the World No Tobacco Day 2007 was "Smoke-Free Inside" which focused on making workplaces smoke-free. Our efforts went hand in hand to support the theme and a tobacco cessation program was initiated at the workplace in a chemical industry in rural Maharashtra, India. According to the Tata Memorial Hospital Cancer Registry, the majority of the men and women seeking treatment from Ratnagiri district, Maharashtra suffer from oral cancers. Data generated through the TMH community-based, rural outreach program also suggests a very high incidence of tobacco consumption in this region. Hence, one of the chemical industrial units in this area was selected to implement the workplace tobacco cessation program. Approval for the trial was received through the Scientific and Ethics Committee of the Tata Memorial Hospital and the trial was registered with clinicaltrials.gov with the registration number 458.

This program, which commenced on the World No Tobacco Day 2007, was planned for duration of one year. The long-term objective of this initiative was to formulate a Model Workplace Tobacco Cessation Program which could be replicated in other workplaces to promote tobacco control activities. The program aimed at studying the prevalence of tobacco consumption in its various forms among industrial employees and to provide professional help for quitting tobacco. The other objectives were to identify reasons for initiation and continuation of tobacco consumption habit, to assess the pre-intervention Knowledge, Attitude, and Practices (KAP) regarding tobacco consumption, compare with the post-intervention responses, and develop local manpower for tobacco cessation activities. In addition, the employees of the selected industry were screened for oral neoplasia and their findings were correlated with their tobacco habit. The present paper describes the detailed methodology and the initial findings. This will be followed another paper with the follow-up interventions and the overall results.

MATERIALS AND METHODS

This is an interventional cohort study of one year's duration among 104 employees working in a chemical industrial unit at Ratnagiri district in Maharashtra, India.

Inclusion and Exclusion Criteria

All 104 employees working in the selected chemical industrial unit were eligible to participate. There were no exclusion criteria.

Program commencement

The program was conducted with due permission and support from the management, union, and employees of the selected industry. The employees of the industry were offered an introductory session on the proposed tobacco cessation and oral cancer screening program. The aim and purpose of the program were explained and the employees were invited to participate. The program was inaugurated on 31st May 2007, the World No Tobacco Day, at the industrial unit. On the day prior to this, all employees took a pledge not to consume any form of tobacco on the 31st of May.

Enrollment of participants

Employees belonging to the industrial unit and who were willing to participate, were enrolled after signing the written informed consent form which was made available in English and also in the local language (Marathi).

The first session included an introductory lecture [Figure 1] and interviews of the employees to collect the pre-intervention data about various socio-demographic and risk factor variables. Diary cards in which the tobacco users were asked to record their daily tobacco consumption were introduced. All employees with or without tobacco habit were screened for oral neoplasia by naked eye visual inspection conducted by doctors. Visual inspection of the oral cavity is simple and acceptable[2,3] with a sensitivity ranging from 57.7–64%[4-6] in previous studies and a specificity ranging from 98.6 to 98.8%.[4,7] All employees using tobacco in smoking forms, were offered a smoke check by a hand-held, battery-operated device to measure the concentration of carbon monoxide in their breath. This easily operable instrument, though a good educational tool as the results are color-coded, has limited sensitivity and specificity and is unable to detect the use of smokeless tobacco products.[8]

The follow-up sessions were offered at an interval of six to eight weeks. During these sessions, professional help in the form of health awareness sessions, focus group discussion [Figure 2], one-to-one counseling, and pharmacotherapy was provided to the employees by a team of doctors and counselors from Tata Memorial Hospital. Self-reporting of tobacco history was validated with biochemical tests.

Capacity building

Medical and Nursing staff from the industrial medical unit and doctors and medical social workers from a local referral hospital were invited to participate as trainees during every active intervention session. This helped in local manpower development for future tobacco cessation activities in the local area. These trainees were also invited to participate in the tobacco cessation training workshop at TMH.

The data was computerized at the TMH. The socio-demographic characteristics and pre-intervention knowledge, attitude, and practices regarding tobacco use were analyzed among tobacco users and nonusers, and the groups were compared using a nonparametric test. The distribution of the overall prevalence of smoking and smokeless forms of tobacco use was calculated. The relationship of tobacco use

385

with oral lesions and reasons for initiation and continuation of the tobacco habit were analyzed.

This trial has received institutional IRB approval and is registered with ClinicalTrials.gov.

RESULTS

The program has been implemented for the duration of one year starting from 31st May 2007 and the results are very encouraging. All employees participated in the initial interviews and oral cancer screening. Among the 104 employees of the industry, 50 (48.08%) were current tobacco users. The different forms of tobacco used by employees are shown in Figure 3. Non-smoking forms of tobacco were predominant in the employees. Tobacco chewing was the most common form of non-smoking tobacco use. Fifty-four employees (51.92%) had never used tobacco. The differences in various socio-demographic characteristics between tobacco users and nonusers are shown in Table 1. There was no difference between tobacco users and nonusers with respect to age, education, income, religion, duration of service, and the presence or absence of shift duty.

The responses of tobacco users and nonusers regarding the knowledge of harmful effects resulting from tobacco use are shown in Table 2.

Many tobacco users were aware that tobacco was harmful, however, they were unsure about the intensity and type of damage that it caused. Although, 100% of the employees agreed that tobacco was injurious to health, only 37 employees (35.58%) knew all the ill effects of tobacco. The majority were only aware that tobacco caused cancer. Most (97%) employees identified passive smoking as being dangerous for health and 83% of the employees knew that tobacco was dangerous even when consumed infrequently. There was a significant difference in the knowledge regarding availability of professional help for quitting tobacco, with tobacco users being more aware of this fact. The employees had mainly received the information about harmful effects of tobacco from printed media, hoardings, television, the industry physician, and their family physicians.

On an average, the tobacco users spent Rs. 66.65 (1.39 USD), (Rs. 48 = 1 USD) every month on tobacco; among which, the employees using smoking forms were spending Rs. 293.33 (6.11 USD) per month, the employees using non-smoking forms spent Rs. 22 (0.46 USD) per month, and the employees using a combination of smoking and non-smoking forms spent Rs. 73.50 (1.53 USD) per month. The mean age at the initiation of cigarette smoking was 24.65 years and at the initiation of the smokeless tobacco habit was 27.51 years. The main reasons for the initiation of the tobacco habit by tobacco users [Figure 4] were peer pressure, miscellaneous factors like pleasure and imitation of others. The main reasons for continuation of tobacco use (Figure 5) were the belief that it would not harm them personally, to avoid physical discomfort on quitting, and to relieve stress. Fifteen employees (10.71%), of whom ten (20%) were tobacco users and five (9.26%) were nonusers had some family member, mainly siblings and parents, with the tobacco habit.

On oral examination, 20 employees were found to have oral precancerous lesions (18 had leukoplakias and two erythroplakias). The majority of the lesions were seen among employees using non-smoking forms of tobacco (two lesions among employees with smoking forms, 13 in employees with non-smoking forms, and five among employees using a combination). Among the 17 employees using smoking forms of tobacco, 13 employees had a Fagerstorm score of zero. Among 43 employees using non-smoking forms of tobacco, 32 employees had a Fagerstorm score of 4 and above. More lesions (80%) were seen among employees with a Fagerstorm score of 4 and above and using smokeless form of tobacco.

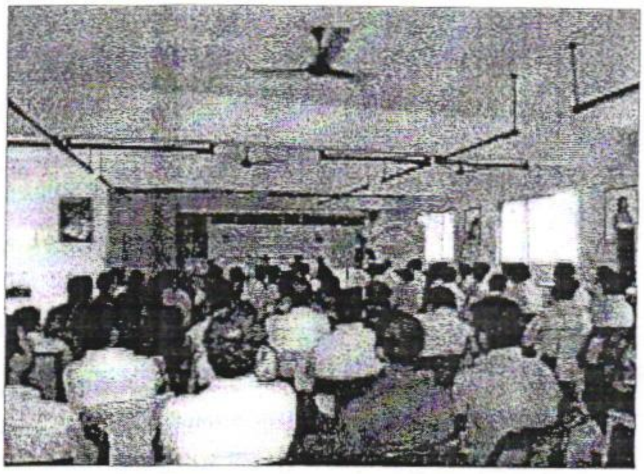

Figure 1: Health awareness lecture

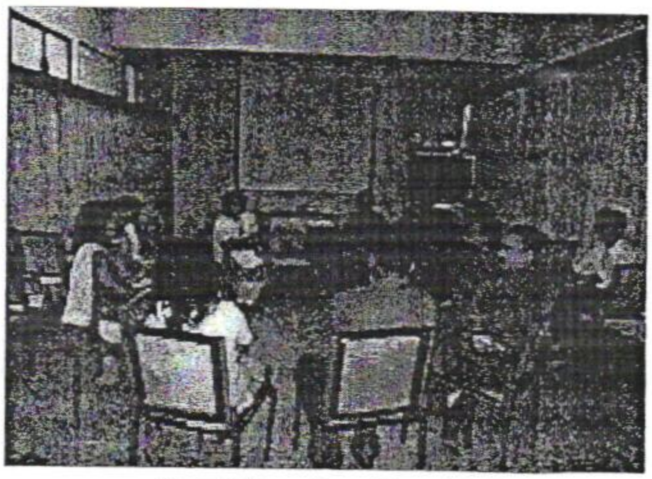

Figure 2: Focus Group Discussions

386

Table 1: Socio-demographic Characteristics of Participants In the Tobacco Cessation Program

Variables Total		Total Participants (%) 104	Tobacco non users (%) 54	Tobacco Users (%) 50	*P* Value
Age Groups (in years)	≤ 30	2 (1.92)	2 (3.7)	-	
	31–35	-	-	-	
	36–40	19 (18.27)	9 (16.67)	10 (20.00)	
	41–45	47 (45.19)	24 (44.44)	23 (46.00)	$\chi^2 = 2.2567$ $P=0.689$
	46–50	24 (23.08)	12 (22.22)	12 (24.00)	
	> 50	12 (11.54)	7 (12.96)	5 (10.00)	
Mean Age in years (SD)	43.28 (4.58)	43.5 (5.09)	44.3 (3.97)		
Education	Primary [1–4]	2 (1.92)	0 –	2 (4.00)	
	Secondary [5–10]	14 (13.46)	9 (16.67)	5 (10.00)	
	Jr. College [11–12]	19 (18.27)	8 (14.81)	11 (22.00)	$\chi^2 = 3.843$ $P=0.428$
	Sr. College [13–15]	35 (33.66)	19 (35.19)	16 (32.00)	
	Graduates and above	34 (32.69)	18 (33.33)	16 (32.00)	
Income per month	Rs. 10,000 – 20,000	30 (29.13)	16 (30.19)	14 (28.00)	
	Rs. 21,000 – 30,000	46 (44.66)	23 ((43.40)	23 (46.00)	$\chi^2=1.0205$ $P=0.796$
	Rs.31,000 – 40,000	19 (18.44)	11 (20.75)	8 (16.00)	
	> Rs.40,000	8 (7.77)	3 (5.66)	5 (10.00)	
Religion	Hindu	102 (98.08)	54 (100)	48 (96.00)	
	Muslim	1 (0.96)	– –	1 (2.00)	$\chi^2=2.202$ $P=0.332$
	Others	1 (0.96)	– –	1 (2.00)	
Duration of Service (in years)	< 5	2 (1.92)	2 (3.70)	0 –	
	5–10	1 (0.96)		1 (2.00)	
	11–15	8 (7.70)	6 (11.11)	2 (4.00)	
	16–20	45 (43.27)	25 (46.30)	20 (40.00)	$\chi^2=6.1608$ $P=0.187$
	21–25	48 (46.15)	21 (38.89)	27 (54.00)	
	> 25	–	–	–	
Presence of Shift Duty	Yes	65 (62.50)	33 (61.11)	32 (64.00)	$\chi^2=0.0924$ $P=0.761$
	No	39 (37.50)	21 (38.89)	18 (36.00)	

Table 2: Comparison of Pre-Intervention responses regarding harmful effects of tobacco in tobacco users and nonusers

Knowledge-based questions on tobacco Total Participants (104)	Employees who identified	Nontobacco users (%) the risk correctly (%)	Tobacco users (%)	*P* Value
Employees who identified tobacco as injurious to health	104 (100)	54 (51.92)	50 (48.08)	–
Employees who identified tobacco as risk factor for Cancer	99 (95.19)	53 (53.54)	46 (46.46)	$\chi^2=2.144$ ($P=0.143$)
Employees who identified tobacco as risk factor for Bronchitis	41 (39.42)	21 (51.22)	20 (48.78)	$\chi^2=0.0134$ ($P=0.908$)
Employees who identified tobacco as risk factor for Heart Attack	49 (47.16)	24 (48.98)	25 (51.02)	$\chi^2=0.3216$ ($P=0.571$)
Employees who identified tobacco as risk factor for Paralysis/Stroke	41 (39.42)	21 (51.22)	20 (48.78)	$\chi^2 = 0.0134$ ($P=0.908$)
Employees who identified tobacco as risk factor for wrinkling of skin, early aging, infertility in females and impotence among males	58 (55.77)	29 (50.00)	29 (50.00)	$\chi^2=2.517$ ($P=0.284$)
Employees who identified cigarettes, beedi, tobacco chewing, betel nuts, betel leaves with tobacco, paan masala, gutkha, hookah all as harmful	45 (43.27)	24 (53.33)	21 (46.67)	$\chi^2=0.0632$ ($P=0.802$)
Employees who identified filtered, low tar, low nicotine cigarettes as unsafe	57 (54.81)	28 (49.12)	29 (50.88)	$\chi^2=0.396$ ($P=0.529$)
Employees who identified passive smoking dangerous	101 (97.12)	54 (53.47)	47 (46.53)	$\chi^2=3.336$ ($v=0.068$)
Employees who knew that tobacco is dangerous even when consumed infrequently	86 (82.69)	45 (52.33)	41 (47.67)	$\chi^2=0.0322$ ($P=0.857$)
Employees who knew that professional help is available to quit tobacco	78 (75)	36 (46.15)	42 (53.85)	$\chi^2=4.160$ ($P=0.041$)

Other medical illnesses had nearly an equal distribution among the tobacco users and nonusers.

DISCUSSION

India is the second largest consumer of tobacco in the world, where tobacco is popular in smokeless forms as well. Literature on tobacco cessation is mostly from the western countries, which made it imperative to study it in the Indian context. The industrial unit described here had a No Tobacco Policy on its campus for over a period of 30 years, in spite of

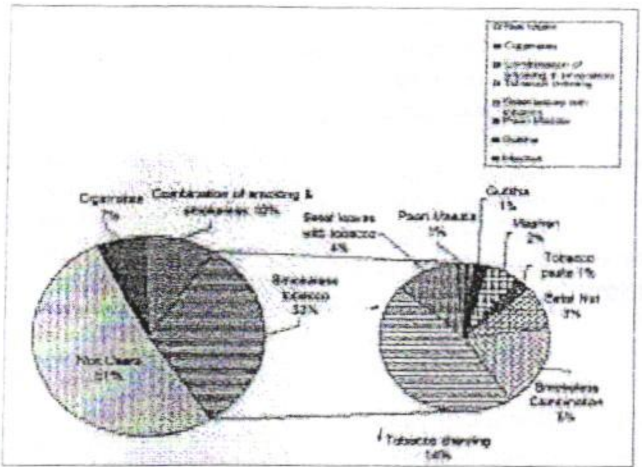

Figure 3: Prevalence of different forms of tobacco use

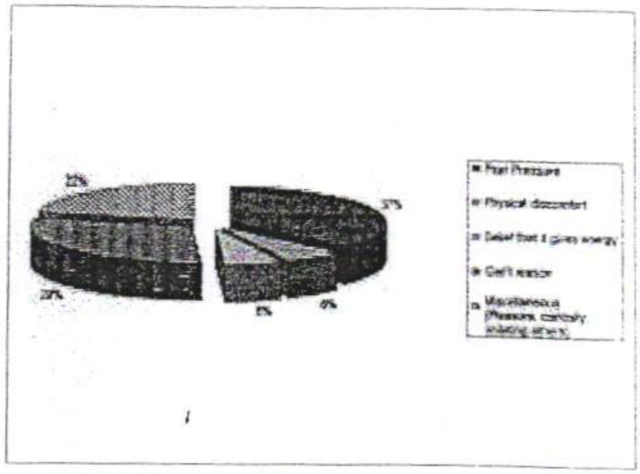

Figure 4: Factors responsible for initiation of tobacco habit

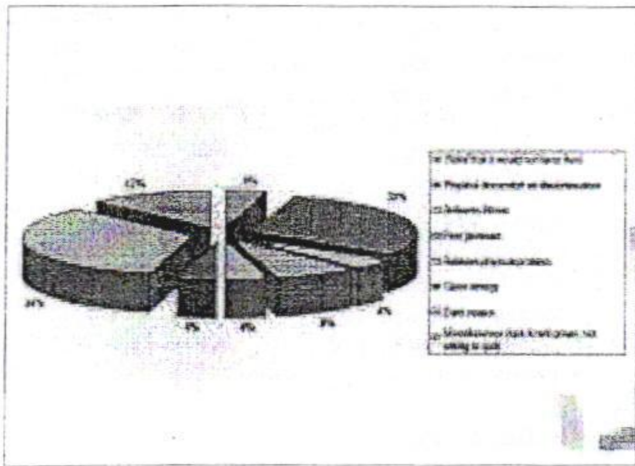

Figure 5: Factors responsible for continuation of tobacco habit

which a very high prevalence of tobacco consumption (48%) was recorded, indicating that tobacco-free workplaces may not result in tobacco cessation without any support for quitting. Tobacco use was mainly in the nonsmoking forms, reflecting the cultural practices of the community. In a study conducted among Indian men, 69.3% were found to be current tobacco users, among whom 23.6% were smokers.[9] In the Kerala community study, 72% of men and 6% of women were "ever users," i.e., had used tobacco at least once in their lives.[10] In Nepal, the overall prevalence of 'ever users' of tobacco products was 13.9% and of 'current users' was 10.2% among junior college students.[11]

The participation in the first session of interviews and the initial screen was 100%, indicating that employees accept tobacco cessation activities when conducted at their workplace. No difference was found in the socio-demographic profile between the tobacco users and the nonusers. This may be attributed to the fact that the employees belonged to the same cohort with similar socio-economic and religious backgrounds. The educational level was inversely associated with tobacco use of all kinds,[9,12-14] except cigarette smoking in a study in Mumbai.[9] In a survey in India, although no significant differences were seen in the prevalence of tobacco use among Hindu, Muslim, and Christian populations, the Sikh population, however, was found to have a significantly lower prevalence of tobacco consumption.[13] Use of smokeless tobacco products was high among Buddhists and low among Christians in Mumbai, while smoking was high among Muslims and Christians and low among Buddhists.[9] Tobacco use was seen to be more commonly associated with low socio-economic status[13,14] and scheduled castes and schedules tribes[13,14] in India. Tobacco use was also found to be correlated with occupation in Mumbai, with unskilled male workers, male service workers, and unemployed individuals being more at risk than professionals.[12]

In the present study, the employees were aware that use of tobacco including passive smoking was harmful, however, they could link only a few diseases like cancer to it. Most employees were unaware about the risk of tobacco on the respiratory and cardiovascular systems. Printed media, television, and doctors were the main source of this health information. Most students in Jaipur schools were aware that tobacco use was harmful and associated it as a major risk factor for respiratory diseases.[15] In rural Kerala, 96.6% of the participants knew that tobacco use was harmful for health, however, only 22.5% of the participants knew that it caused cardiovascular diseases.[16] Electronic and print media were the common source of this knowledge; only 20.6% subjects reported that health care workers were a source of such knowledge.[16] In Italy, the knowledge of risk associated with smoking was significantly higher in more educated subjects and in past smokers compared to current smokers.[17] According to an international tobacco survey in four countries, about 10% or more of smokers did not believe that smoking caused heart disease. Over 20 and 40% did not believe that smoking caused stroke and impotence, respectively. Higher education and income were associated with higher awareness.[18]

The average monthly expenditure on tobacco use in the current study's participants is Rs. 66.65 (1.39 USD), with employees using smoking forms spending significantly higher amounts as compared to the employees using smokeless forms. In a study in Nepal, the average daily expenditure on tobacco was 20 Nepalese rupees (~0.3 USD).[11] In Tehran, 41.8% of the population had daily smoking expenses of 2,510 to 4,500 Rials (1 Dollar = 9000 Rials) while the mean was 4,680 ± 388.78 Rials.[19]

The mean age at initiation of cigarette smoking was 24.65 years and at initiation of chewing tobacco was 27.51 years among these industrial unit employees. Survey data in Kerala suggest that the age at initiation of tobacco use appears to be falling.[10] The median ages at initiation of cigarette smoking and chewing tobacco were 16 and 15 years respectively among junior college students in Nepal.[11] The mean age of initiation of smoking was 21 ± 8.19 years in Tehran.[19]

Among the tobacco users in the present group of participants, peer pressure, pleasure and imitating others were the most important reasons for initiation of the tobacco habit, and the belief that tobacco would not harm them personally, avoidance of physical discomfort on discontinuation, and relief of stress were important reasons for continuation of the habit. Predisposing, reinforcing, and enabling factors associated with tobacco use behaviors among Cambodian Americans included peer group influences, smoking adopted as a coping method, tobacco used for medicinal purposes, and smoking practised within cultural traditions.[20] In the present study, 20% of tobacco users as opposed to only 9% of nonusers had some family member who consumed tobacco, suggesting that the tobacco habit is more common in families with addiction. In Jaipur, tobacco use was significantly more common in families of children who used tobacco.[15] The tobacco use habits of fathers and peers are significant influences on youth smoking.[10] Family members, teachers, and friends using tobacco products were correlated with tobacco use in Nepal.[11]

There is increasing and indisputable scientific evidence showing that tobacco is a major cause of chronic bronchitis, emphysema, and lung cancer, as well as a major risk factor for myocardial infarction, certain pregnancy-related and neonatal disorders, and a number of other serious health problems. It also has harmful effects on those who are involuntarily exposed to tobacco smoke.[21] In the present study, however, medical illnesses were equally distributed among the tobacco users and nonusers. In Helena, Montana, a study found that during the six months that the law that prohibited smoking in most workplaces was enforced, the number of admissions for acute myocardial infarction fell significantly.[22]

In the present study, 40% of tobacco users (19.23% of total employees) had oral precancerous lesions. The prevalence of oral precancerous lesions was more among tobacco chewers than among smokers. The severity of the lesion correlated well with the severity of addiction on the Fagerstorm score. The results of the Kerala study suggest that tobacco chewing is the most important risk factor for multiple, oral, premalignant lesions and dose-response relationships were seen for the frequency and duration of tobacco chewing with the risk of multiple, oral, premalignant lesions.[23]

CONCLUSIONS

This paper reflects the tobacco consumption practices among industrial employees in rural India. The unique feature of this program is that it aims at tobacco cessation and not just smoking cessation, a very important aspect for countries like India, where nonsmoking forms of tobacco use are predominant. Local manpower development for tobacco cessation was inbuilt within the program, to ensure continuation of assistance to the employees even after the study was complete, and to encourage similar activities in nearby industries. A very high rate of oral precancerous lesions detected for the first time among the employees, suggests that in spite of having good medical facilities, the employees are hardly ever examined for oral neoplasia. High tobacco consumption rates among employees of the current industrial unit with the No Tobacco policy indicates that tobacco cessation and awareness should be integrated within industrial health guidelines.

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389

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390

Annexure 11

Original article

Prevalence of Risk Factors for Non-Communicable Disease in a Rural Area of Faridabad District of Haryana

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Abstract

Background & Objectives: To estimate the prevalence and levels of common risk factors for non-communicable disease in a rural population of Haryana. ***Methods:*** The study involved a survey of 1359 male and 1469 female respondents, aged 15-64 years. Multistage sampling was used for recruitment (PHCs/ sub-centres/ villages). All households in the selected villages were covered, with one male and one female interviewed in alternate household. WHO STEP- wise tool was used as the study instrument which included behavioural risk factor questionnaire and physical measurements of height, weight, waist circumference and blood pressure. The age adjusting was done using rural Faridabad data from Census 2001. ***Results:*** The age adjusted prevalence of daily smoked tobacco was 41% for men and 13% for women. Daily smokeless tobacco use was 7.1% and 1.2% for men and women respectively. The prevalence of current alcohol consumption was 24.6% among men and none of the women reported consuming alcohol. The mean number of servings of fruits and vegetables per day was 3.7 for men and 2.7 for women. The percentage of people undertaking at least 150 minutes of physical activity in a week was 77.8% for men and 54.5% for women. Among men 9.0 % had BMI> 25.0 compared to 15.2% among women. The prevalence of measured hypertension, i.e. >140 SBP and/or >90 DBP or on antihypertensive drugs was 10.7% among men and 7.9% among women. ***Conclusion:*** The study showed a high burden of tobacco use and alcohol use among men, inactivity and overweight among women and low fruit and vegetable consumption among both sexes in rural areas.

Key words : Alcohol, BMI, Hypertension, Physical inactivity, Risk factors, Rural, Tobacco.

Introduction

Non- communicable diseases (NCDs) contributed 60% of deaths and 43% of global burden of disease in the year 2002, and by 2020, are projected to account for 73% of deaths and 60% of disease burden[1]. Clearly, NCDs can no longer be regarded as a problem confined to the developed countries and urban society. Affluence, progressive ageing of population, improving socio-economic conditions and changed life styles have caused an increase in non-communicable diseases and these are spreading to rural areas as well and these need to be documented to dispel myths that NCDs are a problem only in urban areas.

Together NCDs (cardio-vascular diseases, cancer, chronic obstructive pulmonary diseases and diabetes) accounted for 42.7% of deaths in 2000 in India[2]. These are linked by common risk factors related to lifestyle like tobacco use, unhealthy diet, physical inactivity, obesity, high blood pressure, raised cholesterol and glucose levels. These risk factors are measurable and largely modifiable and thus continuing surveillance of the levels and patterns of risk factors is of fundamental importance to planning and evaluating preventive activities in the control of NCDs.

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391

An integrated approach to risk factor surveillance is vital for NCD control. Surveillance of NCD risk factors as currently practiced in India has largely focused on separate risk factors like tobacco, alcohol or diet. Very few studies have been undertaken to assess physical activity. There is a felt need to have a comprehensive look at the NCD risk factors using standard methodology to ensure comparability. Such tools have recently been developed by WHO and are being used by health planners to generate evidence for advocacy.

Comprehensive Rural Health Services Project (CRHSP), Ballabgarh run by All India Institute of Medical Sciences (AIIMS) was among the sites where it was pilot tested and later became a part of the multicentric surveillance site coordinated by Indian Council of Medical Research (ICMR). As part of this we studied a rural population of Haryana for prevalence of common risk factors of NCDs using WHO STEPS approach. We report the results of this survey here.

Material and methods

We conducted a survey in the rural area of Ballabgarh, in Faridabad district of Haryana from April 2003 to January 2004. A total of 2500 participants were aimed at, with 250 in each age (15-24, 25-34, 35-44, 45-54 and 55-64) and sex group. Multistage sampling was used for the purpose of recruitment. Two PHCs were selected randomly from among a total of 5 PHCs in the block. Thereafter, one sub-center in each PHC was selected randomly. One village was randomly selected from the list of villages in the sub-center. If the village was small, an additional village was selected from the same sub-center. All the households in the selected villages were covered, with one male and one female being interviewed in alternate households. The selection of the male/female was from the list of eligible in that house and was done in a random manner. If need be, the household was revisited a second time at least one of which was on a different day/time.

The WHO STEP-wise tool was used and the behavioural risk factor Questionnaire was suitably modified and translated in local language. It included questions on socio-demographic status, data on tobacco and alcohol use, measures of dietary habits and physical inactivity. Standard procedure was followed as per STEPs protocol for anthropometric and blood pressure measurements. The height was measured using adult portable stadiometer to the nearest 0.1 cm. SECA digital weighing scales were used to measure weight of the individuals and was recorded in kilograms up to 0.1 kg. A SECA constant tension tape was used to measure Waist circumference to the nearest 0.1 cm. The blood pressure was measured using OMRON digital automatic blood pressure monitor. All measurements were done at domiciliary level. Three male and three female workers were trained by a team of ICMR and were regularly supervised by the investigators and ICMR team.

Definitions: (Source- WHO STEPS manual[3])

Current daily smokers were defined as those who were currently smoking cigarettes, bidis or hookah daily.

Current daily smokeless tobacco users were defined as those who were currently using chewable tobacco products, gutka, naswar, khaini or zarda paan daily.

Current alcohol drinkers were defined as those who reported to consuming alcohol within the past one year.

One standard drink was equivalent to consuming one standard bottle of regular beer (285 ml), one single measure of spirits (30 ml) or one medium size glass of wine (120 ml).

One serving of vegetable was considered to be 1 cup of raw green leafy vegetables, ½ cup of other vegetables (cooked or chopped raw) or ½ cup of vegetable juice.

One serving of fruit was considered to be 1 medium size piece of apple, banana or orange, ½ cup of chopped, cooked, canned fruit or ½ cup of fruit juice, not artificially flavoured.

Physical inactivity was defined as less than 10 minutes of activity at a stretch, during leisure, work or transport.

Body mass index (BMI) was calculated by dividing the weight (in kilograms) by square of height (in meters). Overweight was defined as BMI ³ 25 and < 30

Obesity was defined as BMI ≥ 30

Hypertension was defined as BP ≥ 140/≥ 90 or currently on antihypertensive drugs.

Ethical clearance for the study was obtained from AIIMS. Written informed consent was obtained from each participant. The results of the measurement were provided to the respondents and all case needing referral were referred to the Civil Hospital at Ballabgarh to consult a physician. Data were entered simultaneously. An independent data entry operator did the reentry of 10 percent data and these were validated. The data was analyzed using SPSS for windows (version 10.0). The age standardized percentages for the target age group were computed using rural Faridabad data from Census 2001.

Results

A total of 1359 men and 1469 women were included in the survey. Among the men, majority were unskilled or landless labourers (23.95%). Of the women, 96% were housewives. About 38% of the men had studied up to high school, as against 11.1% who had never been to school. Majority of women had never attended school (56.6%), while only 10% had studied beyond 8th standard.

Tobacco & alcohol use (Table 1)

The age-adjusted prevalence of daily smoked and smokeless tobacco use in men was 41.0% and 7.1% respectively. The same for women was 13.0% and 1.2% respectively. For men, smoked tobacco use was highest in 45-54 years age group, whereas smokeless tobacco in the forms of khaini, gutka, snuff and chewed tobacco was most prevalent in 25-34 years age group. There was a steep rise in daily smoking of tobacco after 24 years of age from 9.4% in 15- 24 years age group to 46.6% in 25- 34 years age group. Thereafter there was a gradual rise to a peak of 72.2% at 45-54 years age group. The prevalence then showed a decline in the later age group. For women both smoked and smokeless tobacco use was more common in the older age group of 55-64 years. The median age for starting to smoke among men was 20.0 yrs (IQR 17.0-25.0), while the median duration of smoking was 20.0 yrs (IQR 10.0-29.4). The median age for starting to smoke among women was 31.0 yrs (IQR 25.0-40.0), while the median duration of smoking was 12.9 yrs (IQR 5.0-22.0). Smoking tobacco in the form of bidis was the most common with the mean number of bidis smoked per day among men being 6.1 and among women being 0.7. Khaini was the commonest form in which smokeless tobacco was consumed, among both men and women.

None of the women reported consuming alcohol. The prevalence of ever alcohol consumption among men was 29.0% and that of current alcohol consumption was 24.6%. The difference between the two was maximum at the age of 55-64 years. The prevalence was highest in the 35-44 years age group. The current alcohol consumers comprised 84.8% of

Table 1. Prevalence of tobacco use and alcohol use by age & sex

Age in years	Men		Women		Men*	
	Daily smoked tobacco use (n=1359)	Daily smokeless tobacco use (n=1359)	Daily smoked tobacco use (n=1469)	Daily smokeless tobacco use (n=1469)	Ever alcohol consumption (n=1359)	Current alcohol consumption (n=1359)
15-24	9.4%	6.5%	0.4%	0.4%	10.0%	9.4%
25-34	46.6%	10.1%	7.3%	0.2%	32.8%	29.7%
35-44	63.8%	6.8%	18.2%	1.7%	47.5%	41.5%
45-54	72.2%	4.9%	34.5%	1.8%	44.1%	34.8%
55-64	67.4%	4.3%	38.7%	4.9%	36.2%	20.2%
Age adjusted prevalence**	41.0% (38.4-43.7)	7.1% (5.8-8.6)	13.0% (11.3-14.8)	1.2% (0.6-1.8)	29.0% (26.5-31.4)	24.6% (22.3-27.0)

* None of the women reported alcohol consumption, **95% CI values in parenthesis

393

Table 2. Pattern of physical inactivity by domains

Age in years	Men Leisure (n=1359)	Men Work (n=1359)	Men Transport (n=1359)	Women Leisure (n=1469)	Women Work (n=1469)	Women Transport (n=1469)
15-24	79.2%	71.4%	15.5%	95.4%	74.1%	54.9%
25-34	89.7%	50.9%	21.0%	99.5%	55.5%	41.1%
35-44	87.5%	43.8%	20.0%	97.3%	39.7%	30.6%
45-54	87.0%	49.1%	19.3%	97.0%	57.1%	41.1%
55-64	90.4%	58.5%	23.2%	98.4%	71.8%	67.5%
Age adjusted Total (95% CI)	85.2% (83.1-86.9)	57.2% (54.4-59.8)	18.8% (16.7-20.9)	97.3% (96.3-98.0)	59.9% (57.4-62.4)	45.7% (43.1-48.2)

those who had ever consumed alcohol. The mean number of drinks consumed in the past 7 days was 12.0 (95% CI 9.2- 14.9). This was highest in the age group 45- 54 yrs. A total of 4.6% men consumed, more than or equal to 5 drinks on any day, in the last week.

Men were consuming more fruits and vegetables than women in any age group. The mean number of servings of fruits and vegetables per day was 3.7 (95%CI 3.6-3.8) for men and for women, it was 2.7 (95% CI 2.6-2.8). The proportion of men consuming >5 servings of fruits and vegetables per day was 6.6%, while only 1.8% women reported to consuming this much amount. Across the age groups, mean number of servings of fruits and vegetables consumed per day were similar. The mean number of days in a week when fruits were consumed was 2.05 (95% CI 1.93-2.16) for men and for women was 1.46 (95% CI 1.36-1.56).

Physical inactivity (Table 2)

The physical inactivity was highest during leisure time and was least during transport from one place to another for both men and women. The percentage of people undertaking at least 150 minutes of physical activity in a week was lesser for women (54.5%) than for men (77.8%) among all age groups. Such level of physical activity was highest in the age group 35-44 years (81.9% and 72.9% for men and women respectively) and lowest in 55-64 years age group (70.2% and 37.9% for men and women respectively). The mean duration of physical activity in minutes for all male subjects for a week was 1103.6 (95%CI 1068.5-1192.7) and 781.4 (95%CI 730.9-832.0) for all women. This was more in the age group 35-44 years for both men and women.

Table 3. Distribution BMI & waist circumference by age & sex

Age in years	Men (n=1359) Mean BMI (95%CI)	Men (n=1359) Mean waist circumference (95%CI)	Women (n=1362) Mean BMI (95%CI)	Women (n=1362) Mean waist circumference (95%CI)
15-24	19.7(19.4-20.0)	72.2(71.5-72.9)	19.6(19.3-19.8)	68.7(68.0-69.4)
25-34	20.7(20.4-21.0)	77.8(76.9-78.8)	20.3(20.0-20.7)	71.9(71.0-72.9)
35-44	21.0(20.6-21.4)	81.5(80.2-82.7)	22.0(21.5-22.5)	77.4(76.0-78.7)
45-54	21.0(20.5-21.6)	82.6(80.9-84.3)	22.9(22.2-23.6)	81.1(79.2-83.0)
55-64	20.7(19.9-21.5)	82.3(79.9-84.7)	22.421.5-23.3)	83.4(81.2-85.7)
Age adjusted mean	20.4(20.2-20.6)	77.4(76.9-77.9)	21.0(20.7-21.2)	74.3(73.7-74.9)

394

Table 4 . Prevalence of thinness, overweight and obesity in the study subjects

Age Group	Male (n=1359) BMI<18.5 (%)	BMI 18.5-24.9 (%)	BMI ≥25.0—<30.0 (%)	BMI ≥30 (%)	Female (n=1362) BMI<18.5 (%)	BMI 18.5-24.9 (%)	BMI ≥25.0—<30.0 (%)	BM ≥30.0 (%)
15-24	36.3	59.8	2.9	1.0	37.2	57.5	5.3	0
25-34	21.9	69.5	7.5	1.2	32.8	56.3%	9.7%	1.2%
35-44	25.8	61.3	10.6	2.3	22.2	54.7%	17.9%	5.2%
45-54	25.6	59.5	13.0	1.9	16.8	52.7%	21.6%	9.0%
55-64	33.0	51.0	13.8	2.1	24.2	48.4	19.4	8.1
Age adjusted prevalence*	29.1 (26.0-30.9)	61.9 (59.6-64.8)	7.5 (6.1-9.0)	1.5 (1.1-2.6)	29.1 (26.2-31.3)	55.8 (52.9-58.3)	12.1 (10.7-14.2)	3.1 (2.4-4.3)

* 95% CI values in parenthesis

Anthropometry (Table 3 & 4)

A total of 107 women were found to be pregnant and these were excluded for anthropometric examinations. Both mean BMI and waist circumference was highest in 45-54 years age group for men. For women, the mean waist circumference was highest in 55-64 years, while mean BMI was highest in 45-54 years age group. There was an increase in BMI among women as compared to men after 25-34 years of age group and thereafter for all age groups; obesity was more common in women. Across all age groups overweight was more common among women than men. The prevalence of underweight was similar for both men and women. After 35 years of age overweight and obesity combined was more than thinness among women while thinness was consistently more prevalent than overweight and obesity combined, for all age

Table 5. Distribution of mean systolic & diastolic BP & % hypertensive by age & sex

Age in years	Men Mean systolic BP (95% CI)	Mean diastolic BP (95% CI)	% Hypertensive (≥140/≥90 or on antihypertensive)	Women Mean systolic BP (95% CI)	Mean diastolic BP (95% CI)	% Hypertensive (≥140/≥90 or on antihypertensive)
15-24	120.6 (119.6-121.6)	70.4 (69.7-71.2)	4.9	110.2 (109.2-111.2)	66.4 (65.6-67.1)	1.5
25-34	118.5 (117.2-119.7)	72.8 (71.8-73.8)	7.1	109.0 (107.8-110.1)	68.4 (67.4-69.4)	2.9
35-44	118.5 (116.7-120.4)	75.6 (74.4-76.9)	12.6	111.9 (110.3-113.6)	71.4 (70.2-72.6)	7.3
45-54	123.0 (120.4-125.5)	78.1 (76.3-79.8)	21.9	121.6 (118.6-124.6)	75.5 (73.7-77.3)	22.4
55-64	127.0 (122.4-131.6)	76.2 (73.7-78.8)	30.1	131.2 (127.3-135.1)	76.1 (74.2-78.0)	30.9
Age adjusted mean	120.4 (119.6-121.1)	73.4 (72.8-73.9)	10.7 (9.0-12.4)	113.3 (112.5-114.1)	69.8 (69.3-70.3)	7.9 (6.6-9.4)

395

groups among men. A total of 2.2% of men had waist circumference ≥ 102 cm, which was most commonly seen in the 55-64 years age. This was against the cut-off for women of ≥ 88 cm which was seen in 13.2%. Again it was more common in the 54-65 years age group.

Blood pressure (Table 5)

The prevalence of self- reported hypertension was 3.5% in men and 6.8% in women, whereas the prevalence of hypertension (defined as BP ≥ 140/90 or currently on antihypertensive drugs) was 10.7% in men and 7.9% in women. The mean systolic and diastolic blood pressure among men was 120.4 mmHg and 73.4 mmHg respectively. The same among women were 113.3 mmHg and 69.8 mmHg respectively. There was a sharp increase in prevalence of hypertension among women after 35-44 years age group. The huge male and female difference in younger age groups disappeared post menopause. The prevalence of self-reported diabetes was 0.7% among men and 0.5% among women and showed an increasing trend with age.

Discussion

Our study presents the burden of major NCD risk factors, in a rural area, using WHO STEPS approach. This is among the first sites to use this comprehensive approach to measure the NCD risk factor burden. It was not the purpose of this survey to compare this burden with other risk factor specific surveys done by different people at different places at different times etc. However, some limited comparison from other surveys would be meaningful to get an insight into the burden at national level.

Tobacco use in India is high and there are considerable differences in the types and methods by which it is used. A prevalence of 41% of daily smokers among men was similar to that reported by NFHS 2 for Haryana (40.6%)[5], but in women our finding of 13% is much higher than that of NFHS 2 (3.6%). The prevalence of ever smokers in NFHS 2 was 42.4% and 3.8% for men and women respectively. A survey of tobacco use in Karnataka and Uttar Pradesh (UP) found the prevalence of ever smoking in Karnataka to be 33.1% among rural men and 0.6% among rural women[4]. The prevalence of current smoking was 31.2% and 0.6% among rural men and women respectively. In UP, the prevalence of ever smoking was 28.3% among rural men and 2.9% among women. Current smoking showed a prevalence of 28.2% and 2.8% among men and women respectively. Similar to our study, others have also found that khaini and bidis to be the commonest form of tobacco use [4-6]. The difference between ever use and current use was small, suggesting that tobacco use once initiated, is continued and quitting of tobacco use is infrequent.

The steep rise in alcohol consumption from 9.4% in 15-24 years age group to 29.7% in 25-34 years age group could be due to the economic independence gained during this time in life. The consumption rose to a peak of 41.5% in 35-44 years age group, and gradually declined thereafter. Most of the men who reported to having consumed alcohol ever in life, had also done so in the last one year indicating that few people quit alcohol. Our prevalence rates were similar to that of NFHS 2 for Haryana[5] (20.7% for men and 0.1% for women) but lower than a previous study conducted in Punjab, which reported a prevalence of 58.3%[7] for men and 1.5% for women. In our study, women did not report to consuming alcohol- a finding that has also been shown by other studies [8,9].

Our study showed that women have a poorer dietary pattern than men for all the age groups, which may be a reflection of their poor social status[10,11]. It is ironical that a low vegetable consumption is prevalent in a predominantly vegetarian community. Developing countries are undergoing various types of transitions-epidemiological, socio-economic, demographic and nutritional. Earlier developing countries had a high prevalence of under-nutrition, but this era of transition has also brought a double burden of under-nutrition and over-nutrition in these countries[12]. Recent data from NFHS 2 identified a significant proportion of Indian women as overweight, coexisting with high rates of malnutrition. However, the survey was confined only to married women in reproductive age group and showed a prevalence rate of 2.2% for women aged 15-49 years using BMI>30.0 The only representative surveys are the ones conducted by the Food and Nutrition Board (i.e. District Nutrition Profiles survey) [13], which have reported prevalence of 0.3% and 0.7% in rural men and women respectively, using a BMI cut-off of >30.0. The present study showed that 1.5% men and 3.1% women have obesity. Our study draws attention to the fact that there exists a pool of women who were overweight in rural areas.

Our study showed that physical inactivity was more common among women across all domains. Maximum physical inactivity was during leisure time while most men were physically active during transport. This could be due to the fact that in rural areas bicycles or walking are the still the usual mode of transport.

Physical activity measurement at community level is difficult with the existing instruments and therefore these results would need to be interpreted with caution. However it does appear that contrary to general impression, physical inactivity is an emerging cause of concern in rural areas of India.

Our findings show a high burden of hypertension among elderly population. Men had a higher prevalence than women in all age categories. Our finding of 10.7% prevalence of hypertension in men and 7.9% in women is lower than that observed in other studies[14]. In a population-based survey carried out during 1994-1995 in Raipur Rani block in the state of Haryana, 4.5% were found to be hypertensive[15]. Women had significantly higher prevalence of hypertension than men (5.8% vs 3.0%). This is contrary to our finding of lower prevalence of hypertension in women as compared to men across all age groups.

Conclusion

Our study confirms the high burden of NCD risk factors in rural areas and reiterates the need to address these issues comprehensively as a part of NCD prevention and control strategy. STEPwise approach of WHO offers an entry point for low and middle income countries to initiate NCD surveillance, as it allows for the development of a flexible, increasingly comprehensive and complex surveillance system depending on local needs and resources[3]. Further surveys are recommended based on this approach to ensure data comparability over time and between different sites. It is also important to study trends of various risk factors and Ballabgarh offers a sentinel site for such activity to be conducted in future.

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397

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Smokeless Tobacco Use and Its Implications in WHO South East Asia Region

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The term **'smokeless tobacco'** is used to describe tobacco that is consumed in un-burnt form. Smokeless tobacco can be used orally or nasally. In the nasal use, a small quantity of very fine tobacco powder mixed with aromatic substances called dry snuff is inhaled. Oral use of smokeless tobacco is widely prevalent in the South East Asia Region; the different forms include chewing, sucking and applying tobacco preparations to the teeth and gums.

Smokeless tobacco use in South Asia raises various concerns. Smokeless tobacco contains several carcinogenic compounds. About 35–40% of tobacco consumption in India is in smokeless forms, mostly of the species Nicotiana rustica, while most smoking tobacco is Nicotina tabacum. Samples of N. rustica have been found to contain higher concentrations of tobacco-specific nitrosamines than N. tabacum.

Prevalence among adults

Prevalence of smokeless tobacco use in South East Asia varies from country to country in the WHO South East Asia Region; from 1% in Thailand and Indonesia to 25% in Bangladesh (Table1). Prevalence of smokeless tobacco use also varies within different regions of one country; for example in India it varies from 7.2% in Jammu and Kashmir to 80.3% in Mizoram.

Projected Prevalence of smokeless tobacco use in South East Asia was calculated on the basis of WHO reports and other relevant studies conducted in different member countries. Among 1.5 billion Southeast Asians, over 250 million people use smokeless tobacco products: about 17% of total population in Southeast Asia uses oral tobacco; of which 95% belong to India (82%) and Bangladesh (13%)(Table1).

Table-1: Smokeless tobacco use prevalence among adults in South East Asia

Country	Prevalence reference used for projection	Present smokeless tobacco use	Population 2001	Projected number of smokeless tobacco users
Bangladesh	Rahman et al[1] 2004	25	1374390000	34359750
India	NFHS[2]	28.3 M 12.4 F	531277078 495738169	150351413 61471533
Indonesia	WHO, 2001[3]	1	212092000	2120920
Myanmar	WHO, 2001[4]	15	47749000	4774900
Nepal	WHO, 2001[5]	10	23043000	2304300
Srilanka	WHO, 2001[6]	10	18924000	1892400
Thailand	WHO, 2001	1	62806000	6280600
SEA Region	Projection[7]	16.9	1529068247	257903276

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Prevalence among youth

In countries of South Asia, traditional values do not favor smoking by the young , but there is no such taboo against using smokeless tobacco.

According to the Global Youth Tobacco Survey, prevalence of smokeless tobacco use among young on students (13-15 year) in Southeast Asia ranged from 4% in Bangladesh to 20.4% in Myanmar [8-11](Table2). There was no statistical difference in smokeless tobacco use among boys and girls in Bangladesh and Myanmar (Table2) indicating changing social norms in SEA. Prevalence of smokeless tobacco use varies within different regions of one country; for example in India it varies from 2% in Himachal Pradesh to 55.6% in Bihar. The use of tobacco products as dentrifice among school going children is a special problem in India. GYTS data indicates that prevalence of use of tobacco products as dentrifice among school going children varies between 6% (Goa) to 68% (Bihar) [12].

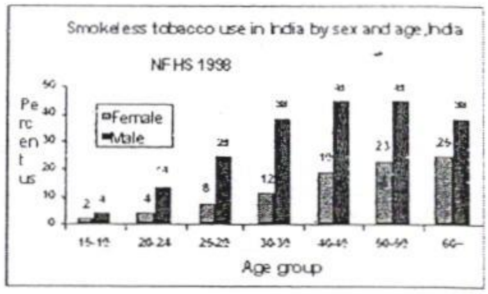
Among disadvantaged youth group high (45%-71%) prevalence of tobacco use was reported in Southeast Asia[7]

Table-2: Current use of smokeless tobacco among students (13-15 years) in SEA;GYTS, 2000-03

	India	Nepal	Myanmar	Bangladesh
Total	14.6 (±1.5)	9.3 (±2.5)	20.4 (±2.7)	4.0 (±0.7)
Male	18.5 (±2.1)	11.8 (±2.8)	35.4 (±4.2)	3.9 (±0.8)
Female	8.4 (±1.9)	5.6 (±3.5)	6.6 (±1.8)	3.5 (±1.1)

Tradition among women

While more and more young girls are taking up smoking in urban areas, women in rural areas still prefer smokeless form of tobacco and most women who initiate tobacco, use it in smokeless forms



Increasing Trend

Increasing use has been reported not only among men, but also among such vulnerable groups as children, teenagers, women of reproductive age and by immigrants of South Asian origin wherever they have settled. In India, per capita smokeless tobacco consumption has increased among the poor between 1961 and 2000 in both rural and urban areas[13]. Though there is no statistical report of increasing use of Smokeless tobacco products through years in Nepal; report of Customs Department of the Ministry of Finance, Nepal, suggesting 87 times increase in import of smokeless tobacco products within three years[6], is an indication of increasing trend in Nepal. In Bhutan, tobacco consumption trend has changed from that of smoking to other forms like oral use. Sacks of 'Baba' are on sale in the vegetable market at Thimphu. Many people, including young boys and monks chew 'Baba' and scented khaini. Evidence for a trend toward increasing use of tobacco and areca nut products like *gutka, pan masala and* tobacco toothpaste by youth has been gathered in several recent studies[7]

The WHO and other Studies throughout region,[1-7] revealed that use of smokeless tobacco products was mainly a rural phenomenon seen more among males with decreasing trend of current use with higher education and socioeconomic level.

Smokeless (Oral & Nasal) tobacco products

A. Chewing

1. Betel quid with tobacco:

   Tobacco is the most important ingredient of betel for regular users in Bangladesh, India, Myanmar and Nepal. In Indonesia tobacco is used as part of the mixture chewed with sirih (betel);practiced for the most part in rural areas.Various tobacco preparations used in betel quid are:Tobacco Leaf – Kaddipudi(South India), Hogesoppu, Gundi(Orissa, India),Zarda(various brands in Bangladesh, India, Myanmar and Nepal), Qiwam Various brands in Bangladesh and India); Hnatsay (Honey Soaked Tobacco) one of the special products used in Myanmar; Betel quid masala (betel quid) Pan masala:

2. Tobacco and slaked lime (khaini) ,

3. Tobacco, areca nut and slaked lime preparations; Examples are Gutka(India, Nepal, Bangladesh) Mainpuri tobacco(India) Mawa(India) Dohra (Uttar Pradesh,India). Recently, varieties of Gutka is being produced industrially on a large scale commercially marketed and are available even in small plastic and aluminum foil. New forms of smokeless tobacco have been emerging over the last few decades, enticing new consumers.

B. Applying Tobacco:

Several oral tobacco preparations such as *mishri, gudhaku, bajjar* Red Tooth Powder - Lal Dantmanjan and creamy snuff, are intended primarily for cleaning teeth. Such use, however, soon becomes an addiction.

C. Sipping/Sucking Tobacco Products:

Tobacco water (Known as Tuibur in Mizoram and Hidakphu in Manipur) is sipped and retained in mouth for 5-10 minutes and then spat out. In general, in one sip usually 5 -10 ml tobacco water is kept within mouth It is either sipped directly from bottle or through cotton soaked with Tobacco water

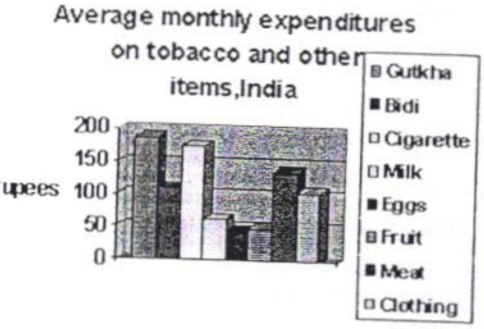
B. Inhaling Tobacco Products:

Include products used nasally, common practice in WB and Bangladesh

Awareness of the hazards of smokeless tobacco use is very low in rural populations and many believe tobacco has curative or palliative effect for common discomforts such as toothache, headache, and stomachache. This often leads to advice for initiating tobacco use from adults to other non-users, even children[14].

Hazards of Smokeless Tobacco Products use in SEA

Many of the risks to health and life caused by tobacco consumption develop over a long period, and take decades to become fully evident but tobacco use also inflicts immediate harm on users and their families. Scarce family resources are spent on tobacco products instead of on food, or other essential needs. Each tobacco user represents one or more people whether the user or his or her spouse or child who is needlessly going hungry. The national household expenditure survey in India in 1986-87 found that between 2.5-4% of all household expenditures were for tobacco, pan, and intoxicants; the percentage was highest for the lowest income urban households[15-17]. Path Canada, India project study, found that disadvantaged adolescents use tobacco at the cost of their meals - spending on gutka purchase the money which they could have spent for buying eggs. [16]



Source [16]

Smokeless tobacco use in South East Asia may be considered as a potent contributor to mortality. The evidence from three cohort studies in India indicates that the age-adjusted relative risk of mortality for users of smokeless tobacco is elevated compared to that of non-tobacco users[18].

The major health consequences associated with smokeless tobacco use in Southeast Asia include cancers of several sites (e.g. the upper respiratory and digestive tracts), and poor reproductive outcomes. The significance of the interaction between alcohol and tobacco in causing head and neck cancers and genotoxicity is well documented[19] In India, the number of newly diagnosed tobacco-related cancers has been estimated at approximately 250 000 out of a total of 700 000–900 000 new cancers diagnosed each year[20]. Tobacco-related cancers account for about one-third of all cancers in Bangladesh, India and Sri Lanka. Significant dose–response trends were observed for frequency of chewing per day in many studies, and for duration of habit in some of them[21]. Retention of the quid overnight, showed a 36-fold increased risk. In case series studies[22] from Bangladesh and Myanmar, the site of origin of the majority of the lesions corresponded with the site maximally exposed to betel quid, usually in the buccal mucosa. There are some research results on the impact of smokeless tobacco on blood pressure and cardiac disease[23-25].

Adverse reproductive outcomes from smokeless tobacco use during pregnancy have been well documented. Many studies, including WHO SEA Region study clearly pointed out significantly higher percentage of lower gestation period, lower birth weight and increased male fetus wastage among smokeless tobacco users[26-28].

Recommendations for Control of Smokeless Tobacco Products

Smokeless tobacco is promoted intensively in India; In Bangladesh, Myanmar and Sri Lanka promotion is not very visible however in Nepal it is visible to some extent. Betel chewing promotion is mainly through culture but its tobacco ingredients especially zarda are heavily promoted in India. Gutka is the most advertised smokeless tobacco product. They are promoted through all media and influence the youth and people at large

The WHO FCTC covers the whole gamut of tobacco products – both smoking and smokeless. Some of the Member Countries in the Region have formulated comprehensive tobacco control legislation[29] covering all types of tobacco products. For a stronger global and regional tobacco control it needs to be enforced vigorously

In Southeast Asia, especially there is evidence of demonstrable feasibility and efficacy of anti-tobacco education for the community through controlled intervention studies in areas with high prevalence of tobacco chewing. WHO initiatives for Community Cessation Intervention have shown that it is feasible, cost effective and sustainable[30]. The government and non-governmental agencies to help over 250 million smokeless tobacco users to quit should establish more community based cessation intervention.

There is need for bringing about a change through appropriate IEC interventions in the widespread belief that smokeless tobacco use is less harmful than smoking Due to lack of information many thousands pregnant women continue with smokeless tobacco use during pregnancy. Actually smoking is supposed to be dangerous for pregnancy so both females and male smokers switch over to smokeless tobacco during the pregnancy. There is a paucity of communication material on the effects of smokeless tobacco.

Keeping in mind the high quality of tobacco advertising that commands the attention of the public, skilled media professionals should work with health professionals and health authorities in preparing attractive communication material, in simple language with unequivocal meaning, incorporating messages about all forms of smokeless tobacco and smoking. Anti-tobacco education must be imparted through schools, hospital outreach programs, existing government health programs such as maternal and child health programs and routine home visits, using suitable materials. Suitable programmes and activities should be developed targeting rural people, in particular the women who use the smokeless tobacco products most.

The tobacco control measures, including national tobacco control legislation in some countries in the Region do not address the problem posed by smokeless tobacco products. These measures and legislation need to be revised or amended in order to control the smokeless tobacco products under the law and in line with the provisions of the WHO FCTC.

402

'Smokeless tobacco use' need to be given a priority during planning and management of comprehensive tobacco control; Smokeless tobacco control should move parallel to control on smoking tobacco products in all respect such as product information, proper warning; price increase etc. .

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403

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404

Annexure 19

Tobacco habit in northern India.

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J Indian Med Assoc. 2006 Jan;104(1):19-22, 24.

Abstract

To study tobacco consumption practices in north-Indian population, a community-based, stratified sampling survey using validated interview schedule was performed in rural/urban areas of Lucknow, Uttar Pradesh. There were 432 tobacco users (385 men, 47 women; 276 urban, 156 rural) taken as subjects. Tobacco use practices ie, chewing/smoking/rubbing/snuffing, frequency, starting age, supply, place/context of use, quid habit, affect, facilitating conditions/barriers, tobacco users' opinion on control measures were all taken into consideration. Single mode of tobacco use was reported by 277 subjects (64.1%) and the rest had a plethora of tobacco practices. Chewing was prevalent in 322(74.5%), smoking in 256(59.3%), rubbing in 32(7.4%) and snuffing in 4 subjects (0.9%). Of the 10 preparations in the questionnaire, the "top 5" preferences ranked as tobacco-betel, gutka, cigarette, bidi and khaini that remained unchanged between sexes, rural/urban people and age groups. Women significantly ($p<0.00001$) preferred smokeless tobacco and perceived social barrier for smoking. Gutka consumption was significantly higher in youngsters (<25 yeans; $p<0.0001$). Most subjects (235; 54.3%) used tobacco 7-24 times/day. Majority (259; 60%) users started consuming tobacco before 21 years of age and about a fifth 95(22%) before 15 years. Majority users (232; 53.6%) did not procure tobacco from a fixed shop. The commonest context of tobacco use was with any refreshment (337; 78.0%). Of the 322 tobacco chewers, about half the subjects (178; 52.2%) rotated the quid in their mouth, 313(97.2%) later spat it out, 9(2.1%) swallowed it and 15(4.7%) admitted to sleep with the quid in mouth. Tobacco along with alcohol was consumed by 82(19%) and with opium by 33 subjects (7.6%). Social barrier to tobacco use was perceived by 231 subjects (53.5%), especially by smokers. Majority users (355; 82.2%) did not have negative feelings or embarrassment in using tobacco. Most users (351; 81.4%) said they would welcome legislative control on tobacco use.

405

DR. Pankaj C.
Annexure 20

Original Articles

Prevalence and determinants of tobacco use in a highly literate rural community in southern India

ANJALI B. DANIEL, K. NAGARAJ, RAMACHANDRA KAMATH

ABSTRACT

Background. The adverse effects of tobacco use on the health of an individual are well known. It is essential to identify factors leading to tobacco use to plan strategies to limit its use. Education is known to influence the prevalence of tobacco use. We aimed to determine the prevalence and patterns of tobacco use in a rural community with a high literacy rate and to examine the socioeconomic and demographic correlates of tobacco consumption in the area.

Methods. A cross-sectional survey using personal interviews was carried out on 832 individuals >15 years of age. The prevalence of current daily use of tobacco was used as the outcome measure. The main analytical methods used were chi-square test and multiple logistic regression analysis.

Results. The prevalence of tobacco use was 17.5%, being common among older persons, the lower socioeconomic group and those who were less educated. Tobacco was used predominantly in smokeless forms (chewing, snuff or both). The commonest reason cited for initiating tobacco use was to relieve toothache.

Conclusions. Our findings in this rural community suggest that improvement in the educational and socioeconomic status may lead to a decline in the use of tobacco. Health education to improve dental hygiene may also help to reduce tobacco use in this community as it is predominantly used in the chewing form.

Natl Med J India 2008;21:163–5

INTRODUCTION

In view of numerous health-related problems associated with the use of tobacco, it is necessary to identify factors that lead to the use of tobacco. This is required to develop plans to curb its use. Identification and targeting of high risk groups through health education may help reduce tobacco use in the community. Previous studies on the prevalence of tobacco use in India suggest that there are differences in the prevalence and patterns of tobacco consumption among different populations[1,2] and that the educational status of the individual has a major influence on the use of tobacco.[1–4] It would follow that strategies to reduce tobacco use would vary depending on the setting and the educational status of the population.

Udupi district is located in Karnataka in southern India. The district has an overall literacy rate of 80% and a female literacy rate of 74%;[5] both are higher than the national averages.[6] We aimed to determine the prevalence and patterns of tobacco use in this rural population with a high literacy rate to plan future strategies to reduce the consumption of tobacco.

METHODS

This study was done in 2004 in the field area of the department of community medicine of Kasturba Medical College, Manipal—an area that covers a population of about 45 000 spread over 11 villages which are similar in their sociodemographic characteristics.

The required sample size was calculated based on WHO's prevalence estimates of tobacco use in India.[7] One of the villages in the area was chosen randomly, following which simple random sampling was used to select study subjects >15 years of age. Subjects were interviewed at their homes by a single investigator. The response rate was 90% and one-fourth of the population >15 years of age in the village was interviewed. If a subject was not available at home, 2 more visits were made to the house at a later date. Those who could not be contacted despite 3 visits were considered non-respondents.

Information on the form of tobacco used, frequency and duration of use, and reasons for initiating tobacco use were noted. Demographic information was obtained, and the socioeconomic status was assessed using the modified Udai Pareek scale.[8] To verify the consistency of reporting of tobacco use, 10% of those who had ever used tobacco were interviewed on a second occasion.

A *current tobacco user* was defined as one who at the time of the survey used any tobacco product either daily or occasionally.[9] An *occasional tobacco user* was defined as someone who used any tobacco product but not every day. A *current daily tobacco user* was defined as one who used any tobacco product at least once a day, and had done so for at least 100 days, while an *ever user of tobacco* was someone who was a current or former user of tobacco.

The collected data were tabulated and analysed using the Statistical Package for Social Sciences (SPSS) version 10.0 for Windows. The findings were described in terms of proportions and their 95% confidence intervals (CI). Age group, education, socioeconomic status, gender, religion and occupation were selected for multiple logistic regression analysis. As co-linearity

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406

may exist between education and socioeconomic status, we also did step-wise logistic regression analysis after excluding the socioeconomic status from the model.

RESULTS

Of the 925 people approached, 93 declined to participate in the study. The demographic characteristics of the study population were comparable with those of the general population in the area. The sex distribution was almost equal (men 49.4%), and almost 50% of the population belonged to the age group of 20–39 years. The majority of the population was Hindu (97.7%) and most belonged to the middle socioeconomic group. The literacy rate was 91%, with over half (54.3%) having attended middle and high school, and a fourth (25.3%) having more than 10 years of schooling. Home-makers who were not earning a livelihood comprised 31% of the population. About 23% were involved in skilled work and 27.1% were in unskilled occupations.

Approximately 23% of the population >15 years of age had ever used tobacco at some point in time, whereas the prevalence of current daily tobacco use was 17.5% at the time of the survey. Occasional tobacco use was reported by 3.8%, while former users of tobacco constituted 2% of the population (Table I).

Table II summarizes the prevalence of current daily use of tobacco in various groups. The prevalence of tobacco use was 19.6% among men and 15.7% among women.

It was predominantly used in smokeless form (as chewing tobacco, snuff or both) by 15.2% of the population, while the prevalence of smoking was only 1.6% (95% CI: 0.7–2.4). Use of tobacco exclusively in chewing form was the most common form of tobacco use with a prevalence of 10.5% (95% CI: 8.4–12.6). Among current daily users of tobacco, 63.1% of men and 55.7% of women used tobacco only in the chewing form. Use of snuff alone was reported by 4.3% (95% CI: 2.9–5.7) of the population, and most snuff users were women. None of the women in this study reported smoking.

The median age at initiation of tobacco use varied with the form of tobacco used, being 20 years (inter-quartile range IQR 19.5–25.75) for smoking, 24 years (IQR 18.75–32.25) for the use of snuff and 28 years (IQR 22–39) for chewing tobacco.

The prevalence of tobacco use increased with age showing a linear trend, and was found to be highest (47%) in those >60 years of age. Although no one between 15 and 19 years of age reported daily tobacco use, the prevalence of occasional use in this group was 4.6%. The median duration of daily tobacco use was 26 years, with an IQR of 15–36.8 years.

The prevalence of tobacco use was higher (24.2%) among those in the low socioeconomic group than in the middle (13.3%) and high socioeconomic groups (3.2%).

The prevalence of tobacco use was highest among the least educated, being 55.4% among those who were illiterate. Prevalence of tobacco use was seen to decrease with the number of years of schooling, and was 3.7% in those with more than 10 years of schooling.

It was highest (22.4%) among those who were not gainfully employed, followed by those with skilled jobs (21.6%). Tobacco use was low among those in business and professional jobs.

The median daily frequency of tobacco use varied with the form of tobacco used, with tobacco being chewed on an average 5 times a day, and smoked or used as snuff 8 times a day.

The variables included in the regression analysis were gender, age group, religion, socioeconomic status, level of education and occupation. Multiple logistic regression revealed that male gender, age ≥40 years, and <10 years of schooling had an indep[illegible] significant association with current daily tobacco use. Ge[illegible] age and education remained significant even after exclusi[illegible] socioeconomic status from the model (Table III).

The commonest reason reported for initiating tobacco che[illegible] was for relief of toothache. The other reasons reported incl[illegible] peer pressure, to alleviate boredom while performing monoto[illegible] tasks, and the use of snuff to control epistaxis or relieve [illegible] stuffiness.

DISCUSSION

The prevalence of tobacco use in our study is distinctly less [illegible] that reported from other parts of the country.[1,4,10,11] Rani et [illegible] reported that 30% of the population ≥15 years of age [illegible] smoked or chewed tobacco,[1] while a study done by the Ind[illegible] Council of Medical Research (ICMR) found the prevalence [illegible] tobacco use in Karnataka to be 28.4%.[4]

In our study area, the literacy levels and health indices [illegible] better than in many other parts of the country. The low prevale[illegible]

TABLE I. Prevalence of tobacco use (n=832)

Subjects	n	Prevalence (%)	95% confidence inter[illegible]
Never users	637	76.6	73.66–79.54
Ever users	195	23.4	20.46–26.34
Current users	178	21.4	18.56–24.2[illegible]
Daily	146	17.5	14.87–20.13
Occasional	32	3.8	2.47–5.13
Former users	17	2.0	1.03–2.97

TABLE II. Prevalence and correlates of tobacco use (n=832)

Correlate of tobacco use	Number of subjects interviewed	Number of current daily users	Prevalence	95% confidence interval
*Gender**				
Men	387	76	19.6	15.6–[illegible]
Women	445	70	15.7	12.3–[illegible]
Age group (years)†				
15–19	86	0	0	-
20–29	190	08	4.2	1.3–[illegible]
30–39	206	17	8.3	4.5–[illegible]
40–49	130	28	21.5	14.3–[illegible]
50–59	103	38	36.9	27.4–[illegible]
>60	117	55	47	37.8–[illegible]
Socioeconomic status‡				
Low	351	85	24.2	19.6–[illegible]
Middle	450	60	13.3	10.1–[illegible]
High	31	01	3.2	-3.1–[illegible]
Education§				
Illiterate	74	41	55.4	43.5–[illegible]
Primary school	94	35	37.2	27.2–[illegible]
Middle and high school	450	62	13.8	10.5–[illegible]
>10 years of schooling	214	08	3.7	1.1–[illegible]
Occupation ‖				
Unemployed	277	62	22.4	17.4–[illegible]
Unskilled	218	38	17.4	12.3–[illegible]
Skilled	176	38	21.6	15.4–[illegible]
Business	42	05	11.9	1.9–[illegible]
Professional	37	03	8.1	0.87–[illegible]
Student	82	0	0	-

* Gender: χ^2=2.185, df=1, p=0.139 † Age group: χ^2 for linear trend=10.03, df=[illegible] p=0.0015 ‡ Socioeconomic status: χ^2 for linear trend=20.7, df=2, p≤0.000[illegible] § Education: χ^2 for linear trend=124, df=3, p≤0.0001 ‖ Occupation: χ^2=27.12, df=5, p≤0.0001

Table III. Correlates of current daily tobacco use: Step-wise multiple logistic regression analysis

Correlate of tobacco use	Category	Odds ratio (unadjusted)	95% confidence intervals	Odds ratio (adjusted, including SES)	95% confidence intervals	p value	Odds ratio (adjusted, excluding SES)	95% confidence intervals	p value
Gender	Male	1.31	0.92–1.87	2.52	1.59–3.99	<0.0001	2.53	1.61–3.97	<0.0001
	Female	1.0	–	1.0	–	–	1.0	–	–
Age group (in years)*	20–29	1.0	–	1.0	–	–	1.0	–	–
	30–39	2.05	0.81–5.31	2.29	0.94–5.59	0.07	1.88	0.78–4.54	0.16
	40–49	6.25	2.60–15.51	5.88	2.49–13.89	<0.0001	4.61	1.98–10.71	<0.0001
	50–59	13.3	5.59–32.75	11.46	4.79–27.39	<0.0001	8.82	3.77–20.62	<0.0001
	≥60	20.18	8.67–48.73	14.14	5.70–35.07	<0.0001	8.63	3.66–20.37	<0.0001
Socioeconomic status (SES)	Low	9.59	1.29–71.35	8.31	0.99–69.41	0.051	–	–	–
	Middle	4.62	0.62–34.47	3.67	0.45–30.02	0.22	–	–	–
	High	1.0	–	1.0	–	–	–	–	–
Education	Illiterate	31.99	13.78–74.25	10.65	3.88–29.23	<0.0001	19.63	7.51–51.29	<0.0001
	Primary	15.28	6.72–34.71	4.68	1.85–11.83	0.001	8.09	3.33–19.62	<0.0001
	Middle and high	4.12	1.93–8.76	3.02	1.34–6.80	0.008	4.13	1.87–9.13	<0.0001
	>10 years	1.0	–	1.0	–	–	1.0	–	–

*The age group of 15–19 years was not included as there were no tobacco users in this group

may be attributable to the difference in sociodemographic characteristics between the population in our study area and the population in the studies we selected for comparison.

One potential weakness of collecting data by interviews in a household is the lack of privacy, leading to some degree of underreporting. This may also have been a reason for the low prevalence of tobacco use noted by us. However, other studies in India have relied on similar interviews and would have been subject to similar limitations. Further, the possibility of underreporting was examined by re-interviewing 10% of those who reported having never used tobacco at a later date. Since they were consistent in their responses, we believe that the low prevalence cannot be attributed to underreporting.

A closer look at the possible reasons for the low prevalence of tobacco use is needed to plan strategies to further reduce the use of tobacco in this population.

The most striking association was with the educational status. This is consistent with observations that those with the lowest level of educational attainment are more likely to use tobacco.[1,3,4] The very low prevalence of tobacco use among those who had >10 years of formal education would suggest that as the number of college-goers increase in a community, the prevalence of tobacco use would decline. However, it would not be realistic to hope that the vast majority of children in the population would over time be able to go to college. The age at initiation of tobacco use in our study was higher than that in the West where people tend to begin using tobacco during adolescence.[12] The later age at initiation of tobacco use in India and other parts of Asia[2] provides a larger window of opportunity for effective health education. Repeated educational input regarding tobacco-related health hazards needs to be provided before the age at which use of tobacco is initiated. Since the median age at initiation of tobacco use in our study population was >20 years, educational interventions aimed at discouraging tobacco use could be directed at children in primary, middle and high school. Such an approach is feasible in this community as the age at initiation of tobacco use is relatively high and a large proportion of children do go to school.

As in studies elsewhere in India, tobacco was predominantly used in smokeless forms.[1,11] In this population, tobacco was mainly chewed, with few using it as snuff and hardly anyone smoking tobacco.

The commonest reason for initiating tobacco use in this population was to alleviate toothache, which may explain the use of tobacco almost exclusively in the chewing form. If appropriate health education regarding oral and dental hygiene is imparted in schools, it may be possible to reduce tobacco chewing in this population. Improvement of community dental services could be yet another strategy that could be adopted to achieve reduction of tobacco use in this population.

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Annexure 21

Smokeless Tobacco

Sociodemographic correlates of male chewable smokeless tobacco users in India: A preliminary report of analysis of national family health survey, 2005–2006

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Abstract

OBJECTIVE: To estimate the prevalence, the socioeconomic and demographic correlates of chewable smokeless tobacco consumption among males in India. **DESIGN:** A cross-sectional, nationally representative population-based household survey. **SUBJECTS:** 74,369 males aged 15–54 years who were sampled in the National Family Health Survey-3 (2005–2006). Data on tobacco consumption were elicited from male members in households selected for the study. **MATERIALS AND METHODS:** The prevalence of various smokeless tobacco use currently was used as outcome measures. Simple and two-way cross tabulations and univariate logistic regression analysis were the main analytical methods. **RESULTS:** Thirty-four percent of the study population (15 years or older) used chewable smokeless tobacco. Smokeless tobacco consumption was significantly higher in poor, less educated, scheduled castes, and scheduled tribe populations. The prevalence of tobacco consumption showed variation with types. The prevalence of chewing also varied widely between different states and had a strong association with an individual's sociocultural characteristics. **CONCLUSION:** The findings of the study highlight that an agenda to improve the health outcomes among the poor in India must include effective interventions to control tobacco use. Failure to do so would most probably result in doubling the burden of diseases—both communicable and noncommunicable—among India's teeming poor. There is a need for periodical surveys using more consistent definitions of tobacco use and eliciting information on different types of tobacco consumed.

Key words: Areca nut, gutka, panmasala, precancer, sociodemographic correlates

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Introduction

In India, tobacco consumption is a major risk factor responsible for oral and oropharyngeal cancer. India has one of the highest rates of oral cancer in the world, partly attributed to the high prevalence of tobacco chewing habits.[1] Nationally representative and reliable prevalence data on chewable tobacco consumption are sparse. Similarly, the sociodemographic predictors of smokeless tobacco are poorly understood. The existing studies on prevalence of smokeless tobacco use are based on nonrepresentative sample surveys or have been conducted primarily for smoking tobacco forms.[1,2]

The nature of chewable areca nut and tobacco consumption in India has undergone a rapid transformation with the introduction of Panmasala and Gutka. These products are conveniently packed and aggressively advertised and marketed.[3]

Smokeless tobacco consumption, in India, shows a wide variation in different geographical areas and socioeconomic groups. However, barring a few regional studies, very little systematic investigation has been published on socioeconomic and geographic distribution of this habit among males in India. The gaps in our understanding of smokeless tobacco consumption need to be addressed to ascertain which epidemiologic determinants are more likely to result in higher consumption. Such analyses are critical for designing policies and interventions aimed at achieving overall reductions in chewable areca nut and tobacco

409

consumption at the population level and at reducing the inequalities in susceptibility.[4]

Preliminary reports in India indicate that 36.3% males used smokeless tobacco, whereas only 8.4% of females used them, and there exists a greater disparity in the geographic and socioeconomic distribution of smokeless tobacco use.[5] Given the paucity of reported exact socioeconomic and geographic prevalence of smokeless tobacco use in India among males, this study was undertaken to estimate the prevalence and socioeconomic and demographic correlates of current chewable tobacco habit among males 15 years and older in India.

Materials and Methods

This secondary analysis of data was done from the Nation Family Health Survey (NFHS) of India conducted during 2005–2006. The data for the study came from the door-to-door survey questionnaire answers for men and women fielded under the NFHS-3—a nationally representative, cross-sectional, household sample survey conducted in 2005–2006. A uniform sample design was adopted in all the states, which has been described earlier.[6]

In the NFHS-3, information was collected from a nationally representative sample of 74,369 men in the age group of 15–54 years. The NFHS-3 sample covers 99% of India's population living in all the 29 states. The demographic details of the interviewed were categorized.[5] The present study was performed using the details of 74,369 males obtained from the survey as males tend to use smokeless tobacco more commonly than females[5] and also considering the fact that sociodemographic determinants of smokeless tobacco use among females will be different.[1,2]

The survey questionnaire had 3 questions addressing self-report on the chewable areca nut and/or tobacco use. They were "Do you currently smoke cigarettes or beedis?," "Do you currently smoke or use tobacco in any other form?," and "In what other form do you currently smoke or use tobacco?" The choices for the last question were cigar/pipe; Panmasala; gutka; other chewing tobacco; and snuff. The answer for the last question was recorded in yes/no format in the database. Use of snuff was not considered as it is not a chewable form of smokeless tobacco.

SPSS version 16.0 (SPSS Inc., Chicago, IL, USA) was used to carry out the statistical analysis. Descriptive variables are presented for demographic variables. The variables for males are presented. Overall prevalence of chewing tobacco and areca nut were computed for various demographic variables as point estimates and 95% confidence intervals are presented by computing the confidence interval around a percent using the statistics calculator (Statpac Incorporation, Version 3, Bloomington, MN, USA). A P value of less than or equal to 0.001 was considered as a significant difference. Binary logistic regression by entering and a simple categoric method was employed to calculate the odds ratio (OR), and 95% confidence interval of the OR are presented.

Results

Over All

There were 748 questions in the survey for males. Of all the data analyzed, for certain variables as much as 6.2% did not answer or the data were missing. The number of people with missing data has been included in all the tables.

Of all the male participants, 25,587 (34.42%) used one or another chewing products; 8.1% used panmasala, 11.8% used gutka, and 12.13% used other chewable tobacco products. Among males, use of chewable tobacco was the most prevalent in the age group of 30–34 years, with 40.5% chewing any form of tobacco. The difference was statistically significant (P = 0.000). Thirty-one percent of urban and 38.1% of rural males used chewing substances. The difference was statistically significant (P = 0.000).

As the level of education increased, prevalence of chewing habit decreased. Similarly, as the wealth index increased, the chewing habits decreased across the subgroups among males and females [Figure 1]. This difference was statistically significant (P = 0.000).

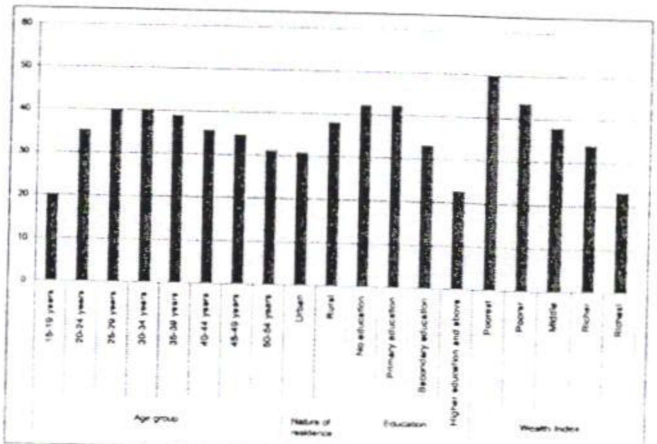

Figure 1: Graph depicting the overall prevalence (in percentages) of chewing tobacco habit among males in the study group

State level variation

The prevalence of tobacco chewing varied significantly among different states in India. Regional patterns were observed for chewing panmasala, gutka, and tobacco. Prevalence of chewing tobacco ranged between 57% (Bihar) and 7.2% (Haryana). This difference in the prevalence of tobacco chewing between various Indian states was statistically significant (P = 0.000). Panmasala use was the highest in Orissa (40.8%), gutka in Uttar Pradesh (22.5%), and other chewable products in Assam (51.9%). The difference was statistically significant (P = 0.000) [Tables 1 and 2].

Demographic and socioeconomic variables

Chewing of panmasala was more common among the 25–29, 30–34, and 35–39 years age group (each 9.4%) than other age groups (P = 0.000) with an OR of 1.78, 1.79, and 1.79 as compared with the 15–19 years age group. Panmasala was more commonly used by rural males (OR = 1.16) as compared with urban males (P = 0.000). Use of panmasala was highest in migrants or nondejure residents (OR = 1.26) as compared with those in nuclear families. Use of panmasala was higher among ever married (OR = 1.22) than with never married. Among the castes, scheduled tribes used panmasala commonly (17.8%) (P = 0.000) [Table 3].

As the level of education and wealth increased, the prevalence of chewing panmasala decreased. This difference was statistically significant (P = 0.000) [Table 4]. Less use of panmasala was observed in males who read newspaper or magazines, listened to radio or saw television. However, their rates were similar to those who never read, listened to radio, or saw television. This difference was statistically significant (P = 0.000) [Table 5].

Use of panmasala was more common among Christians (21.7%) and low among Parsi (0) and Sikhs (1.1%) (P = 0.000) [Figure 2]. Agricultural employees (9%) and salesmen (9%) more commonly used panmasala. The not working class consumed less of panmasala (5.7%). This difference was statistically significant (P = 0.000) [Table 6].

The use of gutka was more in 20–24 years age group (OR = 1.73) and the difference between age groups was statistically significant (P =0.000). Gutka was popular among people in the urban than the rural areas (OR = 0.93). The difference between the nature and place of residence was statistically significant (P = 0.000). The use of gutka was least common in nuclear families and highest in migrants or nondejure residents (OR = 1.26). As the level of education increased, the prevalence of chewing gutka decreased. This difference was statistically significant (P = 0.000). A low use of gutka was observed among males who read newspaper or magazine, listened to radio or saw television almost daily. Although there was a statistical significance (P = 0.000) between the different levels of exposure to various

Table 1: Statewise prevalence of any chewing habit

State	Male (%)
Jammu and Kashmir	9.7
Himachal Pradesh	10.3
Punjab	17.4
Uttaranchal	29.8
Haryana	7.2
Delhi	24
Rajasthan	31.9
Uttar Pradesh	41
Bihar	57.7
Sikkim	38.6
Arunachal Pradesh	52
Nagaland	54.9
Manipur	56.8
Mizoram	38.6
Tripura	45.9
Meghalaya	39.6
Assam	57
West Bengal	34.2
Jharkhand	52.5
Orissa	57
Chhattisgarh	49.1
Madhya Pradesh	45.6
Gujarat	42.9
Maharashtra	38.1
Andhra Pradesh	16
Karnataka	21.3
Goa	15.4
Kerala	14.9
Tamilnadu	15.2
Total	34.42

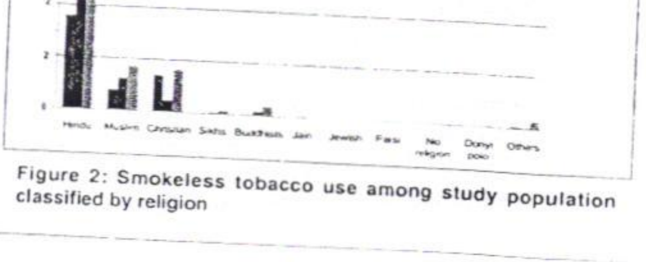

Figure 2: Smokeless tobacco use among study population classified by religion

Table 2: Statewise distribution of prevalence of panmasala, gutka, and other chewing products used by the study population

State	Total sample	Panmasala n (%)	95% CI*	Gutka n (%)	95% CI*	Other chewing n (%)	95% CI*
Jammu and Kashmir	1075	2 (0.2)	−0.7–0.47	31 (2.9)	1.9–3.9	79 (7.3)	5.74–8.86
Himachal Pradesh	1066	11 (1)	0.40–1.6	43 (4)	2.82–5.18	63 (5.9)	4.48–7.32
Punjab	1327	14 (1.1)	0.54–1.66	29 (2.2)	1.41–2.99	195 (14.7)	12.79–16.61
Uttaranchal	980	24 (2.4)	1.44–3.36	154 (15.7)	13.42–17.98	190 (19.4)	16.92–21.88
Haryana	1083	7 (0.6)	0.14–1.06	28 (2.6)	1.65–3.55	46 (4.2)	3–5.4
Delhi	1436	64 (4.5)	3.43–5.57	152 (10.6)	9.01–12.2	171 (11.9)	10.22–13.58
Rajasthan	1471	9 (0.6)	0.2–1	209 (14.2)	12.41–15.99	296 (20.1)	18.05–22.15
Uttar Pradesh	11,455	638 (5.6)	5.18–6.02	2572 (22.5)	21.73–23.27	2840 (24.8)	24.01–25.59
Bihar	1214	175 (14.4)	12.42–16.3	203 (16.7)	14.6–18.8	567 (46.7)	43.89–49.51
Sikkim	810	11 (1.4)	0.59–2.21	7 (0.9)	0.25–1.55	310 (38.3)	34.95–41.66
Arunachal Pradesh	711	122 (17.2)	9.79–14.61	48 (6.8)	4.94–8.66	329 (46.3)	42.63–49.98
Nagaland	3971	1287 (32.4)	30.94–33.86	334 (8.4)	7.54–9.26	1265 (31.9)	30.45–33.35
Manipur	3950	627 (15.9)	14.76–17.04	326 (8.3)	7.44–9.16	1796 (45.5)	43.95–47.06
Mizoram	665	156 (23.5)	20.27–26.73	3 (0.5)	−0.04–1.04	129 (19.4)	16.39–22.41
Tripura	709	249 (35.1)	31.58–38.62	15 (2.1)	1.04–3.16	98 (13.8)	11.25–16.35
Meghalaya	720	183 (25.4)	22.21–28.59	30 (4.2)	2.73–5.67	100 (13.9)	11.37–16.43
Assam	1394	65 (4.7)	3.59–5.81	71 (5.1)	3.94–6.26	724 (51.9)	49.27–54.53
West Bengal	2669	185 (6.9)	5.94–7.86	201 (7.5)	6.5–8.5	677 (25.4)	23.75–27.05
Jharkhand	996	8 (0.8)	0.25–1.36	81 (8.1)	6.4–9.8	493 (49.5)	46.39–52.61
Orissa	1591	649 (40.8)	38.38–43.2	265 (16.7)	14.86–18.54	203 (12.8)	11.16–14.45
Chhattisgarh	1384	72 (5.2)	4.03–6.37	370 (26.7)	24.37–29.04	345 (24.9)	22.62–27.18
Madhya Pradesh	2725	53 (1.9)	1.38–2.42	665 (24.4)	22.77–26.03	813 (29.8)	28.08–31.52
Gujarat	1425	188 (13.2)	11.44–14.96	300 (21.1)	18.98–23.22	214 (15)	13.14–16.86
Maharashtra	8859	227 (2.6)	2.27–2.93	1070(12.1)	11.42–12.78	2648 (29.9)	28.95–30.86
Andhra Pradesh	7120	362 (5.1)	4.59–5.61	656 (9.2)	8.52–9.87	231 (3.2)	2.79–3.61
Karnataka	5521	350 (6.3)	5.66–6.94	425 (7.7)	7–8.4	497 (9)	8.24–9.76
Goa	1185	46 (3.9)	2.8–5	75 (6.3)	4.91–7.69	86 (7.3)	5.82–8.78
Kerala	1120	91 (8.1)	6.5–9.7	23 (2.1)	1.26–2.94	65 (5.8)	4.43–7.17
Tamilnadu	5696	162 (2.8)	2.37–3.23	389 (6.8)	6.15–7.46	409 (7.2)	6.53–7.87
Total	74,328	6037 (8.1)	7.91–8.3	8775 (11.8)	11.57–12.03	15,879 (21.4)	21.11–21.7

*Confidence interval for percentage at 0.001 significance

media, the actual prevalence was similar to those who were never exposed to any media. Use of gutka was common among atheists (42.9%) and low among Jewish (0%), Parsi (0%), and Sikhs (2%). Other products were commonly used by Jews (60%) and less common among Sikhs (12%). The difference between religions was statistically significant (P = 0.000).

The use of gutka decreased as the wealth index increased and this pattern was statistically significant (P = 0.000). The use of gutka was favored by salesmen (13.15%) and least favored by individuals in professional/technical or managerial levels (6.2%), and this difference between professionals was statistically significant (P = 0.000).

The use of other chewable products was highest in 35–39 years age group (26.5%) and lowest in 15–19 years age group (P = 0.000). This habit was widely prevalent among people in rural areas (OR = 1.65), nondejure residents (OR = 1.47), ever married (OR = 2.28), scheduled tribe (OR = 1.53), no education (OR = 1), only primary education (OR =0.93), and among poorest section (OR = 1).

Resultant health information

Panmasala use was highly prevalent in males (9%) with normal body mass index (BMI) and lowest in severely thin (4.7%). Panmasala use was highly prevalent in severe anemic (7.6%) males than not anemic (6.6%). Of all the diabetics, 8.8% chewed panmasala as compared with 8% in nondiabetics. Gutka use was highest among males whose BMI was mildly less (13.9%). Gutka use was highest among severely anemic (13.5%) as compared with 12% of nonanemic persons. The use of other chewable forms was highest in normal BMI males (23.1%) and severely anemic (27.9%) males [Table 7].

412

Table 3: Bivariate logistic regression of demographic variables of the study population

	Panmasala					Gutka					Other chewing products				
	n (%)	OR	95% CI for OR		P value	n (%)	OR	95% CI for OR		P value	n (%)	OR	95% CI for OR		P value
			Lower	Upper				Lower	Upper				Lower	Upper	
Age group (y)															
15-19	717 (5.5)	Reference				1391 (10.6)	Reference				1169 (8.9)	Reference			
20-24	1022 (8.2)	1.54	1.40	1.70	0.000	2131 (17.1)	1.73	1.61	1.86	0.000	2346 (18.8)	2.36	2.19	2.55	0.000
25-29	1036 (9.4)	1.78	1.62	1.97	0.000	1719 (15.6)	1.55	1.43	1.67	0.000	2658 (24.1)	3.23	2.99	3.47	0.000
30-34	918 (9.4)	1.79	1.62	1.98	0.000	1328 (13.6)	1.32	1.22	1.43	0.000	2545 (26.1)	3.59	3.33	3.87	0.000
35-39	858 (9.4)	1.79	1.61	1.98	0.000	926 (10.1)	0.95	0.87	1.03	0.000	2421 (26.5)	3.67	3.40	3.96	0.000
40-44	640 (8.2)	1.54	1.38	1.72	0.000	621 (8)	0.73	0.66	0.80	0.225	1997 (25.6)	3.51	3.24	3.80	0.000
45-49	537 (8.2)	1.54	1.37	1.73	0.000	431 (6.6)	0.59	0.53	0.66	0.000	1663 (25.4)	3.47	3.20	3.77	0.000
50-54	309 (6.8)	1.26	1.10	1.45	0.001	228 (5)	0.45	0.39	0.51	0.000	1080 (23.8)	3.19	2.91	3.49	0.000
Nature of residence															
Urban	2899 (7.6)	Reference				4652 (12.2)	Reference				6602 (17.3)	Reference			
Rural	3138 (8.7)	1.16	1.10	1.20	0.000	4123 (11.4)	0.93	0.89	0.97	0.001	9277 (25.7)	1.65	1.59	1.71	0.00
House hold structure															
Nuclear	3050 (7.9)	Reference				3957 (10.3)	Reference				7920 (20.6)	Reference			
Nonnuclear	2814 (8.2)	1.04	0.99	1.10	0.127	4502 (13.2)	1.32	1.27	1.39	0.000	7472 (21.9)	1.08	1.04	1.20	0.000
Not de jure resident	173 (9.8)	1.26	1.08	1.49	0.005	316 (17.9)	1.90	1.68	2.16	0.000	487 (27.6)	1.47	1.32	1.64	0.000
Marital status															
Never married	Reference					Reference					Reference				
Ever married		1.22	1.15	1.29	0.000		0.91	0.87	0.96	0.000		2.28	2.19	2.38	0.000
Caste															
Scheduled caste	829 (6.5)	Reference				1855 (14.6)	Reference				2878 (22.7)	Reference			
Scheduled tribes	1595 (17.8)	3.09	2.83	3.38	0.000	843 (9.4)	0.61	0.56	0.66	0.000	2786 (31.1)	1.53	1.44	1.63	0.000
Other backward classes	1629 (6.1)	0.93	0.85	1.01	0.078	3431 (12.8)	0.86	0.81	0.91	0.000	5194 (19.4)	0.82	0.78	0.86	0.000
Others	1816 (7.7)	1.20	1.10	1.31	0.000	2504 (10.7)	0.70	0.65	0.74	0.000	4432 (18.9)	0.79	0.75	0.84	0.000
Don't know	12 (5.2)	0.78	0.44	1.41	0.411	16 (6.9)	0.43	0.26	0.72	0.001	21 (9.1)	0.34	0.22	0.53	0.000

Discussion

Prevalence

To the best of our knowledge, this is one of the few studies to provide nationally representative aggregate prevalence estimates of consumption of different chewing tobacco products related to different socioeconomic and demographic characteristics from

413

Table 4: Bivariate logistic regression of demographic variables of education and wealth of the study population

	Panmasala					Gutka					Other chewing products				
	n (%)	OR	95% CI for OR		*P* value	n (%)	OR	95% CI for OR		*P* value	n (%)	OR	95% CI for OR		*P* value
			Lower	Upper				Lower	Upper				Lower	Upper	
Education															
No education	957 (9)		Reference			1327 (12.4)		Reference			3151 (29.5)		Reference		
Primary education	1095 (9.5)	1.07	0.98	1.18	0.126	1576 (12.4)	1.12	1.04	1.22	0.000	3154 (27.5)	0.91	0.86	0.96	0.001
Secondary education	3193 (7.8)	0.87	0.80	0.93	0.000	5010 (12.3)	0.99	0.93	1.06	0.003	8146 (20)	0.60	0.57	0.63	0.000
Higher education and above	789 (6.9)	0.76	0.68	0.83	0.000	861 (7.5)	0.58	0.53	0.63	0.751	1419 (12.4)	−0.34	0.32	0.36	0.000
Wealth index															
Poorest	645 (9.1)		Reference			1101 (15.5)		Reference			2539 (35.9)		Reference		
Poorer	900 (8.8)	0.96	0.86	1.07	0.435	1429 (13.9)	0.88	0.81	0.96	0.003	3049 (29.7)	0.76	0.71	0.81	0.000
Middle	1378 (9.3)	1.02	0.93	1.13	0.690	1839 (12.4)	0.77	0.71	0.83	0.000	3650 (24.6)	0.58	0.55	0.62	0.000
Richer	1693 (8.8)	0.96	0.87	1.05	0.368	2349 (12.4)	0.75	0.70	0.81	0.000	3881 (20.1)	0.45	0.42	0.48	0.000
Richest	1421 (6.2)	0.66	0.60	0.73	0.000	2057 (9)	0.54	0.50	0.58	0.000	2760 (24.4)	0.25	0.23	0.26	0.000

the NFHS-3 from India.[1] This study has dealt with panmasala and gutka, the products that are being increasingly used by Indians. Till date no study has provided a detailed analysis of the prevalence of chewing of panmasala and gutka habit. This present study has an advantage of proper study design and representativeness; however, it also suffers from several data limitations, which could alter the prevalence estimates, including considering only males, absence of details of intensity, frequency, and duration of use. A detailed question on the type of smokeless form of tobacco use has been included in NFHS-3, which has enabled us to do this study. Household informants in this survey may not be aware of the use of tobacco by other household members rather than the individual self-reports and this drawback is in similar studies in the literature that employed earlier NFHS studies.[1] Hence in the present study, only individual self-reports have been used as per recommendations from earlier studies.[1] Taking into account all the limitations of the study and the previous literature on the prevalence of tobacco consumption in India, it is safe to conclude that this study provides robust lower bound estimates for the prevalence of chewing tobacco consumption in India.[1] Moreover, this study takes into consideration all those who chew panmasala, gutka, or other products individually but does not consider the overlap of the mixed habits. Figure 3 shows the population aggregate who use chewing tobacco in various forms in the study population. Literature has several reports of smokeless tobacco usage among the locoregional population,[4,7] but none on a national or a state level; and hence, the results of this study could not be verified.

State level variation

The chewing tobacco consumption varied significantly across different Indian states. For example, the chewing prevalence was distinctly higher in Central and Eastern

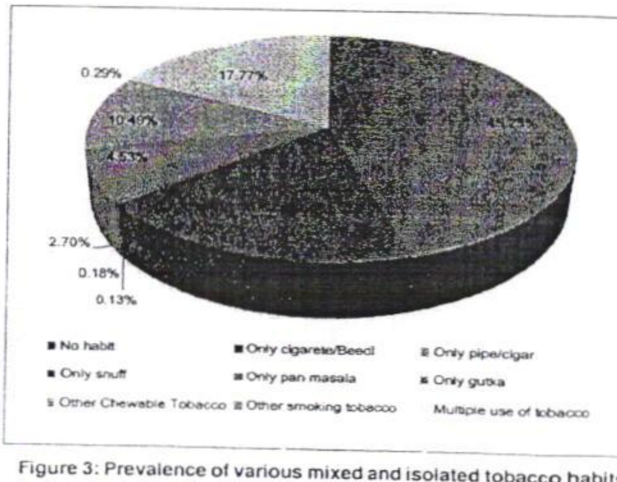

Figure 3: Prevalence of various mixed and isolated tobacco habits in the study population

Table 5: Bivariate logistic regression of demographic variables related to exposure of the media in the study population.

	Panmasala					Gutka					Other chewing products				
			95% CI					95% CI					95% CI		
	n (%)	OR	lower	upper	*P* value	n (%)	OR	lower	upper	*P* value	n (%)	OR	lower	upper	*P* value
News paper															
Not at all	1862 (9.3)	Reference				2486 (12.4)	Reference				5617 (28.1)	Reference			
Less than once a week	910 (8.3)	0.89	0.82	0.96	0.004	1474 (13.5)	1.10	1.03	1.18	0.007	2785 (25.5)	0.88	0.83	0.93	0.000
At least once a week	1272 (9.2)	0.99	0.92	1.07	0.831	1804 (13.1)	1.06	1.00	1.13	0.067	2880 (20.9)	0.68	0.64	0.71	0.000
Almost daily	1991 (6.7)	0.70	0.66	0.75	0.000	3002 (10.2)	0.80	0.75	0.84	0.000	4583 (15.5)	0.47	0.45	0.49	0.000
Radio															
Not at all	1643 (7.5)	Reference				2125 (9.8)	Reference				4067 (18.7)	Reference			
Less than once a week	1558 (8.8)	1.18	1.10	1.27	0.000	2353 (13.3)	1.42	1.33	1.51	0.000	4258 (24.1)	1.38	1.31	1.45	0.000
At least once a week	1369 (9.5)	1.28	1.19	1.38	0.000	1943 (13.4)	1.44	1.35	1.53	0.000	3268 (22.6)	1.27	1.21	1.34	0.000
Almost daily	1466 (7.2)	0.95	0.88	1.02	0.145	2354 (11.5)	1.20	1.13	1.28	0.000	4284 (21)	1.16	1.10	1.21	0.000
Television															
Not at all	644 (7)	Reference				851 (9.2)	Reference				2879 (31.2)	Reference			
Less than once a week	1160 (9.8)	1.45	1.32	1.61	0.000	1715 (14.6)	1.68	1.54	1.83	0.000	3695 (31.4)	1.01	0.95	1.07	0.843
At least once a week	1260 (10.5)	1.56	1.42	1.73	0.000	1615 (13.5)	1.53	1.40	1.67	0.000	2937 (24.5)	0.71	0.67	0.76	0.000
Almost daily	2972 (7.2)	1.03	0.94	1.13	0.495	4594 (11.1)	1.23	1.14	1.33	0.000	6367 (15.4)	0.40	0.38	0.42	0.000

Table 6: Smokeless tobacco use among the study population classified by occupation

Variable	Total n	Panmasala n (%)	95% CI*	Gutka n (%)	95% CI*	Others n (%)	95% CI*
Occupation							
Not working	10,933	620 (5.7)	5.3-6.1	764 (7)	6.56-7.44	864 (7.9)	7.4-8.41
Professional/technical/Managerial	5625	413 (7.3)	6.65-7.96	347 (6.2)	5.59-6.81	838 (14.9)	13.97-15.83
Clerical	3465	301 (8.7)	7.78-9.62	320 (9.2)	8.26-10.14	581 (16.8)	15.55-18.05
Sales	9737	874 (9)	8.47-9.53	1315 (13.15)	12.52-13.78	1920 (19.7)	18.91-20.49
Agriculture employee	17,287	1553 (9)	8.63-9.37	1951 (11.3)	10.89-11.71	5043 (29.2)	28.52-29.88
Service related	3942	319 (8.1)	7.27-8.93	519 (13.2)	12.17-14.23	880 (22.3)	21-23.6
Skilled/unskilled/Manual	23,207	1949 (8.4)	8.1-8.7	3548 (15.3)	14.92-15.69	5734 (24.7)	24.14-25.26
Don't know	9	0 (0)	-	1 (11.1)	-14.57-36.77	1 (11.1)	4.57-36.57
Total	74,205	6029 (8.1)	8.09-8.11	8765 (11.8)	11.79-11.81	15,861 (21.4)	21.11-21.7
Missing	164						
Other habits							
Smoking cigarette/beedis	24,248	2700 (11.1)	10.7-11.5	3421 (14.1)	12.93-15.27	5795 (23.99)	23.45-24.53
Smoking cigar/pipe	911	140 (15.4)	13.05-17.75	72 (7.9)	3.37-12.43	181 (19.87) P = **0.268**	17.27-22.47
Smoking others	601	51 (8.5)	6.26-10.74	83 (13.8) P = **0.13**	11.03-16.57	73 (12.15)	9.53-14.77
Use of snuff	327	80 (24.5)	19.81-29.19	49 (15) P = **0.074**	11.11-18.89	41 (12.54)	8.93-16.15
Tobacco chewing	15,879	1690 (10.6)	10.12-11.08	2686 (16.9)	16.32-17.48	-	
Alcohol	25,360	3014 (11.89)	11.49-12.29	4388 (17.30)	16.83-17.77	8049 (31.74)	31.17-32.31

Bold indicates significance, *CI -confidence interval for percentage at 0.001 significance, All significance at a level of 0.001 unless mentioned

Table 7: Health disorders and smokeless tobacco use among the study population

Variable	Total n	Panmasala n (%)	95% CI*	Gutka n (%)	95% CI*	Others n (%)	95% CI*
Body mass index							
Severely thin	3199	151 (4.7)	3.97-5.44	345 (10.8)	9.72-11.88	505 (15.8)	14.53-17.07
Moderately thin	4703	300 (6.4)	5.7-7.1	624 (13.3)	12.33-14.27	971 (20.6)	19.44-21.76
Mildly thin	11,888	872 (7.3)	6.83-7.77	1647 (13.9)	13.28-14.52	2735 (23)	22.24-23.76
Normal	41,189	3706 (9)	8.72-9.28	4918 (11.9)	11.59-12.21	9525 (23.1)	22.7-23.51
Over weight	7017	547 (7.8)	7.17-8.43	574 (8.2)	7.56-8.84	1116 (15.9)	15.04-16.76
Obese	1176	73 (6.2)	4.82-7.58	84 (7.1)	5.63-8.57	137 (11.6)	9.77-13.43
Anemia							
Severe	763	58 (7.6)	5.72-9.48	103 (13.5)	11.08-15.92	213 (27.9)	24.71-31.09
Moderate	5402	432 (8)	7.3-8.7	671 (12.4)	11.55-13.25	1380 (25.5)	24.34-26.66
Mild	7245	499 (6.9)	6.35-7.46	906 (12.5)	11.78-13.23	1693 (23.4)	22.42-24.38
Not anemic	50,924	3341 (6.6)	6.48-6.72	6100 (12)	11.84-12.16	10,328 (20.3)	19.95-20.65
Diabetes							
No	71,865	5771 (8)	7.96-8.04	8518 (11.9)	11.86-11.94	15,351 (21.4)	21.1-21.7
Yes	1161	102 (8.8)	7.18-10.42	81 (7)	5.54-8.46	187 (16.1)	13.98-18.22
Don't know	1294	164 (12.7)	10.9-14.5	176 (13.6)	11.75-15.46	340 (26.3)	23.9-28.7
Asthma							
No	72,560	5844 (8.1)	8.07-8.13	8589 (11.8) P = **0.205**	11.76-11.84	15,433 (21.3)	21-21.6
Yes	1225	125 (10.2)	8.52-11.88	125 (10.2)	8.52-11.88	312 (25.5)	23.06-27.95
Thyroid/goiter							
No	73,439	5932 (8.1)	8.08-8.12	8694 (11.8) P = **0.009**	11.77-11.83	15,962 (21.4)	21.1-21.7
Yes	345	40 (11.6)	8.21-14.99	23 (6.7)	4.05-9.35	84 (24.3) P = **0.163**	19.75-28.85
Don't know	537	65 (12.1)	9.34-14.86	58 (10.8)	8.18-13.43	102 (19)	15.67-22.33

Bold indicates significance, *CI - confidence interval for percentage at 0.001 significance, All significance at a level of 0.001 unless mentioned

416

India, and in the Northeastern states as reported earlier.[1] Future studies should be designed to explore the reasons for interstate variation for various products as this can provide important sociocultural dimensional insights that may be essential to design public policies and probable interaction with local sociocultural patterns on the use of tobacco. It has been observed that the use of gutka is greater than panmasala among males at the national level. But in certain North Eastern states, among males, use of panmasala is higher than gutka. There is a distinct pattern in the consumption of types of chewing tobacco emerging across various regions of India, implying the fact that tobacco cessation programs and awareness campaigns have to be modified to suit the locoregional use of these products rather than a mere vernacular translation of nationally used campaigns.

Poverty and illiteracy

Chewing tobacco was the highest in the least educated, poorest, and scheduled castes, and scheduled tribes. This has been demonstrated by the increase in OR. The socioeconomic differentials in chewing tobacco consumption from this study also compared well with the findings from previous studies in India.[1] The question raised by such studies that why poor and less-educated males consume more chewing tobacco still remains an open empirical question for further investigation and can be partially attributed to the poor level of exposure to the media and awareness campaigns as indicated by this study. Under-reporting of chewing tobacco use by other groups due to social stigma attached with tobacco use in different situations may also have contributed to this trend as reported earlier.[1] Education emerged as a stronger indicator than wealth and occupation for smokeless tobacco use. It is likely that poor and less-educated Indian males are less aware of the health hazards of tobacco consumption; more likely to find themselves in conditions predisposing them to initiation of chewing tobacco. The findings of the study highlights that an agenda to improve health outcomes for the poor and other similar disadvantaged groups in India must also include effective interventions to control smokeless tobacco use, as these groups suffer from the disproportionate burden of smokeless tobacco–induced diseases. In addition, each intervention should be evaluated for its effectiveness separately in different socioeconomic and cultural groups, since access and effectiveness of different program strategies may vary across these groups.[1] The effect of smokeless tobacco advertisement ban, pictorial warning on packages, and limiting sales in certain areas, such as educational zones, and the efforts in this regard by the National Rural Health Mission, have to be evaluated in future studies.

Demographics of tobacco consumption

The cross-sectional nature of the data did not permit the assessment of the trends in tobacco consumption over time. The observation of increase in prevalence of chewing tobacco consumption with age has been previously explained as due to a cohort effect (declining prevalence over time with younger cohorts having lower prevalence) or an age effect (younger people having lower prevalence, with more people initiated into tobacco consumption as they get older) or simply due to under-reporting of tobacco use among young people or a higher awareness among younger individuals.[1] Previous literature suggests no declining trends in tobacco consumption over time in India. The present study portrays a different result for different products. Panmasala and gutka are more popular among younger males, whereas other forms are preferred by the older population. This has been reported earlier by Gupta *et al*, and discussed in detail.[8] This has important policy and program implications—the initiation into tobacco use may occur at any age and not just among young people and hence programs to control tobacco have to focus on almost all age groups up to the age of 50 years. The results of the present study are similar to the results of an independent study in Mumbai in the 1990s indicating that education and occupation have important simultaneous and independent relationships with tobacco use that require attention from policymakers and researchers alike.[9]

A typical Indian male who uses panmasala or gutka is aged below 40 years, from rural parts, is often a non-dejure resident, and is married or separated. He has primary or no education and rarely reads newspaper or listens to radio, whereas he sees television at least once a week. Economically, he belongs to middle to poorer group and often an agricultural employee or a salesman. He has normal BMI and often moderately anemic. He has high chances of having diabetes, asthma, or goiter as compared with nonchewers.

Media implications

Of the study population, only 17.58% of males reported that they cannot read at all and 26.95% of males were never exposed to print media. Radio was not at all used by 29.28% and television was never seen by 12.46% of them. This proportion was still higher among males who use chewing tobacco. This vital factor should be taken care in designing awareness campaigns. Advertisement stating the ill effects of chewing tobacco products can have a better reach only via people to people or a mass people movement rather than involving any media as at least one eighth of males do to have access or see these campaigns.[10]

417

Resultant health

Anemia and diabetes are multifactorial diseases. Areca nut is a known diabetogenic agent and its prolonged use causes increased BMI.[11] This secondary data analysis fails to highlight a strong association of diabetes–increased BMI to panmasala and gutka use. Although the intensity and duration of habits are vital to arrive at a correlation, due to nonavailability, it was not considered for this study. However, the increased prevalence of severe anemia and diabetes among panmasala and gutka chewers as compared with nonchewing population still remains a cause of concern and requires further investigation.

Conclusion

Sociodemographic details of smokeless tobacco use among representative Indian population are presented. This study for the first time identifies the difference between the prevalence of panmasala, gutka, and other tobacco chewing products. Using results of this study, programs aimed at limiting the spread of smokeless tobacco use can be effectively modified to suit the requirements of local populations. The findings of the study highlight that an agenda to improve health outcomes among the underprivileged in India must include effective interventions to control tobacco use. Failure to do so would most likely result in doubling the burden of diseases—both communicable and noncommunicable among marginalized society. There is a need for periodical surveys using more consistent definitions of tobacco use and eliciting information on different types of tobacco consumed and its long-term effects.

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418

Annexure 22

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Tobacco consumption patterns and its health implications in India

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Abstract

The main objective of this paper is to analyze the pattern of tobacco consumption and its health implications in India. We use various rounds of National Sample Survey for this purpose. The paper finds that, though there is a reduction in tobacco consumption in the form of bidi and cigarette in India as a whole, this decrease is compensated for by an increase of pan consumption in rural India. It has also been observed that the consumption of tobacco is more among the poor in India and we argue that the consequent higher health care spending arising out of tobacco related diseases leaves them economically worse off. Thus the paper concludes that, apart from the economic gains that tobacco industry is generating, tobacco use also imposes burden, especially on users, in the form of numerous tobacco related diseases and high health care spending. This, coupled with the fact that the investment on health by government is declining over the years, has the potential to trap the poor in a vicious circle of poverty and ill health. Hence government policy needs to be targeted towards an effective control of tobacco use.

JEL classification: I12; I18; R22

Keywords: Tobacco Consumption; Health; India

1. Introduction

It is well known that tobacco use in any form is potentially harmful from both economic and human development considerations. It is estimated that by 2030, it would account for the death of about 10 million people per year; half of them aged 35–69. This is a matter of serious concern for the developing countries, where more than 82% of the world smokers reside [1]. India, where nearly 17% of the smokers in the world reside [2], is no exception to this tobacco menace. The costs and consequences of tobacco use are multifold. It leads to high morbidity and increased death rate, thereby imposing heavy economic costs on the society in the form of high spending on health care and lost productivity. These factors could prove detrimental to the development process of the nation. Much of the cost in the form of disease and death can and needs to be avoided with policy action aimed at discouraging tobacco consumption.

Government of India has passed certain legislations in the past to curb tobacco use. But unlike in the past, legislation for curbing tobacco use has taken a qualitative change in the recent times mainly with the introduction of Cigarette and Other Tobacco Products

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419

(Prohibition of Advertisement, Regulation of Trade and Commerce, Production, Supply and Distribution) Act, 2003. Many state governments are also enacting various legislations to curb tobacco use in recent times. But in spite of all, tobacco use is still widespread in India. This raises a number of policy relevant questions: What is the pattern of tobacco consumption across various regions and social groups? Is it the poor or the rich, who consume more of tobacco and are thereby susceptible to various health calamities and hence bear the consequent economic costs?

In this context we make a simple attempt to analyze the prevalence of tobacco consumption at various levels and its associated health implications in India. This, we believe, will help us underline the need for effective policy intervention by the government. The fact that the literature on economics of tobacco has not received adequate attention from the researchers in India points out that hitherto this has been a much-neglected topic and underscores the need for such a study. Therefore, while analyzing the data on tobacco consumption from various rounds of National Sample Surveys (NSS) our paper also contributes to the existing literature on tobacco in India. In Section 2 we give a brief review of literature on tobacco consumption in India. Section 3 gives an overview of the tobacco economy in India followed by a detailed description of the data we have used including the particular methodology by which the survey has been carried out. In Sections 5–7 we analyze the pattern of tobacco consumption at various levels. In Section 8 we discuss the health implications of tobacco consumption in India followed by a concluding section.

2. Review of literature

A close examination of the literature on tobacco in India suggests that economics of tobacco is something that has not received adequate attention among Indian researchers. An annotated bibliography of research on use, health effects, economics, and control efforts of tobacco, compiled by Ray et al. [3], provides an excellent source of literature on tobacco in India. Most studies on tobacco in India were confined to either tobacco farming and supply related issues [4,5] or tobacco related diseases [6–9]. However, of late, there have been a few studies on tobacco consumption patterns in India. Using various rounds of the NSS, Gupta and Shankar [10] analyzed the pattern of tobacco consumption in India. But the authors did not examine the implications of the differences in tobacco consumption among different socio-economic groups in India especially in terms of health. Apart from NSS, National Family Health Survey (NFHS) also collects data on tobacco consumption habits in India. Using this data, Rani et al. [11], Subramanian et al. [12], etc. analyzed the pattern and distribution of tobacco consumption and health behavior of households in India. These studies concluded that prevalence of tobacco use was higher among poor, less educated, scheduled caste (SC) and scheduled tribe (ST) populations.[1] A limitation of the above studies is that, NFHS surveys generally collect information from female members in the household, but tobacco consumption habits are more prevalent among males. This could result in serious underreporting.[2] Another limitation is that these studies also do not address the possible health implications of tobacco consumption. This paper contributes to the literature by analyzing tobacco use data by social groups, and by emphasizing the health effect of tobacco consumption.

3. Tobacco economy in India

Following are some important features of the tobacco economy in India:

- India is the second largest producer and fourth largest exporter of tobacco in the world [14];
- Tobacco in India generates nearly Rs. 20 billion of income per annum at the farm, state and central government levels [15];
- In India an estimated 65% of all men and 33% of all women use some form of tobacco [2];
- Approximately 3.5 million people are engaged in tobacco cultivation in India representing less than 0.5% of agricultural labor force [16].

The above statistics depict a flourishing tobacco industry in India. But this growth of the tobacco industry

[1] SCs and STs are historically marginalized and the most deprived section in Indian society. SCs are a constitutionally declared collection of castes, which suffered from the practice of untouchability. Whereas, STs constitute the tribal population, which may be also referred to as the indigenous groups.

[2] See [13] for a detailed critique of NFHS.

in India has not been with out costs. The following statistics show the epidemic dimension of tobacco related diseases in India.

- Around 9-lakh people die in India every year due to tobacco related diseases (The Hindu, June 5 2001);
- Tobacco related cancers account for nearly half of all cancers among men and one-fourth among women [2];
- India has one of the highest rates of oral cancers in the world;
- Oral cancer accounts for one-third of the total cancer cases in India, with 90% of the patients being tobacco chewers (http://www.cdc.gov/tobacco/who/india.htm);
- An estimated 8.3 million cases of coronary artery diseases and chronic obstructive airway diseases are attributable to tobacco every year [2];
- The cost of tobacco related diseases in India amounts to 270 billion rupees every year and it far outweighs the economic gains from tobacco [17].

Given the above facts we feel that it is worthwhile to analyze the pattern of tobacco consumption in India and the associated health impacts.

4. Data and methodology

The National Sample Survey (NSS) was commenced by the Government of India in 1950 to collect socio-economic data using scientific sampling methods. Different subjects are taken up for survey in different rounds of NSS. The 55th round (July 1999–June 2000) and 50th round (July 1993–June 1994) of NSS surveys collected household consumer expenditure data from a large sample of households. These surveys covered almost whole of the Indian Union.

NSS adopts a two-stage stratified sampling design instead of a simple random sampling. Household is the ultimate sampling unit. The sample households for the survey are selected on the basis of probability proportional to the population. Consumption data on various tobacco products are collected using 30-day recall periods.[3] When the entire sample is considered the reference period, in effect, becomes a moving one as NSS spreads the interview of different households uniformly over the duration of the survey that lasts nearly 1 year. It thus helps to average out the possible seasonal variations. These characteristics, coupled with the coverage of more than 100,000 households spread across more than 10,000 villages in India makes NSS, the source of the largest and most widely accepted household level data in the country.

Since our objective is to emphasize the health related aspects of tobacco consumption and its effect on the poor, and not to model the household behavior leading to tobacco consumption as such, we have not attempted any rigorous econometric exercises here. Instead, we have used a simple descriptive analysis to observe the general patterns in terms of the trends in per capita tobacco consumption of various tobacco products from different rounds of NSS. We report the data only for those states and union territories (UT) for which sample size is more than 100.

5. Consumption patterns (national scenario)

According to the 55th round (1999–2000) of NSS, in India, 54% of tobacco consumers consume bidi, 15% consume cigarettes and 30% consume different chewing tobacco products.[4] Table 1 gives the change in pattern of consumption of different tobacco products in India over the last decade as obtained from different NSSO quinquennial surveys. The table clearly shows the differences in consumption habits as well as the decreasing trend in the consumption of tobacco products among both rural and urban households. The values

[3] From the 55th round onwards the data on tobacco products are collected for both 30-day and 7-day recall periods. However for the purpose of comparability over different rounds, we have used only the 30-day recall period data for all the rounds. However there are debates on which recall period to be used etc.

[4] Both bidi and cigarette are two commonly used smoking tobacco products in India, bidi being the most popular. Bidi is much cheaper compared to cigarette and is used mostly by relatively poorer individuals. Bidi contains only a small amount of tobacco (0.15–0.25 g) compared to 1 g in cigarette. But it delivers as much as 45–50 mg of tar and 1.74–2.05 mg of nicotine compared to 18–28 and 1.55–1.92 mg of tar and nicotine respectively in Indian cigarette. Pan (betel–quid chewing) is a smokeless tobacco, which consists of betel leaf, areca nut, slaked lime, catechu and tobacco [7]. Many households use a combination of products. For example, households who consume bidi may also consume cigarette or some other tobacco products such as pan, tobacco leaf, zarda, etc.

Table 1
Trends in per capita quantity and value of consumption of various tobacco products per 30 days in rural and urban India

Item	43rd round, 1987–1988		50th round, 1993–1994		55th round, 1999–2000	
	Quantity (no.)	Value (Rs.)	Quantity (no.)	Value (Rs.)	Quantity (no.)	Value (Rs.)
All-India rural						
Pan	0.65	0.21	0.64	0.39	0.83	0.78
Bidi	49.5	1.93	45.74	3.7	38.18	4.91
Cigarette	1.05	0.27	0.8	0.45	0.96	0.88
All-India urban						
Pan	1.7	0.7	1.39	1.16	1.2	1.76
Bidi	38.67	1.6	32.39	2.79	22.13	3.12
Cigarette	4.89	1.47	3.65	2.45	3.24	3.68

Source: Ref. [23].

given in the table are in current prices. The main observations may be summarized as follows:

- Bidi consumption has been steadily declining in both rural and urban areas and the relative consumption of bidi is more in rural areas than in urban areas. This could be because of the low unit value of the bidi and the low income of the rural population;
- It is also interesting to note that the percentage decline in per capita bidi consumption is more in urban (42.77%) than in rural (22.87%) India over the period of analysis;
- Another interesting feature is that, the decrease in bidi consumption has more or less been compensated by an increment in the consumption of pan in rural areas. In other words, consumption of pan has increased in the rural areas over the same period. However, this sort of a shift in consumption has not been observed among the urban population. It may be a sign that the urban populace, in general, is gradually decreasing the consumption of various tobacco products relative to their rural counterparts;
- Per capita number of cigarettes consumed is more in urban India than in rural India. One obvious reason could be the higher price of cigarette and relatively higher purchasing power of urban population. It may be also due to some cultural factors, e.g., the taboo associated with smoking cigarettes among some villagers [18];
- There is a consistent decrease in cigarette consumption in urban India whereas, in rural India even though it has decreased over the period, it shows an increase in last period of the study. From the year 1987–1988 to 1999–2000 the percentage decrease in cigarette consumption was also very high (33.74%) in urban India compared to rural India (8.6%);
- The pan consumption has been increasing in rural India especially between the 50th and 55th round surveys, while it has been showing a declining trend in urban area.

In short, one can safely conclude from the above figures that the tobacco consumption habit of the urban household is showing a declining trend on the whole. But among the rural households, though bidi and cigarette consumption are declining, we see that pan consumption has actually increased over the years. The possible reasons for this kind of consumption behavior can be understood only by further research.

6. Consumption patterns (state level)

Table 2 shows the state-wise per capita annual consumption of bidi and cigarette, compiled from the NSS reports for both rural and urban population. The detailed figures are not available for the year 1987–1988. As we can see from the table, figures for the rural and urban households at the state level are very much in conformance with the National level estimates. It reflects an over all decline in the per capita consumption of tobacco with differences in rural areas. The main observations are highlighted in the following:

- Among the rural households, Meghalaya, Tamil Nadu and Dadra Nagar Haveli are the only states/UTs, which showed an increase in the bidi consumption; on the other hand, Mizoram is the only

422

Table 2
State-wise per capita monthly tobacco consumption (rural and urban)

State	Rural India				Urban India			
	Bidi (no.)		Cigarette (no.)		Bidi (no.)		Cigarette (no.)	
	1993–1994	1999–2000	1993–1994	1999–2000	1993–1994	1999–2000	1993–1994	1999–2000
Andhra Pradesh	48.06	38.95	2.80	3.52	25.47	14.27	7.86	8.03
Arunachal Pradesh	28.46	14.43	1.71	0.37	22.30	5.59	7.52	4.91
Assam	33.19	13.83	1.16	0.57	17.07	7.29	8.31	4.01
Bihar	10.63	6.92	0.13	0.14	6.57	3.92	1.15	0.93
Goa	34.84	16.55	4.54	3.78	31.01	14.14	4.21	1.78
Gujarat	74.17	63.84	0.16	0.26	47.12	31.57	0.90	0.41
Haryana	80.50	80.01	0.12	0.42	58.86	51.73	1.81	1.67
Himachal Pradesh	72.67	62.60	0.93	1.66	50.01	29.15	6.68	7.35
J&K	70.72	32.30	3.04	7.45	33.79	10.44	7.79	10.60
Karnataka	51.55	42.63	0.65	0.67	32.09	19.70	2.59	2.31
Kerala	45.09	26.35	3.35	4.95	32.70	17.65	5.27	5.66
Madhya Pradesh	52.46	42.23	0.17	0.24	38.38	30.00	1.58	1.27
Maharashtra	22.17	16.43	0.39	0.01	15.52	9.84	2.81	1.99
Manipur	51.05	27.85	2.40	2.39	39.97	19.98	3.16	4.08
Meghalaya	37.07	49.24	4.67	2.37	24.31	19.52	23.17	9.24
Mizoram	10.12	9.08	0.98	5.17	1.04	2.03	6.37	12.57
Nagaland	63.07	37.53	5.78	0.85	47.39	36.05	12.87	2.67
Orissa	14.24	9.45	0.17	0.23	14.64	5.69	3.70	1.06
Punjab	22.77	13.40	0.82	0.63	32.02	22.25	2.22	0.94
Rajasthan	87.34	78.60	0.43	0.44	56.95	40.74	1.99	1.55
Sikkim	20.48	8.12	2.85	1.95	13.82	9.21	3.87	3.67
Tamil Nadu	26.90	35.03	1.77	2.32	21.73	12.70	4.26	5.49
Tripura	94.66	79.29	3.32	2.11	57.76	55.40	15.02	15.18
Uttar Pradesh	54.94	46.52	0.26	0.31	36.21	31.56	2.00	1.23
West Bengal	65.96	61.61	0.89	0.66	45.57	42.79	8.20	8.43
A&N Island	24.09	13.73	4.29	0.84	18.65	6.61	9.78	2.54
Chandigarh	84.32	54.93	0.15	2.49	79.71	35.71	3.92	3.57
Dadra & Nagar Haveli	26.37	28.02	0.37	0.84	–	–	–	–
Damen & Diu	63.93	11.16	0.72	0.98	34.54	21.08	1.14	1.35
Delhi	125.29	27.84	4.36	2.43	56.31	19.72	5.43	3.81
Lakshadweep	–	–	–	–	43.12	30.60	4.77	9.57
Pondichery	16.09	15.36	0.28	1.29	7.33	3.89	2.40	5.26
All India	45.74	38.18	0.80	0.96	32.39	22.13	3.65	3.24

Source: Ref. [23]; Sarvekshana October–December 1996 for the year 1993–1994.

state, which shows an increase in bidi consumption in urban India;

- While the rural households of 18 states including three UTs have shown an increase in cigarette consumption in the 55th round compared to the 50th round, only 12 states/UTs showed a similar increase in cigarette consumption in urban India;
- In both Tamil Nadu and Dadra Nagar Haveli consumption of both bidi and cigarette have gone up among the rural population. Similarly in Mizoram, consumption of both bidi and cigarette has gone up among the urban population;
- Haryana, Tripura and Rajasthan are the states with very high per capita consumption of bidi in both rural and urban India. The per capita number of monthly bidi consumption in these states are above 80;
- J&K, Mizoram, Tripura and Kerala are states, where per capita consumption of cigarette is relatively higher in both rural and urban areas. Urban Mizoram is unique in the sense that the per capita number of cigarette consumption is six times higher than bidi. On the other hand, it is interesting to note that in some of the states/UTs like Nagaland and Andaman & Nicobar Islands, the per capita cigarette

423

Table 3
Percentage consumption of tobacco among socio-economic groups (all India)

Category	Rural			Urban		
	Smoke	Smokeless	Total	Smoke	Smokeless	Total
Income						
Lower	32.50	32.70	59.10	28.69	16.97	42.58
Middle	44.40	29.50	65.70	30.47	14.73	41.48
Higher	45.60	24.70	60.80	27.28	10.86	34.52
Caste						
ST	44.80	41.90	74.60	38.66	35.45	63.12
SC	46.70	30.30	68.10	40.12	19.25	54.00
OBC	38.53	30.25	60.64	29.48	14.22	40.31
Others	39.40	21.51	55.43	24.94	10.44	33.20
Religion						
Hindu	40.8	30.70	63.40	28.36	14.04	39.21
Muslim	51.2	18.00	63.20	35.70	12.12	44.23
Christian	4.80	32.00	65.60	31.51	26.05	49.15
Sikh	8.50	7.900	15.10	4.18	2.32	5.48
Jains	12.00	12.00	24.00	9.90	7.49	16.18
Buddhist	32.90	37.00	61.10	23.50	29.80	48.71
Others	43.30	39.60	69.80	44.30	11.41	52.01

Note: lower-income groups represent distribution of households up to 30th percentile and middle-income represent 30th to 70th percentile. SC: scheduled castes; ST: scheduled tribes; OBC: other backward castes.

consumption has fallen substantially over the period of analysis.

As we can see there are perceptible differences in consumption patterns across various states. The possible reasons behind this could be found only by more rigorous state-wise analyses.

7. Consumption patterns (socio-economic groups)

Table 3 shows the percentage of people consuming tobacco among different socio-economic groups. As we can see from the table, in rural India, the percentage of households consuming smoke tobacco increase as we move from lower to higher income groups, while the opposite is happening in case of smokeless tobacco. In urban India, on the other hand, prevalence of smoke tobacco is highest among the middle-income group. But still the smokeless tobacco consumption increases as we go from higher to the lower income groups. Coming to religious groups, excepting Sikhs and Jains all other groups exhibit more or less similar consumption patterns. Prevalence of tobacco consumption is very less among Sikhs and Jains and this is probably due to the religious sanctions against using tobacco among these communities.

Moving over to the social groups we can see that all forms of tobacco consumption is higher among the backward castes (scheduled tribes, scheduled castes and other backward castes) compared to the general category. These results are in conformance with the results from NFHS. Using the data from NFHS, Subramanian et al. [12] showed that there is a strong relationship between the health behaviors and household socio-economic position, with the better off smoking, chewing and drinking less. Within the backward castes itself the consumption is more among ST and SC who are relatively more backward than OBC. All these point to the fact that the tobacco consumption is more prevalent among the poorer sections of the society compared to its richer counterparts.[5] But this does not mean that there is a negative relation between income and tobacco

[5] It may be confusing that in rural areas smoke tobacco consumption increases as we go from lower to higher income groups, whereas the consumption of smoke tobacco is higher among STs and SCs who are relatively poorer. This is because SC/ST together constitute only around 30–35% of the population and even the lowest income group comprises roughly 55% of it OBC and general category that are relatively richer than the SC/ST.

Table 4
Engel elasticity estimates for tobacco products: all India

Products	Rural India		Urban India	
	1961–1962	1999–2000	1961–1962	1999–2000
Bidi	0.923	0.693	0.581	0.007
Cigarette	1.985	–	1.697	1.46
Tobacco (leaf)	0.518	0.013	–	–
Tobacco (total)	0.827	0.792	0.866	0.572

Source: Ref. [19].

Table 5
Prevalence of certain types of diseases among tobacco consumers and non-consumers aged 10 years and above

Tobacco habit	Tuberculosis	Cancer	Heart disease	BP	Acute respiratory
Rural India					
Smoking	12	490	610	1730	550
Smokeless	18.2	150	610	1310	200
None	9.8	200	870	1140	160
Total population	10.8	220	790	1210	210
Urban India					
Smoking	12.4	250	1080	2200	630
Smokeless	20.2	120	2000	2390	540
None	6	170	1220	2480	270
Total Population	7.7	170	1260	2460	310

Source: Refs. [22,24] (all figures are per 10,000 person).

consumption. We can verify this by examining the Engel elasticities for the tobacco consumption.[6] Suryanarayana [19] has estimated the Engel elasticity for tobacco products using NSS data, which has been reproduced here in Table 4.

As we can observe, for both rural and urban India, the Engel elasticity is positive for all the items. One can also see that these elasticities have declined between the years 1961–1962 and 1999–2000, meaning the effect of income on tobacco has decreased over this period. Thus we see that an increased income does have the effect of increasing the tobacco consumption though at a lesser rate than the increase in income. But, an increase in income may not be the reason behind a high prevalence of tobacco consumption among the poor. It may be due to the lack of awareness about the ill effects of tobacco use, myths about the medicinal properties of tobacco, etc. among them.

[6] Engel elasticity is defined as a percentage change in consumption expenditure on a particular commodity as a result of a given percentage change in the total expenditure (income) of the consumer.

8. Health implications of tobacco consumption

The high prevalence of tobacco consumption in India has not been without costs as we have already seen in Section 3. The morbidity caused by a variety of chronic diseases like tuberculosis, cancer, etc. poses a serious threat to the nation as a whole and the tobacco consuming population in particular. Several studies abroad and some in India have established the causal relation between smoking and Tuberculosis. The most recent study is by Gajalakshmi et al. [9] in Chennai, which found that the risk of mortality for smokers aged 25–69 from respiratory tuberculosis, after adjusting for age, education and chewing tobacco, was 4.2 times higher than that for non-smokers of the same age. Similarly the risk ratios (ever to never smoked at 95% confidence interval) for other diseases as given in the study are as follows. Other respiratory: 3.6, vascular: 1.7 and neoplastic: 2.5. Table 5 shows the prevalence of different tobacco related diseases among tobacco consumers and non-consumers. Data for this was collected for the period July 1995–June 1996 by NSSO in its 52nd round. The data here is reported only for the

Table 6

Investment in health in India as a percentage of total plan investment

Plan periods	1951–1956	1956–1961	1961–1966	1969–1974	1974–1979	1980–1985	1985–1990	1992–1997	1997–2002
Investment (%)	3.3	3	2.6	2.1	1.9	1.8	1.7	1.7	2.31[a]

Source: Health Information of India, Ministry of Health and Family Welfare, Government of India.

[a] This is outlay, not actual.

age group above 10 years, since tobacco consumption habits in India, in general, is not so prevalent among less than 10-year age group. More over one would not expect to see tobacco-attributable illness among less than 10-year age group.

We can note that the prevalence of all the diseases is very high among tobacco users (both smoking and smokeless tobacco) than non-users in both urban and rural India.[7] It is also higher than the prevalence of those diseases among the general population. This is very much an expected result. From the table it is evident that tobacco consumers, in general, have higher incidence of a variety of diseases compared to non-users and that would also mean the money spent on health by tobacco users would be much higher than that by non-users. More over many of the present tobacco users, who belong to the younger generation, will succumb to diseases only at a later period and that will increase the cost of their health care only in future. It thus points to the huge health care costs the country will have to incur for treating tobacco related diseases.

In India what is alarming is the fact that in spite of the higher health burden due to tobacco related diseases; the investment on health has been undergoing a steady decline over the years. Table 6 shows total investment on health in India during different Five Year Plans as a percentage of total plan investment.[8] We can observe a continuous decline of investment in health as a percentage of total plan investment. On the one hand investment in health is declining while on the other hand the tobacco related diseases and the associated health burden remains to be higher. In India we also note that general government expenditure on health as a percentage of total expenditure on health constitutes just 18% and the remaining 82% is private expenditure [20]. More over, nearly all the private spending in India is out-of-pocket at the point of service use, which is an inefficient way to finance health care that leaves people highly vulnerable [21].

If we also consider the fact that the prevalence of tobacco use is higher among the poor and it puts them at a higher risk of cardiovascular and other tobacco-related diseases than the rest, the welfare implications become enormous for the following reasons. Any disease has the effect of reducing a person's capacity to earn by making him unhealthy. A reduced income coupled with high expenditure on health care, in effect, makes the poor person poorer, thus trapping him in a vicious circle of poverty and ill health. Higher spending on health by an individual would also mean his inability to spend on food and other essential items. In India, as we have noted above, private expenditure constitutes the major chunk of total health expenditure. More often than not, poor are simply unable to afford this huge private health expenditure. Thus higher prevalence of tobacco use among the poor leads to worsening of the already high inequality in the poor income countries by way of an increased expenditure on tobacco-related diseases.

9. Conclusions

The above analysis gives us a reasonable picture of the tobacco economy in India, the patterns of consumption of tobacco and its associated health implications. We saw that tobacco consumption is decreasing in urban India, while at the same time such decreases are compensated for by an increase in pan consumption in rural India. We also observed that, apart from the economic gains that tobacco industry is generating, tobacco use also imposes burden, especially on users, in the form of numerous tobacco related diseases and high health care spending. Tobacco consumption be-

[7] The prevalence of heart diseases is found to be higher among the non-users in rural India. This is an unexpected result and may be due to some problems in reporting; else we require scientific evidence to prove otherwise. It may be also due to some selection bias operating in the sample, as many tobacco users may have already died and are, hence excluded from the sample.

[8] In India, Plan Investment always does not necessarily mean the total money spent. The actual money spent will be often less or some times more than the Plan Investment.

426

ing higher among the poor people, the burden of health hazards will also be greater on poor. The adverse health impacts of this high tobacco use will be enormous when the country is already facing poverty and malnutrition. Since the opportunity cost of spending huge amounts of money on tobacco related morbidity is very high government policy needs to be targeted towards an effective control of tobacco use. The recent Cigarette and Other Tobacco Products (Prohibition of Advertisement, Regulation of Trade and Commerce, Production, Supply and Distribution) Act, which came into force on May 1, 2004 is a right step in this regard. But what is to be emphasized is the effective implementation of such Acts.

The nature of consumption of tobacco varies across states in India with people in different regions using a variety of tobacco products such as bidi, cigarette, tobacco leaf, zarda, hookah, etc. and more often that not, these products cater to different sections of the society. Hence any policy formulations on tobacco control should be able to address these issues. There is a greater need for a thorough study on the economics of tobacco in India with special emphasis on issues like incidence of tobacco use across socio-economic groups in a given state/region, the economic costs associated with tobacco consumption and production, regulatory potential of various policy options in curbing consumption and production of different tobacco products and various determinants of tobacco production. This can give adequate guidelines for state specific and product specific policies that can effectively curb the use of tobacco.

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428

TOBACCO USE AMONG STUDENTS IN BIHAR (INDIA)

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Summary

Determination of the prevalence and attitudes toward tobacco use was assessed among 13-15 years school students in Bihar (India). Settings and design: Schools having grade 8-10 in Bihar. A two stage cluster sample design was used. SUDAAN® and the C-sample procedure in Epi-Info was used for statistical analysis. Of the 2636 respondents, 71.8% (76.5% boys, 57.2% girls) were ever tobacco users; of them 48.9% had used tobacco before 10 years of age. Current use was reported by 58.9% (Boys 61.4%, Girls 51.2%); smokeless tobacco by 55.6% (Boys 57.6%, Girls 49.2%); and smoking by 19.4% (23.0 % boys, 7.8% girls). Nearly one third (29%) students were exposed to ETS inside their homes and nearly half (48%) outside their homes. Almost all students reported watching cigarette and gutka advertisements in almost all kinds of media and events. Tobacco use by parents and friends, knowledge on harmful effects of chewing tobacco, smoking and environmental smoke, and attitudes on tobacco use by others were strongly associated with student tobacco use. Current tobacco use was reported significantly more by students who received pocket money/or were earning than by students who did not receive any pocket money/ or did not earn (p value for trend <0.0001). Over half of current users (56%) bought their tobacco products from stores; of these, over 3/4th (77.2%) of them despite their age, had no difficulty in procuring these products. Teaching in schools regarding harmful effects of tobacco use was non-existent (3%). This urgently requires a comprehensive prevention program in schools and the community especially targeted towards girls.

Keywords: Adolescent, Smoking, tobacco use Environmental tobacco smoke

Introduction

The prevention of tobacco use in young Indians appears as the single greatest opportunity for preventing non-communicable disease in the world today as it is home to one sixth of the global population. Tobacco use is one of the major preventable cause of death and disability worldwide. WHO estimates, 4.9 million deaths annually are attributable to tobacco (1). This figure is expected to rise to 10 million in 2030, with 7 million of these deaths occurring in developing countries, mainly China and India. India is home for one sixth of global population. Currently about one-fifth of all worldwide deaths attributed to tobacco occur in India, more than 8,00,000 people die and 12 million people become ill as a result of tobacco use each year. The deaths attributable to tobacco, in India, are expected to rise from 1.4% of all deaths in 1990 to 13.3% in 2020 (2). It is estimated that 5,500 adolescents start using tobacco every day in India, joining the 4 million young people under the age of 15 who already regularly use tobacco.

World Health Organisation and Centres for Disease Control, USA, developed the Global Youth Tobacco Survey (GYTS) for this purpose.[3-4]

The GYTS is a school-based tobacco specific survey that focuses on students' age 13-15 years. The objectives of this survey are the following: to document and monitor prevalence of tobacco use; to better understand and assess students' attitudes, knowledge and behaviors related to tobacco use and cessation, their exposure to environmental tobacco smoke (ETS) and tobacco in the media and advertising, their access to tobacco in the marketplace, and information on tobacco in their schools' curricula. Various reports on GYTS in India have been published.[5-7]

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Bihar is geographically located at Latitude: 25.11° N Longitude: 85.32° E, covering a population of 82,878,796 (Men, 43,153,964, Women, 39,724,832). Density (per sq. km.) is 880 with a sex ratio of 921 women per 1000 men.[9] Bihar State produces 1.6% of raw tobacco of total production in India[9] however the oldest cigarette factory was established in Bihar (name and date of establishment). High prevalence tobacco use in Bihar is known across the years.[10-16]

Materials & Methods:

The India-Bihar Global Youth Tobacco Survey (GYTS) project of WHO/CDC was a school-based survey of students in standard VIII-X. A two-stage cluster sample design was used to produce representative data for all of Bihar. Initially a file of all 9905 schools in Bihar having grades 8, 9 and 10 was prepared with the enrollment of boys and girls in each class. At the first stage, 50 schools were selected with probability proportional to their enrollment size. At the second stage, depending upon the number of classes, 1-5 classes were randomly selected and all students in selected classes were eligible to participate. In GYTS a core questionnaire containing core questions is mandatory for all countries. For India additional questions were suitably added to include tobacco use in the form of bidi smoking and various kinds of smokeless tobacco use. The questionnaire was pre-tested among young boys in Patna. Survey administrators were trained for three days. Permission from the State Government and schools were obtained. The study was carried out during April -December 2000, in 50 selected schools of Bihar, eastern India. The questionnaires were self-administered without any identifying information, skipping or branching pattern. Anonymity was maintained. The responses were recorded on machine-readable special answer sheets. In the computation, confidence intervals and the probability of selection were taken into account. Analysis was performed with Epinfo software. Definitions and other guidelines for GYTS (described elsewhere)[3-4] were followed.

Results:

All 50 selected schools participated. Among 3760 sampled students, 2636 responded; 76% were boys; 59.8% were rural and 40.25% were rural students. The mean age for respondents was 14.0 years (with SD 0.9 years).

Ever tobacco use (used even once) was reported by 71.8% (76.5% boys, 57.2% girls); nearly half of them 48.9% (girls 63.8% and boys 45.4%) reported tobacco use at 10 years of age or earlier. Current tobacco use (within 30-day preceding the survey) was reported by 58.9% (Boys 61.4%, Girls 51.2%). Current use of smokeless tobacco products was reported by 55.6% (Boys 57.6%, Girls 49.2%) (Table1); gutka being the most popular (84%). Current smoking was reported by 19.4% (23.0 % boys, 7.8% girls) students (Table1); of them cigarette being the most popular (69%).

There was no statistical difference in any type of tobacco use between students of urban and rural area (Table 1). Students aged 15 years reported more current tobacco use than students aged 13 and 14 years, however the difference was not statistically significant. (Table-1)

Tobacco users reported having one or both parents who smoked significantly more often than never tobacco users (51.7% vs. 27.2%). Similarly more tobacco users reported that all or most of their friends smoked (26.2% vs. 4.6%) grades or chewed grades (31.6% vs. 3.6%). (Table-2)

Over 2/3rd of students considered smoking (66.1%) and chewing (65.3%) harmful, and more than half considered ETS (58.2%) harmful. Significantly more tobacco users reported that 'Smoking, Chewing/ETS is harmful' than never tobacco users. (Table-2)

Twenty-nine percent of students lived in homes where others smoked. Nearly half of the students (48.0%) were around others who smoke in places outside their home. Students who smoked were exposed to ETS three times more in their homes and twice more outside their homes compared to those who never used tobacco. (Table 2) 'Smoking should be banned from public places' was reported by 72.2% students.

Student tobacco users reported to have a 1.5-2 times greater positive perception towards tobacco use by other boys and girls, 5-14 times greater positive perception towards tobacco use by men and 3-5 times greater positive perception towards tobacco use by women than never tobacco users. (Table 2)

Smoking at home was reported by nearly one third to one half (30.8%) (boys 28.2%, girls 53.5%) by current smokers. Chewing, applying at home was reported by half about 48.8% of students who currently used smokeless tobacco (boys 41%, girls 81.9%). Purchasing tobacco products in a store was reported by 56.1% of current tobacco users. Among students who bought cigarettes/other tobacco products in a store over three fourths (77.2%) (boys 41%, girls 81.9%) were not refused purchase because of their age.

Almost all students reported having seen advertisement messages on gutka and cigarettes in different media (Table 3). Among current smokers 66.4% wanted to stop smoking and 59.1% tried to stop smoking during the past year. Very few students (3.0%) accepted that they had been taught about the dangers of smoking and the effects of tobacco use in class during the past year.

Current tobacco use was associated significantly with the amount of pocket money received (pocket money < Rs. 10/-; odds ratio (OR) 1.78; 95% CI: 1.57-2.01 and =Rs. 10; OR 2.16 (95% CI: 1.99-2.35) as compared to students who did not receive any pocket money (p value for trend <0.0001). The same was true for girls as well (Figure 1).

Discussion:

Current tobacco use prevalence among students (61.4% boys, 51.2% girls) was high. Such high prevalence has been reported from a few places in the world.[7] In Bihar tobacco use among adults is culturally ingrained. Tobacco use among adults in various studies in Bihar across the years has been shown to be high.[10-12] In one study in rural area of Sitamarhi district with 2910 male and 2586 females participants tobacco use prevalence was74.1 and45.0 among men and women respectively.[10] Among professional groups too like school personnel (daily smoking 14.5%, daily smokeless tobacco use 41.7%),[13] print media personnel, (98%)[14], male medical students, (43 %)[15] and dental students (boys 65.9%, girls 38.5%) in Bihar[16] tobacco use was reported high. High prevalence of tobacco use among students therefore is attributed to high rates of tobacco use in the community. The literacy rate[8] (male 60.3%, female, 33.6%) in Bihar is the lowest in country; that could be additional contributory factors.

Tobacco use by adolescent (especially by girls) is not culturally acceptable in Indian society. Beyond these cultural norms, the present study demonstrated current smoking among 8% girl students; over half of them usually smoking at home (53.5%). Nearly half (49.2%) of the girls used smokeless tobacco products and over 81% (81.9%) of them used these products in home. Gender gap in tobacco use is narrowing globally.[14] High prevalence of smoking and smokeless tobacco use among girls in Bihar may be attributed to globalisation and tobacco industry's advertisement impact in glamorising tobacco as a tool of women emancipation.

Initiation of tobacco use at 10 years or below was reported by 45.4% boys and 63.8% girls. Consequently, strategies need to be developed to reduce initiation of tobacco use among the under ten years age group.

A recent report demonstrated an increase in oral cancer incidence in India [17]. This is supported by a comparison of the age specific incidence rates of mouth cancers (ICD 143-5) during 1983-1987 and 1995 which showed that the incidence had significantly increased in the younger population (< 50 years). The prevalence of mawa (chewing product) use in Bhawnagar, Gujarat went from 4.7% in 1969, mainly among older women to 19% in 1994-95 mainly among the younger generations.[18] These trends indicate that smokeless tobacco use and incidence of oral cancer are increasing among the younger population. The majority of tobacco chewers in the present study reported chewing gutka, confirming the countrywide trend of increasing gutka use. Gutka is one of the most highly advertised products. It is noteworthy that almost all students reported watching a lot of gutka advertisements in almost all media. (Table 3)

45

The relationship between current use of tobacco and selected characteristics was examined. Like in the previous GYTS studies[5], current use of tobacco in Bihar students was associated with a positive perception of students towards tobacco use by others, parental use of tobacco, most or all friends smoking or chewing, less knowledge of harmful effects of smoking, chewing and exposure to environmental tobacco smoke.

Current tobacco use was also associated with having pocket money. (Figure 1). Shah et al in a study among street children found that they were spending over 6 rupees per day on gutka. The amount spent on gutka also represents a large portion (21%) of the 29 rupees earned on average daily by the children. Some children earning less than 20 rupees a day spent as much as 8.6 rupees daily on bidis (an astounding 43% of their earnings on tobacco). Some children earning less than 60 rupees per day spent 8 rupees per day buying mava (representing 13% of their income). Quantities of tobacco products consumed increased consistently until daily income levels reached 200 rupees, after which they declined.[19] This disadvantaged group has no parents. In case of school children guardians need to keep a careful watch on their children when allotting pocket money.

Parental tobacco use was strongly associated with tobacco use among the school children. Such evidence, however, indicates a potential for improved health education in the community and through the mass media, and within antenatal and child health clinics, to inform current and future parents about the dangers of introducing children to health-damaging practices.

The present study demonstrated that-(1) There is no restriction on sale of tobacco to minors in Bihar; over three fourths of students (77.2%) had no difficulty in procuring tobacco products from stores because of their age. (2) Almost all students were exposed to cigarette and gutka advertisements in different media (Table 3) (3) Eighty- percent young students are non-smokers. They need to be protected from tobacco smoke.

The existing law "The Cigarettes and Other Tobacco Products (Prohibition of Advertisement and Regulation of Trade and Commerce, Production Supply and Distribution) Act, 2003 No 34 of 2003 and the Bihar State Prevention of Food Adulteration Act, 1954 (37 of 1954), Amendment 2003 restricts tobacco promotion, sale of tobacco products to minors and protects non smokers in public places. These provisions need to be implemented vigorously.

Curricular teaching on tobacco in Bihar was reported to be virtually nil (3%), however majority of the students were aware of the dangers of smoking (66%) and passive smoking (58%) and supported tobacco control (ban public smoking 72.2%). In Western settings, comprehensive school control policies have shown success in delaying initiation of smoking and in decreasing smoking rates.[20-22] Thus there is great potential for such Comprehensive School Tobacco Control Policy comprising a combination of tobacco-free school policies and an evidence-based curriculum linked to community- wide programs to provide young people with the ability to resist pressure to start tobacco use.

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Table 1: Ever and current tobacco use by sex, grade and settings, India-Bihar GYTS, 2000

	Ever tobacco use (%)	Current Use				
		Any tobacco Product	Any smoked Product	Smokeless Product	Cigarette	Gutkha
Total	71.8 (±5.8)	58.9 (±6.9)	19.4 (±3.2)	55.6 (±7.5)	7.9 (±2.7)	14.4 (±3.4)
Male	76.5 (±4.5)	61.4 (±7.8)	23.0(±2.7)	57.6 (±8.6)	9.6 (±2.5)	16.7 (±3.7)
Female	57.2 (±11.3)	51.2 (±11.3)	7.8(±3.4)	49.2(±11.5)	2.5 (±2.8)	7.0 (±3.0)
Rural	72.8 (± 5.6)	59.4(±8.0)	21.8(±3.3)	55.3 (± 9.0)	7.5 (± 3.2)	14.4 (± 2.9)
Urban	70.1 (± 10.6)	58.2 (±11.4)	15.6(±5.5)	56.2(±11.5)	8.3 (± 4.7)	14.2 (±6.0)
13 years	69.8 (± 8.3)	55.7 (±9.2)	18.6(±5.8)	53.0(±9.7)	7.1 (± 4.1)	10.6 (± 4.1)
14 years	67.8 (± 6.4)	56.0 (±6.8)	17.6(±4.2)	52.1(±7.0)	6.5 (±2.7)	12.1 (± 3.7)
15 years	78.8 (± 7.6)	67.6 (± 10.2)	22.2(±4.6)	64.7(±10.9)	12.4(± 5.0)	18.7 (± 5.7)

Figures in parentheses denote 95% confidence interval

Table 2: Associated factors with current tobacco use, India-Bihar GYTS, 2002

	Never user of tobacco (%)	Current Smoker (%)	Current Smokeless (%)
Users parent or peers			
User parents	27.2 (± 5.0)	51.7 (± 12.9)	45.2 (± 6.0)
User friends (smoke)	4.6 (± 2.2)	26.2 (± 11.2)	11.5 (± 4.2)
User friends (chew)	3.6 (± 2.2)	31.6 (± 14.9)	13.7 (± 4.5)
Knowledge on harmful effects			
Smoking is harmful	72.0 (± 4.4)	49.1 (± 14.7)	64.2 (± 5.1)
Chewing is harmful	72.0 (± 4.8)	50.8 (± 13.4)	62.7 (± 5.7)
(66.9) ETS is harmful	64.2 (± 8.9)	47.7 (± 13.4)	54.2 (± 6.3)
Exposed to smoke from others in the past 7 days			
in their home	21.4 (±4.6)	56.8 (±7.0)	—
outside their home	42.6 (±6.4)	67.0 (±6.0)	—
Attitude			
who smoke are Successful/Intelligent/Macho/sophisticated			
Men	3.1(±1.6)	41.9(±12.9)	16.5(±3.8)
Women	11.9 (±3.2)	57.2(±15.2)	29.9 (±6.9)
Think boys/girls who smoke or chew have more friends			
boys	20.0 (±5.1)	40.4 (±7.4)	34.7 (±6.0)
girls	12.2 (±3.9)	29.3 (±7.0)	26.2 (±6.1)
Think smoking makes the boys/girls look more attractive			
boys	19.0 (±4.7)	37.4 (±7.1)	29.4 (±5.3)
girls	17.2 (±4.2)	36.5 (±6.8)	27.5 (±5.1)

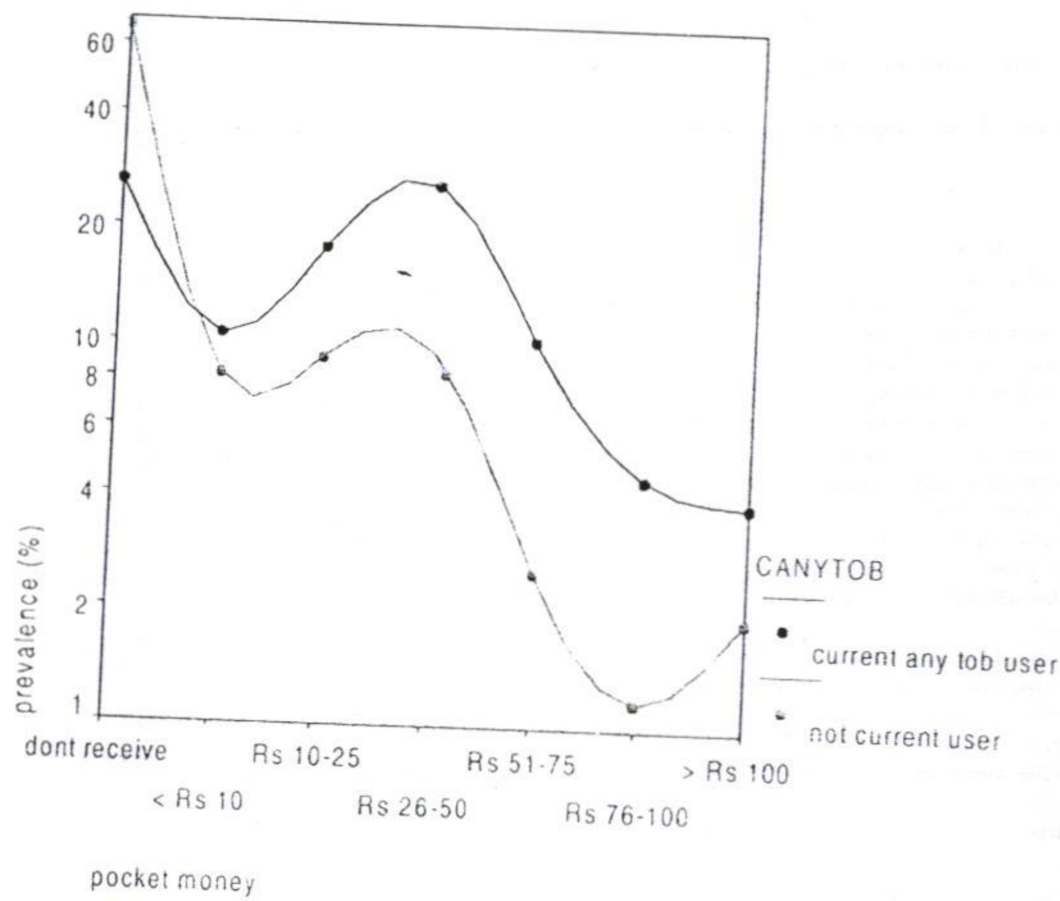
Figures in parentheses denote 95% confidence interval

Table 3: Media and Advertising – Cigarette and Gutka / Pan masala India-Bihar GYTS, 2000

Category	Seen alot of advertisement and media messages about guthka / pan masala on:							
	TV		Print Media		Newspapers/Magazines		Social gatherings	
	A lot	Sometimes	A lot	Sometimes	A lot	Sometimes	A lot	Sometimes
Cigarette	2.9(±1.6)	94.7(±2.8)	3.3 (±1.9)	95.1 (±2.8)	4.3(±3.6)	92.2(±5.1)	3.1(±1.8)	93.9(±3.2)
Gutka	94.6(±3.3)	2.8(±2.1)	93.0(±4.6)	4.4(±3.5)	93.2(±3.7)	4.3(±2.6)	93.5(±3.4)	3.5 (± 2.2)

Figures in parentheses denote 95% confidence interval, n= denominator

Figure 1: Current tobacco use according to the amount of pocket money received.



435

Annexure 24

SCHOOL POLICY AND TOBACCO USE BY STUDENTS IN BIHAR, INDIA

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Summary

The association between school tobacco policies and tobacco use prevalence among students were examined. A two stage cluster sample design with probability proportional to the enrolment in grades VIII-X was used. Comparison was made between schools with a tobacco policy (Federal schools) and schools without a policy (State schools). Stratified probability samples of 50 schools each were selected. SUDAAN® and the C-sample procedure in Epi-Info was used for statistical analysis. Students from State schools (without tobacco policy) reported significantly higher ever and current any tobacco use, current smokeless tobacco use and current smoking compared to Federal schools (with tobacco policy) both in rural and urban areas. Classroom teaching on the harmful effects of tobacco was significantly higher (17-24 times) in Federal schools than State schools both in rural and urban areas. Parental tobacco use was similar for students in Federal and State schools. Students attending state schools were more likely than students attending Federal schools to have friends who smoke or chew tobacco. These findings suggest that the wider introduction of comprehensive school policies may help to reduce adolescent tobacco use.

Keywords: School policy, adolescents, tobacco use, smoking, federal schools, state schools.

Introduction

Bihar (Bihar and Jharkhank presently) is one of the largest states in eastern India. Bihar is geographically located at latitude 25.1° N and longitude 85.3° E, covering a population of 82,878,796 (43,153,964 men, 39,724,832 women) at a decadal growth rate 28.4%. Density (per sq. km.) was 880 with a sex ratio of 921 women per 1000 men and the literacy rate was 47.5% (60.3% men, 33.60% women).[1]

The Global Youth Tobacco Survey (GYTS) is a school-based tobacco specific survey which focuses on adolescents aged 13-15 years. It assesses students' attitudes, knowledge and behaviors related to tobacco use and exposure to environmental tobacco smoke (ETS), as well as "youth exposure to prevention" curriculum in school [2,3].

In Bihar, there are two types of schools – those governed by the State government (called State schools in this paper) and those governed by the Federal government (called Federal schools in this paper). In Bihar, the number of State schools is much higher than the number of Federal schools but the Federal schools are about three times larger than State schools. State schools have no regulation about tobacco use on school premises, either for students or for school personnel; whereas, Federal schools have specific rules and regulations prohibiting the use of tobacco and tobacco products within the school premises by students, school personnel, parents and visitors[4]. Federal schools have been instructed to ban the sale of tobacco products within a distance of 100 meters, but that is not generally enforced [5].

Prohibition of tobacco use by students and school personnel on school premises is a critical component of school policy intended to reduce tobacco use of students. This has been studied in the west [6-9] but there is little on this issue reported from the developing world. The present research

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aims to investigate the applicability of such a conclusion to Bihar, India.

Materials & Methods:

GYTS is a cross sectional school-based survey, which employed a two-stage cluster sample design to produce a state representative sample of school children aged 13-15 years. In India, the minimum age for school enrollment is 5 years; therefore, age 13-15 years correspond to Standards 8, 9 and 10.

School-wise enrollment data of students in Standards 8, 9 and 10 of State schools were obtained from the Ministry of Education, Bihar and its regional branch offices (District Education Office). The enrollment databases for the Federal schools (Central and Navoday Schools) were obtained in the same way from Patna and Ranchi offices of Kendriya Vidyalay Samiti and Jawahar Navodaya Vidyalay Samiti. Electronic files were prepared.

Sample description:

The GYTS employs a two-stage samples design. At the first stage, schools were selected with probability proportional to school enrollment size. School enrollment was the count of students in standard 8, 9 and 10 in each schools. The second stage consisted of a random selection of classes from each school. All students in each selected class were eligible to participate.

There are 9,905 schools in Bihar that teach students in Standards 8, 9 and 10. The 9,905 schools are composed of 9,802 State Schools and 103 Federal Schools. The Federal Schools included two systems – Central (55 schools) and Navoday (48 schools). The sample included: 50 schools for the State and 25 each for Central and Navoday (which were combined into the Federal Schools). No schools selected in the state sample were in either the Central or Navoday system.

The questionnaire:

Tobacco use in India is unique because of the variety of tobacco products consumed including *bidi*, cigarette, *huka*, *cigars* chewing tobacco like *Gutka*, *Khaini* and applying tobacco like *gul*, tobacco containing tooth powder and tooth paste. Most of these habits are also common in other parts of India and have been described elsewhere [10,11]. The GYTS questionnaire for India was developed to include questions on each of these types of tobacco. The final questionnaire consisted of 85 questions. All questions were multiple choice in design with a maximum of 8 response categories and each question was to be answered by each student.

The final India questionnaire was translated into Hindi by the Tata Institute of Fundamental Research in Mumbai and the School of Preventive Oncology in Patna. To check the accuracy of the translation, the Hindi version was back translated into English by an independent translator not related to this project. The questionnaire was piloted tested in the city of Mumbai and Patna in a group of young students. The pilot test was followed by focus groups to discuss each question and their answers.

Data Collection:

A letter of support was obtained from the Chief Secretary, Government of Bihar and Education Secretary of Bihar. A letter of request from the State co-coordinator introducing the survey administrator was issued in the name of Principal/ Headmaster of every school. The survey administrators were instructed to get a certificate from the Principal/ Headmaster of the selected school at the end of survey administration.

Survey procedures were designed to protect the students' privacy by allowing for anonymous and voluntary participation. The self-administered questionnaire was administered in the classroom.

The state school GYTS was completed in 8 weeks time (April –May 2000) The GYTS in the Central schools was performed in February 2001 and Navoday Schools in June 2001. The same GYTS questionnaire was used in all State, Central and Navoday schools.

Data analysis:

For the analysis, a weighting factor was applied to each student record to adjust for non-response and for the varying probabilities of selection. The program Epi-Info was used to compute prevalence and 95% confidence intervals for the estimates.

A weight was associated with each questionnaire to reflect the likelihood of sampling each student and to reduce bias by compensating for differing patterns of non-response. The weight used for estimation is given by:

W = W1*W2*f1*f2*f3*f4

Where

W1 = the inverse of the probability of selecting the school, W2 = the inverse of the probability of selecting the classroom within the school, f1 = a school-level non-response adjustment factor calculated by school size category (small, medium, large), f2 = a class-level non-response adjustment factor calculated for each school, f3 = a student-level non-response adjustment factor calculated by class, f4 = a post stratification adjustment factor calculated by form. Differences between prevalence estimates were considered statistically significant if the 95% confidence intervals did not overlap.

The prevalence measures used in this study included: current any tobacco use - defined as "The percentage of students who used any tobacco product on one or more days during the past 30 days" and current smokeless tobacco use - defined as "The percentage of students who had used any smokeless form of tobacco products on one or more days during the past 30 days" and current smoking - defined as "The percentage of students who had smoked any tobacco product on one or more days during the past 30 days."

Results:

Fore For each survey (State Schools, Federal Schools) all schools selected agreed to participate. Student participation ranged from 86.5 % in Federal schools and 70.1% in State schools (Table1).

In Rural and urban areas, students in State schools (72.8% and 70%) were significantly more likely than students in Federal schools (35.6% and 35.2%) to have ever used tobacco. In rural and urban areas, students in State schools were significantly more likely than students in Federal schools to currently use any tobacco product, currently use smokeless tobacco, and currently smoke(Table2).

In rural and urban areas, students in Federal Schools were significantly more likely than students in State schools to be taught the dangers of smoking in the schools, and the reasons why people of their age smoke (Table 3).

In rural and urban areas, parental tobacco use was similar for students attending State or Federal schools (Table 4). Students in urban areas attending State schools (8.6%) were significantly more likely than students attending Federal schools (3.3%) to have friends who smoke. In rural and urban areas students attending State schools were significantly more likely than students attending Federal schools to have friends who chewed tobacco.

Discussion:

This study examined the relationship between a school having policy regarding tobacco use and students using tobacco. The premise tested was that a school having policy (and its proper implementation and enforcement) would result in lower tobacco use among students than in schools with no policy. Results from this study confirm the premise. Tobacco use among students in State schools (no school policy) was significantly higher than use among students in Federal schools (have school policy), both in urban and rural areas. Further, Federal schools were more likely than State schools to have courses teaching students about the harmful effects of tobacco use. Therefore, it was not surprising that students in Federal schools were less likely than students in State schools to have friends who smoked or chewed tobacco.

Conclusion:

In conclusion, a school having policy regarding tobacco use and offering classes that teach about the harmful effects of tobacco appears to have a strong negative impact on tobacco use among students. That is very encouraging; yet, even in the Federal schools tobacco use among students was not zero. The goal of any effective tobacco control program should be zero tobacco use among adolescents. To reach this goal states and countries need to develop, implement and evaluate comprehensive tobacco control programs [6-9].

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Table 1: Sample size and response rates – State and Federal Schools in Bihar, India – Global Youth Tobacco Survey, 2000-2001

Bihar	Number of schools in sample	Number of schools that participated	School response rate	Number students selected to participate	Number students who participate	Student response rate	Overall response rate
* State schools,2000	50	50	100.0%	3,760	2,636	70.1%	70.1%
** Federal schools, 2001	50	50	100.0%	4,566	3,951	86.5%	86.5%

* Without tobacco policy schools, ** With tobacco policy schools

Table 2: Prevalence — percentage of students in grade 8-10 who used tobacco by place of residence and type of school – Bihar, India — Global Youth Tobacco Survey, 2000-2001

Place of Residence and type of School	Ever used any tobacco (%)	Current Use * Any tobacco Product (%)	Current Use * Smokeless tobacco Product (%)	Current Use * Any smoking (%)	Current Use * Cigarettes smoking (%)
Rural — State schools, 2000	72.8(±5.6)	59.4(±8.0)	55.3(±9.0)	21.8(±3.3)	7.1(±3.1)
Rural — Federal schools, 2001	35.6(±4.4)	11.2(±2.1)	8.6(±1.8)	5.8(±2.1)	0.5(±0.5)
Urban — State schools, 2000	70.0(±10.6)	58.2(±11.4)	56.2(±11.5)	15.6(±5.5)	7.2(±4.3)
Urban — Federal schools, 2001	35.2(±8.2)	11.3(±3.2)	9.6(±3.2)	6.1(± 2.5)	3.0(±1.8)

* used any tobacco products on ≥ 1 of the 30 days preceding the survey.

Figures in parentheses means 95% confidence interval

Table 3: School Curriculum — percentage of students in grade 8-10 who were taught about tobacco in class during the past school year by place of residence and type of school – Bihar, India — Global Youth Tobacco Survey, 2000-2001

Place of Residence and type of Schools	Percent taught in class: Dangers of smoking (%)	Percent taught in class: Reasons why people of their age smoke in class (%)
Rural — State schools, 2000	1.8(±1.5)	0.0(±0 0)
Rural — Federal schools, 2001	72.7(±4.7)	49.9(± 4 4)
Urban — State schools, 2000	2.5(±2.8)	1.9(±2.4)
Urban — Federal schools, 2001	51.6(± 3.7)	37.6(±2.8)

Figures in parentheses means 95% confidence interval

Table 4: Percentage of students whose parents use tobacco or whose friends smoke or chew tobacco by place of residence and type of school – Bihar, India — Global Youth Tobacco Survey, 2000-2001

Place of residence and type of Schools	One or both parents use tobacco (%)	All and most friends smoked (%)	All and most friends chewed (%)
Rural — State schools, 2000	37.0 (±6.9)	8.6 (±2.8)	10.5 (±3.2)
Rural — Federal schools, 2001	38.9 (±3.7)	3.3 (±1.0)	2.4 (±0.8)
Urban — State schools, 2000	39.3 (±4.9)	9.9 (±6.3)	7.9 (±4.9)
Urban — Federal schools, 2000	38.8 (±4.8)	5.9 (±1.1)	0.8 (±0.5)

Figures in parentheses means 95% confidence interval

440

Annexure 25

TOBACCO USE AMONG SCHOOL STUDENTS IN GOA, INDIA

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Summary

Information about prevalence of tobacco use was assessed among school children in Goa, India. Among 50 sampled schools, the school response rate was 98% and, over 94% students participated in the survey (56% were boys, 44% girls). Ever tobacco use was reported by 13.5% of which over 40% reported initiation at 10 years of age or earlier. The current tobacco use (any product) was reported by 4.5%, without much difference in smokeless tobacco use (2.8%) and smoking (3.0%). Smokeless tobacco was use mainly in the form of applying mishri, tobacco containing toothpaste or toothpowder. Smoking among boys was 3.5% and girls 2.2%. Non-users reported knowledge about the harmful effect of tobacco two to three times more than tobacco users. Over about 50% of students reported having been taught in school about the dangers of tobacco use. Tobacco users (60.5%) as well as non-users (63%) favoured ban smoking in public places equally. Tobacco use by parents and close friends was positively associated with students' current tobacco use.

Introduction:

Given the current pattern of tobacco use globally, it is estimated that 250 million children and adolescents who are alive today, would die prematurely because of tobacco, most of them in developing countries.[1] In India tobacco use is estimated to cause 800,000 deaths annually.[2] The prevention of tobacco use in young people appears to be the single greatest opportunity for preventing non-communicable disease in the world today.

In this era of globalization, youth and adolescents are adopting behaviour patterns that are comparable from country to country. Tobacco companies are taking advantage of this situation. They are advertising tobacco products using mass media techniques targeting "the youth of the world". To counteract the effect of this strategy in India, as in the rest of the developing world, there is an urgent need for good, scientifically sound data about tobacco use patterns that would allow cross-country and within-country comparisons. This would permit the fulfilment of the dual objective of designing preventive strategies targeting "the global youth" while taking into consideration local peculiarities.

The Tobacco Free Initiative of the World Health Organisation, in collaboration with the Office on Smoking and Health, Centers for Disease Control, USA, has undertaken the Global Youth Tobacco Survey (GYTS). This survey focuses on 13 to 15 year old school going students using standardized methodology. The survey uses a "core" questionnaire and an optional bank of questions. The objectives of this survey are to: 1) document and monitor the prevalence of tobacco use including cigarette smoking and other tobacco use; 2) understand students' attitudes, knowledge and behaviours related to tobacco use and its health impact, including cessation, and environmental tobacco smoke (ETS); 3) measure exposure to advertising and promotion of tobacco products; and, 4) assess minors' access and understand school curriculum about tobacco.[3,4]

Earlier report of prevalence of tobacco use among school children aged 10-18 years in Goa, showed 13.4% boys and 9.5% girls used tobacco.[5]

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GYTS in Goa was conducted to obtained representative data for the state.

Materials & Methods:

The study was carried out during January–March 2000. In Goa as in the rest of India, 13 to 15 year old students corresponded to grades VIII to X. A list of all schools having grades VIII to X was prepared with enrolment numbers for boys and girls in each school. A two-stage cluster sample design was used to produce a representative sample of students. At the first sampling stage, a fixed number of schools (50) were selected with a probability proportional to enrolment size. At the second sampling stage, classes were selected by systematic equal probability sampling (with a random start), depending upon the estimated number of classes in grades VIII to X in the selected school. All students in the selected classes irrespective of age were eligible to participate.

For India, the core questionnaire of the GYTS was suitably expanded to include tobacco use in the form of *bidi* smoking and smokeless tobacco use. All questions required answering (i.e. there was no skipping or branching pattern). The questionnaire was self-administered with no identification information collected (name of student, class or school), maintaining complete anonymity. Responses were recorded on optically readable answer sheets.

Tobacco use was classified as ever use (the use of tobacco even once) and current use (use of tobacco within 30 days preceding the survey). In India tobacco is used for smoking as well as smokeless use. In Goa tobacco is smoked mainly in the form of cigarettes or *bidis* (tobacco rolled in a tendu leaf).

Smokeless tobacco use could include, *betel quid*, *gutka* (an industrially manufactured tobacco product, containing areca nut, tobacco and other ingredients), *sada* (tobacco leaf and lime mixture), *mishri* (used as dentifrice), snuff, tobacco toothpaste and *lal dantamanjan* (red tooth powder). Most of these habits are also common in other parts of India and have been described elsewhere.[6]

Many of these products (*betel quid*, *gutka*, *sada*, *khaini* etc.) are chewed whereas some (*mishri*, tobacco tooth paste, red tooth powder etc.) are applied in the oral cavity. Chewing and applying were distinguished as the two different ways of using smokeless tobacco.

Data analysis was performed using SUDAAN and the C-sample procedure in Epi-Info taking the probabilities of selection (schools and classes) into account as well as adjustment for non-response at the school, class and students level. Ninety-five percent confidence intervals were calculated and used to test for significance of difference.

The state of Goa lies on the west coast of India tucked between the states of Maharashtra and Karnataka. After being a Portuguese colony for several hundred years it became a part of the Indian Union in 1961. Goa has a population (census 2001) of 1,343,998 (685,617 men, 658,381women) at a decadal growth rate of 14.9%. Density (per sq. km.) was 363 with a sex ratio of 960 women per 1000 men and a literacy rate of 82.3% (88.9% men, 75.5% women).[7]

Results

Among 50 sampled schools, one school refused for conducting GYTS despite numerous requests. Response rate of students among 49 schools was 94.4%, the non-response being due to absence on the day of the survey. A total of 2256 students participated, 56% were boys and 44% girls.

Ever tobacco use was reported by 13.5% (boys 14.9%, girls 10.9%, Table 1) with 40.5% users (boys 39.5%, girls 49.2%) reporting initiation at 10 years of age or earlier (results not shown in the table). Current use of tobacco (any product) was reported by 4.5% (boys 5.5%, girls 3.2%). Current smokeless tobacco use was reported by 2.8% (boys 3.3%, girls 2.1%). Current smoking was reported by 3.0% (boys 3.5%, girls 2.2%, Table1). Smoking included cigarette, bidi and other unspecified forms. Smokeless tobacco use in the form of chewing was reported by 4.1% and applying by 6.0%. Among chewers, *gutka* (31.9%) use was the most popular followed by betel quid (11.0%) and tobacco alone (11.0%). Among appliers, 36.7% applied *mishri*, 27.3% tobacco toothpaste, 25.8% red toothpowder.

442

Tobacco users as well as non-users revealed equally positive attitude towards tobacco use such as boys or girls who used tobacco looks more attractive, boys or girls who use tobacco have more friends, men or women who smoke is successful (Table 2). They also felt that tobacco helped people to feel more comfortable at parties. However, current tobacco users (38.1%) felt that tobacco helped in relieving toothache or in morning motion twice more often than non tobacco users (19.2%). Over three-fifth of non tobacco users (74.5%) and current tobacco users (60.4%) reported that smoking helps in losing weight. Tobacco smoking (62.9% vs. 29.1%), smokeless use (62.1% vs. 22.4%) and environmental tobacco smoke (59.2% vs. 41.3%) was reported harmful more often by non-users than tobacco users (Table 2).

Current smokeless tobacco use at home was reported by 61.7%, more often by girls (87.9% vs.56.6%). There was significant influence of tobacco use by parents and close friends on current tobacco use of students (Table 2). Purchasing tobacco products in a store was reported by 55.2%, and around three-fifth (59.1%) were not refused because of age (results not shown in the table). Exposure to ETS at home was significantly associated with students' current tobacco use (42.6% vs. 19.4%). Interestingly over 60% of both non-users as well as current tobacco users favoured banning smoking in public places (Table 2).

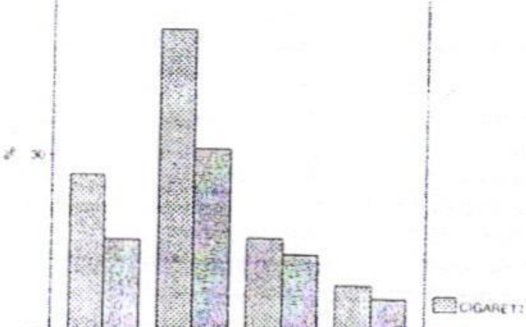
Classroom teaching during the past year on various aspects of tobacco use, like dangers of smoking and chewing tobacco, reasons why people of their age smoke or chew and the effect of smoking and chewing tobacco was reported by 36% to 51% of students (results not shown in the table). Around one-fifth to one-third reported watching a lot of cigarette and gutka advertisements on TV, outdoor media, newspaper/magazines and during social events. (Figure 1).

Discussion

The data available on tobacco use by youth and related problems is sparse, except in few developed countries. The GYTS was initiated as a means of providing baseline data on youth and tobacco for all countries.

This study demonstrates that there was a significant amount of tobacco use among 13 to 15 year-old schools going students in Goa as reported in other parts.[4,8] Tobacco was used both in smokeless forms and for smoking in Goa like in all other parts of India.[8-10] A study reported from Goa in 1986-87 among 10-18 yr old school going children, the overall tobacco use prevalence as 11.7% with 0.3% smokers.[5] In current study the overall tobacco use was 4.5% with 3.0% smokers. The target population of our study was the students in the aged group 13-15 yr, but the age reported by students range from 11 to 17 yr. The current study shows decreased in the overall tobacco prevalence, but there is considerably increased in smoking prevalence. This was true for both boys (0.4% vs. 3.5%) and girls (0.2% vs 2.2%). Earlier study in Goa shows, health education imparted a negative attitude to tobacco among children.[5] In our study, over 50% reported having been taught in school about the dangers of tobacco use. Also the Goa Prohibition of Smoking and Spitting Bill 1997 (Bill No. 22 of 1997) was passed and enacted in 1998. The Act provide for prohibiting smoking and spitting in places of public work or use and in public service vehicles in the state of Goa. These could be some of the reasons in

Figure 1:Exposure to tobacco advertisement in different media in Goa.



overall decreased in tobacco use.

In India it is generally thought that smoking by girls is socially unacceptable and therefore they do not smoke very much but in this study, girls reported a similar smoking prevalence as boys. Similar results have been reported from other parts of India.[8,9] As reported in earlier studies smokeless tobacco use was dominated by dentifrice (mainly *mishri*) in current study as well. Use of smokeless tobacco as dentifrice has been reported from other parts of India.[8,10]

Even though tobacco use by small children is thought to be not culturally acceptable in Indian society, current study reported initiation of tobacco use at age 10 years or before by over one-third of boys and one-half of girls in Goa. A study from Goa in 1986-87 reported nearly one-third of boys and one-half of girls had began to use tobacco before the age of 5.[5] These results are along the same lines as those found in a small study in three rural areas in Gujarat, Tamilnadu and Karnataka, where one-third to one-half of children under the age of 10 years experimented with smoking or smokeless tobacco in some form.[11] This is of concern, since the younger the age at which children start using tobacco, the more likely are they to become addicted and suffer from health consequences. Consequently, strategies to reduce initiation of tobacco use need to be targeted more towards younger age groups.

A recent report demonstrates an increase in oral cancer incidence in India.[12] This is supported by an increasing prevalence of oral submucous fibrosis, especially in younger individuals, caused by industrially manufactured smokeless tobacco products.[13-15] The majority of tobacco chewers in the present study reported chewing *gutka*, confirming the countrywide trend of increasing *gutka* use. *Gutka* is one of the most highly advertised products in almost all media and it is noteworthy that tobacco users reported seeing more tobacco advertisements compared to non-users.

A high percentage of users showing positive attitude towards tobacco use by others seems to be an effect of tobacco advertising. Youth-targeted media advertisements and sports sponsorship influence this attitude. Sports sponsorship by tobacco companies influence the childrens' minds and helps initiate smoking in India.[16,17] This could be one of the factors responsible for overall increased in smoking prevalence among both boys and girls, although further research needed to be carried out.

In this study several factors showed a strong association with tobacco use: parental and closest friends' tobacco use; lack of knowledge on harmful effects of tobacco; positive attitude towards tobacco use by others; and viewing of tobacco advertisements. Several of these associations have been reported, for example, parental tobacco use.[8,11]

It should be noted that in Goa, seven out of eight young students are non-smokers and they need to be protected from tobacco smoke in homes and in public places. For preventing exposure at home, the public need to be educated on health consequences of exposure to second-hand smoke on children. For preventing exposure in public places, the exiting law "The Cigarettes and Other Tobacco Products (Prohibition of Advertisement and Regulation of Trade and Commerce, Production, Supply and Distribution) Act, 2003 No. 34 of 2003" needs to be implemented vigorously, while the public need to be informed about the danger of environmental tobacco smoke.

The findings of the GYTS will enhance the capacity of countries to design, implement, and evaluate their own tobacco control and prevention programmes by following a standard format. It also offers a unique tool for improving the information base on tobacco use among young people, which will support medium-term and long-term programming and advocacy actions for youth targeted tobacco control. Earlier study in Goa[5], documented the importance of desirability of including health educational material on tobacco in school curricula. The study highlights findings that such material is useful in shaping the childrens' attitudes towards tobacco in a proper perspective and propagating the intervention message to their parents. This approach needs to study globally through successful programs like GYTS.

Acknowledgments

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445

Table 1: Ever and current tobacco use by sex, Goa-GYTS-2001.

Category	Ever tobacco use	Current tobacco use Any form	Smokeless	Smoking	Cigarette
Total	13.5(±4.5)	4.5(±1.5)	2.8(±1.2)	3.0(±1.1)	0.4 (±0.3)
Boys	14.9(±4.2)	5.5(±2.0)	3.3(±1.6)	3.5(±1.3)	0.5(±0.5)
Girls	10.9(±5.5)	3.2(±1.5)	2.1(±1.4)	2.2(±1.2)	0.4(±0.4)

Figure in the parentheses denotes 95% confidence intervals (±CI).

Table 2: Knowledge, exposure, and attitude towards tobacco control policies, Goa-GYTS-2001.

	Non tobacco user	Current user
Attitude		
Boys who smoke or chew looks more attractive	17.8(±4.0)	24.0 (±6.1)
Boys who smoke or chew have more friends	34.1(±4.0)	40.6 (±7.8)
Girls who smoke or chew looks more attractive	14.5(±3.4)	25.2 (±10.0)
Girls who smoke or chew have more friends	21.2(±3.4)	27.6 (±10.5)
Men who smoke is Successful/Intelligent/Macho	4.5(±1.1)	12.3 (±9.3)
Women who smoke is Successful/Intelligent/Sophisticated	8.6(±2.0)	20.3 (±8.2)
Tobacco helps relieving toothache/morning motion	19.2(±2.3)	38.1 (±12.0)
Tobacco helps to feel more comfortable at parties	30.6(±3.4)	37.8 (±10.2)
Smoking helps in loosing weight	74.5(±3.8)	60.4 (±13.7)
Knowledge		
Smoking is harmful	62.9(±6.6)	29.1 (±10.5)
Smokeless tobacco is harmful	62.1(±6.7)	22.4 (± 7.9)
Environmental tobacco smoke (ETS) is harmful	59.2(±6.0)	41.3 (±3.2)
Exposure		
Exposure to ETS at home	19.4(±3.5)	42.6 (±9.1)
Exposure to ETS out side home	33.4(±5.6)	47.1 (±13.3)
Ban smoking in public places	63.0(±7.4)	60.5 (±9.1)
Parental use of tobacco	22.6(±3.8)	41.7 (±11.4)
Most or all friends smoke	4.5(±1.5)	12.7 (±6.7)

Figure in the parentheses denotes 95% confidence intervals (±CI).

446

Annexure 26

Original Article

Tobacco Use Amongst Children in Karnataka

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ABSTRACT

Objective. To estimate the prevalence, pattern and correlates of tobacco use amongst the 13-15 year olds in schools of Karnataka

Methods. A three stage (area, school level and class level) cluster sample design was adopted and 80 schools from 12 districts of the statewere selected. A total of 4,110 students participated in the study with an overall response rate of 87%.

Results. Point prevalence of tobacco use amongst 13-15 year old was 4.9%. Current tobacco use was predominantly a male feature and use of smokeless variety predominated (transitional Karnataka (8.2%); metropolis (6.8%); rural (3.4%). One third of current tobacco users (30.8%) purchased tobacco product in a store and one-fifth used it at home. Nearly half of the never smokers (43% to 56.7%) were exposed to tobacco smoke outside home and 83% favored a ban on smoking in public places. A male tobacco user was perceived to have more friends and was reported to make them look attractive. Print media was a predominant source of message, more so in the metropolitan region. Only one-third (31.6%) reported that the reasons of tobacco usage amongst youth was discussed in formal school settings.

Conclusion. GYTS Karnataka has provided reliable estimates and shown the feasibility of implementing a surveillance programme. Specific challenges for Public health that emerge from the study are increasing number of users in transitional areas, continued media exposure, tobacco users being perceived to be popular and attractive, easy and relatively unrestricted access, lack of systematic support within schools and social acceptance of tobacco use at home. The need of the hour is to target and focus interventions through comprehensive programmes aimed at children, school authorities, parents and policy makers. **[Indian J Pediatr 2007; 74 (12) : 1095-1098]** *E-mail : guru@nimhans.kar.nic.in*

Key words : *Tobacco use; Public health challenges; School health education; Behavioural determinants; Transitional area*

Tobacco and alcohol use among youth and children are a part of the spectrum of adverse health behaviours leading to acute and long term health problems. The diverse socio-economic, cultural and political milieu characterizing Indian states presents several challenges in delivery of health care services and organizing preventive programmes.[1,2,3] While the traditional models of health care delivery have been found to be inadequate, there is a lack of new insight to appropriately manage the diseases of transition represented by high risk behaviours. With the central legislation in place for regulating trade and commerce including advertisement of tobacco products[4], an emerging trend has been the decreasing age of tobacco use and need to understand its determinants.[5,6,7] Overcoming the meth[illegible] limitations of earlier individual studies [illegible] Tobacco Survey (GYTS) – India a[illegible] methodology to estimate tobacco use [illegible] across the States and Union ter[illegible] report outlines salient findings fro[illegible] State of India, *viz.*, Karnataka

MATERIALS AN[illegible]

GYTS – Karnataka [illegible] tobacco use in 13-[illegible] 2003-04 adopting a [illegible] class level) cluster [illegible] Bangalore [illegible] Karnataka as [illegible] remaining [illegible] enrollment [illegible] select scho[illegible] Operation[illegible] study [illegible]

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447

sheets as response sheets, need for use of a local language version of the study instrument) were attended to in the main study.

The survey work was undertaken in the sampled schools from 12 districts of the State. Twenty schools each were randomly selected in the metropolis and other urban area and 40 schools in rural area. A total of 4,110 students participated from amongst 4,708 on roll. The overall response rate was 87.3% (84% to 91%). Key reasons for non-participation were absence due to festivals and fairs, sickness, extra-curricular activities in schools and monsoon rains. The responses were suitably weighted to arrive at final estimates.

RESULTS

Overall point prevalence of tobacco use among the 13 to 15 yr old was 4.9% and life–time prevalence was 5.1%. Current tobacco use was predominantly a male feature and was nearly four fold greater among males (M: 8% *vs* F: 2.1%). Smokeless tobacco (*gutkha* or *pan-masala*) use was greater than smoking variety (5.9% and 4.0%, respectively) amongst males, but similar amongst females (1.4% and 1.3%, respectively). Proportion currently using tobacco was greater in transitional Karnataka (10.1%) than in the metropolis (8.3%) and was twice that of rural (4.7%) population. Across 3 regions, use of smokeless variety predominated and proportions were highest in transitional Karnataka (8.2%) compared to metropolis (6.8%) or rural (3.4%). One third of current tobacco users (30.8%) reported that they had purchased the tobacco product in a store. One-fifth of current users smoked (17.2%) or chewed / applied (18.6%) tobacco at home. The proportion of females using smokeless variety at home was nearly double (28.2% *vs* 13.1%) than those smoking at home. In the other urban Karnataka areas 42% reported smoking at home.

While 46.9% were exposed to tobacco smoke outside their home, 29.7% were exposed to tobacco smoke within their home. Further, between the two genders and across the three regions, nearly half of the never smokers (43% to 56.7%) were exposed to tobacco smoke outside their home. Eighty three percent of the never smokers favored and recommended for a ban on smoking in public places.

Enquiries regarding perceived image of tobacco user revealed that nearly one half of respondents (41.8 to 44.0%) reported that a male tobacco user has more friends and nearly one third (31.0% to 37.4%) opined that tobacco use makes boys look attractive. Two-thirds of the female smokeless tobacco user perceived that a male tobacco user has more friends (72.3%) and reported that tobacco use makes boys look attractive (69.5%).

Print media was a predominant source of information for tobacco use and the respondents also reported that they witnessed large numbers of tobacco advertisements on either TV or in social gatherings. There was a greater exposure to media messages on tobacco in the metropolis region (25.7% to 52.2%) when compared to transitional

TABLE 1. Recollections of Media Messages Regarding Tobacco Usage by Never Users (%)

Category	Total	Bangalore-Mysore	Other Urban Karnataka	Karnataka Rural
Seen a lot of advertisement and media messages about Cigarette on				
TV	33.5	36.5	29.2	33.3
Print Media	48.0	52.2	39.4	47.8
Newspapers/Magazines	28.5	31.8	21.3	28.3
Social gatherings	41.2	41.3	34.0	41.3
Seen a lot of advertisement and media messages about Bidis on				
Print Media	42.1	41.8	38.4	42.2
Social Events	34.1	36.7	33.5	33.9
Seen a lot of advertisement and media messages about Gutka/Pan Masala on				
TV	38.2	40.0	26.9	38.2
Print Media	37.3	33.4	28.5	37.8
Newspapers/Magazines	29.3	25.7	22.8	29.7
Social gatherings	36.7	32.6	26.8	37.1

TABLE 2. Harm Perception of Tobacco Use and Curricular Discussion Regarding Tobacco Use (%)

Category	Total	Male	Female
Percent who think smoking is definitely harmful to their health	82.0	78.7	85.3
Percent who think that chewing/applying is definitely harmful to their health	80.6	77.9	83.3
Never smokers who definitely think smoke from others is harmful to them (%)	79.8	77.4	82.1
Taught dangers of smoking (%)	68.0	65.4	70.7
Discussed tobacco and health as part of a lesson in class (%)	50.9	53.9	48.2
Taught the effects of tobacco use in class (%)	42.7	39.2	46.1
Discussed reasons why people their age smoke or chew (%)	31.6	33.1	30.5

areas (21.3% to 39.4%) or even rural communities (28.3% 47.8%) (Table 1). Children had not come across many messages on *bidis* in the Television, newspapers or magazines.

An overwhelming proportion felt that tobacco use is definitely harmful to their health and 80% of never smokers felt that smoke from others use of tobacco is harmful to them. Despite being taught about dangers of smoking (68%), only about one-third (31.6%) reported that the reasons of tobacco usage amongst youth was discussed in formal school settings (Table 2).

DISCUSSION

GYTS-Karnataka has provided a valid and representative benchmark estimate for planning and implementing anti-tobacco policies and programmes. In addition, the study has shown that it is possible and feasible to implement a surveillance programme which could also evaluate the impact of ongoing tobacco control programmes. In the absence of a surveillance programme for non-communicable diseases across the State, the framework that has been developed could very well serve as sentinel surveillance approach for risk factor surveillance of non-communicable diseases.[8]

Against the national average of 17.5% (with variations across States and regions), [2,9] GYTS – Karnataka estimates of current tobacco users amongst the 13 to 15 yr group was 4.9% and these constitute 96% of life-time tobacco users. Undoubtedly, these early experimenters are bound to develop tobacco-related disorders at an early age;[10] have a greater probability of transforming themselves to regular and addictive users; a greater likelihood of acquiring other risk behaviours, chiefly alcohol use[11] and thus over–burdening the already fragile health care delivery system. In this vulnerable group, the predominant use of smokeless tobacco across the three areas and between the two sexes would accelerate the early development of tobacco related health problems.[12-14]

The present study has brought to the fore specific challenges for public health. Firstly, the emerging tobacco use in districts, talukas and rural areas needs serious attention of policy-makers. In the absence of concerted efforts in these populations, the numbers are likely to increase over a period of time. Secondly, the exposure to media messages regarding tobacco has a significant influence on initiators, experimentors and users, while increasing sales and availability.[15,16] In addition, those using tobacco were perceived to be both popular and attractive. These two complementing issues are indeed a challenge, especially in the context of industry driven strategies of promoting "new life styles". Research conducted has already shown that children are targeted heavily by both direct and indirect methods.[17,18] Thirdly, purchase of a tobacco product by one third of users points to the easy and relatively unrestricted access at vending outlets. The large number of outlets, many of which are also located in the neighborhood of schools[19] and their regulation for restricting the sales to underage users is indeed a major public health challenge. The laxity in the implementation of the legislation (ban of sales to underage persons and ban on selling outlet within 100 yards of an educational institution) specifically calls for a multi-sectoral approach to tobacco control initiatives. Fourthly, despite the greater harm perception, there was a major lacuna in systematic support within the schools to prevent tobacco use. "Saying No to Tobacco" requires acquiring of life skills and changes in attitude; and not just enhanced cognition or acquiring information. Information transfer alone without emphasis or focus on attitudinal changes and environmental modification will have limited impact and is a major public health challenge. Finally, Tobacco use at home, especially the smokeless variety amongst females is indicative of the prevalent social acceptance of tobacco use and would very well turn out to be a major threat in creating tobacco free environs.

CONCLUSIONS

There is need for targeted and focused interventions by adopting a comprehensive approach. Anti-tobacco programmes should make inroads into transitional towns and rural areas. The focus in schools should be to make them tobacco-free. The school authorities should be included in stricter implementation and monitoring of the implementation of legislation. Regular and systematic education programmes catering to teachers, children and also their parents should be undertaken. Enabling teachers to educate the young impressionable minds regarding life style disorders should be a cornerstone activity in preventing the establishment of life style disorders like tobacco and alcohol use within the community.

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449

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Annexure 2

Tobacco use and related factors among pre-university students in a college in Bangalore, India

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ABSTRACT

Background. Tobacco use imposes a huge burden of disease in India. Most studies on the use of tobacco among students in India have focused on secondary school students with a few studies investigating younger children and university students. We aimed to ascertain tobacco use among pre-university college students in Bangalore.

Methods. A cross-sectional study was conducted among 300 students of a purposively selected boys-only, pre-university college in Bangalore. All the students from 4 of 10 randomly selected classes were enrolled in the study. An anonymous self-administered questionnaire was used to collect information on the extent and pattern of tobacco consumption, factors associated with use/non-use of tobacco products, and awareness of the harmful effects of tobacco use.

Results. The prevalence of 'ever use' of tobacco was 15.7% (95% CI: 11.7–20.3) of which 5.3% (95% CI: 3.1–8.7) were current users of tobacco. The mean (SD) age of initiation of tobacco use was 14.7 (2.05) years; 78.3% of users were aware that tobacco was harmful. The most common reasons by ever users to start using tobacco included peer pressure, having fun/enjoyment, and curiosity. 'Never users' abstained from usage because of awareness of the negative health implications of tobacco use, a dislike for tobacco products, and the negative social implications of tobacco use.

Conclusion. Interventions need to be designed to reduce the use of tobacco among students. Such interventions should raise awareness on the social and economic implications of the use of tobacco, equip students to overcome peer influence and provide counselling to quit using tobacco.

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INTRODUCTION

India is the second largest consumer of tobacco in the world, after China. Even a conservative estimate of tobacco-attributable deaths in India currently ranges between 800 000 and 900 000 per year.[1] In 2002–03, the cost of the tobacco-attributable burden of just three groups of diseases—cancer, heart diseases and lung diseases—was estimated to be Rs 308.33 billion.[1]

In India, tobacco use among children and youth is quite high. The Global Youth Tobacco Survey (GYTS) 2006 reveals that the prevalence of current use of tobacco among 13–15-year-olds is 14%.[2] Studies among students across the Indian metropolises provide variable estimates of the current use of tobacco from as low as 4% in Mumbai[3] to as high as 41.1% in Chennai.[4] Students from grades 8–10 have been included in the majority of studies investigating tobacco use among Indian students. The GYTS for different cities and regions in India also draws its sample of students from grades 8 to 10.[2] Studies by Kumar *et al.*[4] in Chennai and by Mohan *et al.*[5] in Thiruvananthapuram also drew their samples of students from grades 8 to 10 and 8 to 11, respectively. Singh *et al.*[6] used a wider age group (10–18 years) of students in Delhi, but did not provide an age-wise prevalence of tobacco use.

A few recent studies have investigated younger students. Grade 7 students were studied in New Delhi,[7] grades 6 and 8 students in Chennai and New Delhi,[8] and grades 5–7 students in Patna district of Bihar.[9] On the other hand, the study by Nichter *et al.*[10] investigated college students (16–23 years) in Karnataka.

No Indian data are available in the recent literature on the prevalence of tobacco use and related factors specific to students of grades 11 and 12, except for the study by Singh and Gupta[11] among students of grades 9–12 in Jaipur, which reported a prevalence of 2.2% of current use among 13–18-year-old boys.

Schools offering grades 11 and 12 studies in Karnataka are classified as pre-university colleges (PUC), which come under the purview of the Commissioner of Pre-university Education. In other Indian states these schools are often known as higher secondary schools. Pre-university education (grades 11 and 12) provides a link between school and university life. In Karnataka, most PUCs are facilities independent of secondary schools and many also offer degree courses on the same campus. The educational environment and culture in these 'colleges' is different from that of schools being less formal and controlled. For many students, entry into a PUC also marks more independence for the individual and less family control. Because of these reasons, we assessed the extent and pattern of tobacco consumption, factors influencing use/non-use of tobacco products, and the awareness and source of awareness, of the harmful effects of tobacco use among the students of grades 11 and 12 in Bangalore city.

METHODS

A cross-sectional survey among students of a private boys-only PUC was carried out in Bangalore. The college was selected through purposive sampling after it showed a willingness to develop a tobacco-control intervention for its students. The survey formed a baseline for a school-based intervention, which aimed to raise awareness among students on various aspects of tobacco use. All students from 4 of 10 randomly selected classes were enrolled.

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451

A pre-tested, anonymous, self-administered questionnaire was used to collect data on the extent and patterns of tobacco consumption, the age of initiation of tobacco use, and awareness among students about the ill-effects of tobacco use. Information was also collected on the perceived factors influencing use/non-use of tobacco products. The questionnaire was a mix of open- and close-ended questions. Open-ended questions were used to collect data on the specific ill-effects of tobacco use known to the students, and their reasons for use/non-use of tobacco products.

After explaining the purpose of the survey, instructions were given on how to fill the questionnaire. The voluntary and anonymous nature of participation in the survey was also explained. Thereafter, a questionnaire was given to all students. The first and second authors of this paper remained present throughout the survey to respond to any doubts/queries of the students. The data were entered into an Excel spreadsheet and analysed using EpiInfo (TM) software. Data from all the students who responded to at least one or more of the questions were included for analysis. The overall response rate was 98.7%. The response rates for particular variables, whenever they differed from the overall response rate, have been mentioned in the subsequent sections describing those variables.

Definitions. 'Ever users' were defined as anyone who had used tobacco even once in any form at any point in a lifetime. 'Never users' were those who had never used tobacco. 'Current users' were those who had used tobacco in any form during the 30 days preceding the survey and past users were defined as ever users who were not current users. These definitions were adapted from those used for the GYTS.[2]

RESULTS

All 300 male students with a mean (SD) age of 16.4 (0.79) years belonged to a private PUC that caters to the middle socioeconomic class of Bangalore. Of the 92.7% students who self-reported their socioeconomic status, a majority (89.6%) identified themselves as belonging to the middle socioeconomic class, with 8.6% and 1.8% from upper and lower socioeconomic classes, respectively.

Tobacco use

The prevalence of ever use of tobacco was 15.7% (95% CI: 11.7–20.3) whereas 5.3% (95% CI: 3.1–8.7) were current tobacco users. Smoking was the predominant form of tobacco consumption among ever and current tobacco users (Table I).

For 75% of ever tobacco users who responded to the question 'At what age did you first start tobacco use?', the mean (SD) age for initiation of tobacco use was 14.7 (2.05) years.

Awareness about harmful effects of tobacco use

Of the 300 students, only 78.3% reported that they were aware of the harmful effects of tobacco use. Students were more aware of the impact on health of tobacco use but had limited awareness of the social, economic and environmental ill-effects of tobacco use (Fig. 1).

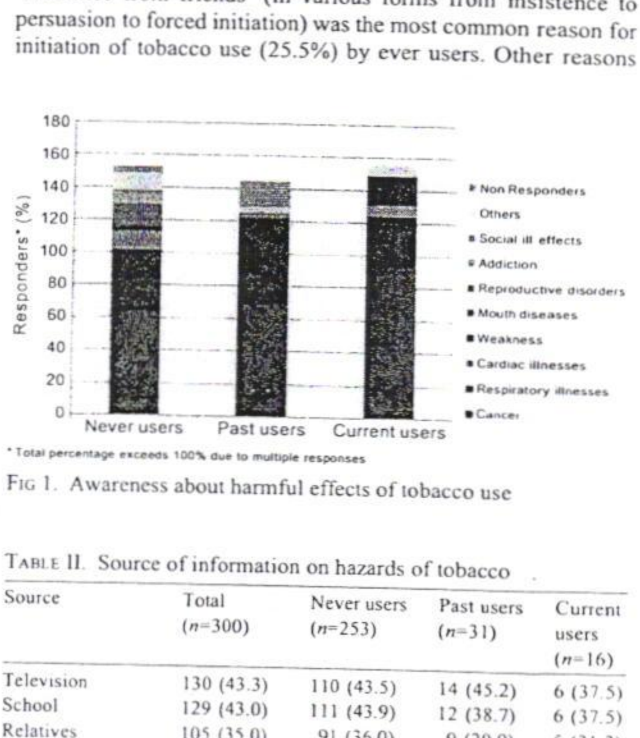
Awareness about the ill-effects of tobacco use among past users and current users was 83.4% and 81.3%, respectively, with 85.8% of never users reporting that tobacco use is injurious to health; the differences in awareness across different categories of tobacco users were not statistically significant. The awareness regarding the ill-effects of tobacco use on health was mainly in terms of cancer (67%) and respiratory illness (38%). This trend was similar among all categories of tobacco users.

Interestingly, some never users were aware of the 'social ill-effects' of tobacco use (2.4%) and the fact that tobacco use causes reproductive disorders (4.4%), while none of the past and current users were aware of these facts. Negative social effects relating to the consumption of tobacco include the following perceptions reported by the students: 'Tobacco use is a symbol of indecency'; 'It creates arrogance'; 'It affects the neighbourhood'; 'It (tobacco use) reflects a bad character'; and 'It (tobacco use) corrupts society'. Further, the addictive nature of tobacco use perceived by a few never users (5.9%) was not reported either by past or current users.

Television (43.3%) and schools (43%) were found to be the most common sources of information on tobacco hazards among all the categories of tobacco users (Table II). This suggests the importance of these means in creating awareness and influencing students of this age group on tobacco-related issues.

Reasons for use/non-use of tobacco products

'Influence from friends' (in various forms from insistence to persuasion to forced initiation) was the most common reason for initiation of tobacco use (25.5%) by ever users. Other reasons



* Total percentage exceeds 100% due to multiple responses

FIG 1. Awareness about harmful effects of tobacco use

TABLE I. Tobacco use among students (n=300)

Form of tobacco use	% (95% CI)
Ever users	15.7 (11.7%–20.3%)
Only smokers	14.7
Only smokeless users	0.7
Both	0.3
Current users	5.3 (3.1%–8.7%)
Only smokers	4.7
Only smokeless users	0.3
Both	0.3
Never users	84.3 (79.7%–88.3%)

TABLE II. Source of information on hazards of tobacco

Source	Total (n=300)	Never users (n=253)	Past users (n=31)	Current users (n=16)
Television	130 (43.3)	110 (43.5)	14 (45.2)	6 (37.5)
School	129 (43.0)	111 (43.9)	12 (38.7)	6 (37.5)
Relatives	105 (35.0)	91 (36.0)	9 (29.0)	5 (31.3)
Magazine	101 (33.7)	87 (34.4)	9 (29.0)	5 (31.3)
Friends	98 (32.7)	83 (32.8)	10 (32.3)	5 (31.3)
College	91 (30.3)	76 (30.0)	9 (29.0)	6 (37.5)
Health professionals	89 (29.7)	74 (29.3)	11 (35.5)	4 (25.0)
Others	53 (17.7)	46 (18.2)	3 (9.7)	4 (25.0)

Values in parentheses are percentages Total percentage exceeds 100% due to multiple responses

452

included consuming 'for the sake of fun' (14.8%), 'curiosity to try tobacco products' (12.8%) and 'for style' (10.6%; Table III).

Current users (31.3%) reported that 'addiction' was the most common reason for the continuation of tobacco use. The reasons by never users for not using tobacco included 'awareness about the harmful effects of tobacco use' (62.1%), 'lack of interest or dislike for tobacco use' (23.7%), and 'social reasons' (10.3%; Table III). Social reasons included the negative association of tobacco use with an individual's character and social image. For instance, never users reported, 'It (tobacco use) is not a good habit', 'It shows your character and mindset and a lack of control over oneself', 'I don't have any such bad habits', 'It (tobacco use) reduces our dignity in society and creates a bad name in society', and 'Tobacco use reflects bad character'. Because of such perceived negative social connotations, tobacco use was seen as something that students who perceive themselves to be 'sincere' or 'sensible' do not indulge in (e.g. 'I am a very sincere student. To even imagine tobacco use creates a guilty consciousness' and 'I am a sensible person. I know the difference between right and wrong.').

DISCUSSION

Our study shows a prevalence of 15.7% for ever use and 5.3% for current tobacco use. Smoking appeared to be the predominant form of tobacco use for both ever users and current users. Among current tobacco users 87.5% were smokers compared with 6.3% who were tobacco chewers; 6.3% were using both forms of tobacco.

We used a purposive sample and hence the quantitative data regarding tobacco use cannot be extrapolated to a larger population. However, we have presented these data to better analyse and understand the qualitative data. Other limitations of our study are the relatively small sample size and self-reported data on the prevalence of tobacco use, which can be biased. We suggest that larger, systematic studies be conducted to better understand tobacco use and its associated factors among students of classes 11 and 12.

We found the prevalence of current tobacco use to be slightly lower than state-level estimates for boys in Karnataka[12] (8%) and regional estimates for southern India[13] (9.2%), as reported by the GYTS. The prevalence of current tobacco use in our study was lower than the national estimate of 17.2% reported by the GYTS for boys.[2] Similarly, the study from Chennai reported a higher use of tobacco (41.6% ever users and 46.3% current users) among boys than our study.[4] A study of tobacco use among grades 6 and 8 students in Chennai and Delhi revealed higher tobacco use among younger students compared with the older students.[8] It is noteworthy that studies showing higher tobacco use among students compared with our study used a younger age group. This may point to higher tobacco use among boys/students from grades 8 to 10 compared with 11 and 12 graders, but this assumption needs to be substantiated by larger studies.

When comparing our findings from Bangalore with those from north Indian cities, the prevalence of current tobacco use was found to be much lower than that reported by the GYTS for boys in Ahmedabad[14] (23.7%), but similar to those reported from Mumbai[3] (5.9%) and Delhi (4.6%[6] and 5.5%[15]). Jaipur was the only city in north India for which a lower prevalence (2.1%) of current tobacco use was found.[11]

As we were unable to find studies on prevalence data specific to pre-university students, we compared our findings with studies on students of slightly different age groups. A possible discrepancy in our results compared with that of other studies could be because of the improved implementation of tobacco-related laws on access to tobacco products by minors, which could account for the relatively low prevalence of tobacco use in our study. With regard to the tobacco consumption pattern (notwithstanding the GYTS for Ahmedabad[14] and the study of children in Karnataka[12] that found a higher prevalence of smokeless tobacco use compared with smoking [the proportions being 8.6% and 6.3%, respectively]), studies from Chennai,[4] Jaipur[11] and Delhi[15] corroborated our finding of a higher prevalence of smoking compared with smokeless tobacco use.

The observations of Nichter *at al.*[10] of college students in urban areas of Karnataka also confirmed a higher use of smoking (46%) compared with smokeless tobacco (29.7%). Moreover, they found that school culture might be an important factor in influencing the pattern of tobacco use, with students from professional educational institutes (i.e. medicine, law and engineering) being more likely to smoke cigarettes compared with students from government, *kannada* medium schools who were more likely to use smokeless tobacco products and *vice versa*.[10] The GYTS sampling technique allows a mix of government and private schools and uses a younger sample than that used in our study. These factors can explain, in part, the variations in the pattern of tobacco use found by the GYTS and our study.

Our findings showed that influence from friends was the most common factor in initiating tobacco use, which is similar to observations from studies in Delhi (38%)[6] and Mumbai (46%).[16] Also, current users in our study said that 'friends' were the second most common reason for continuing tobacco use.

TABLE III. Reasons for use/non-use of tobacco products

Reason	
Reason to start use of tobacco	*Ever users (n=47)*
Influence from friends	12 (25.5)
Just for fun	7 (14.8)
Curiosity/wanted to try it out	6 (12.8)
For style/showing off	5 (10.6)
Got influenced/tempted	3 (6.4)
Stress/sadness/depression/family problems	3 (6.4)
For passing time	3 (6.4)
Others	3 (6.4)
Do not know	1 (2.1)
Non-responders	10 (21.3)
Reason to continue use of tobacco	*Current users (n=16)*
Addiction	5 (31.3)
For fun/pleasure	3 (18.8)
Friends	3 (18.8)
I like it	2 (12.5)
To overcome tensions/depressing feelings	2 (12.5)
Others	2 (12.5)
Non-responders	2 (12.5)
Reason for not using tobacco	*Never users (n=253)*
Negative health effects/harmfulness	157 (62.1)
Don't like it/not interested in it	60 (23.7)
Social reasons	26 (10.3)
Don't like the smell	15 (5.9)
Family reasons	12 (4.7)
Economical reasons	9 (3.6)
Waste of time	7 (2.8)
Addiction	7 (2.8)
Nothing to gain from it	5 (2.0)
Environmental (air pollution)	4 (1.6)
Others	10 (4.0)

Values in parentheses are percentages Total percentage exceeds 100% due to multiple responses

455

Akin to our findings, a study from the urban areas of Dakshina Kannada district of Karnataka found that curiosity (52%), encouragement from friends (40%), and appearing 'in style' (18%) were reasons given frequently to start smoking.[10] Similarly, a study from Delhi reported 'enjoyment' and 'curiosity' as major factors that influence adolescents to start using tobacco.[6]

Most (78.3%) of the students in our study were aware of the harmful effects of tobacco use; other studies in urban India have reported comparable or higher levels of such awareness. The GYTS for Karnataka reported that 78.7% and 82% of boys were aware of the harmful effects of smoking and smokeless tobacco use, respectively.[12] Studies from Jaipur[11] and Delhi[6] have shown that 80% and 99.2% of students, respectively were aware of the harmful effects of tobacco use on health. Our study has amply demonstrated that it is the harmful effects of tobacco use that is the commonest reason for never users to abstain from tobacco use. Despite a relatively large number of students in our sample reporting that they knew about the harmful effects of tobacco use on health, only 2% reported their concern about the social implications of tobacco use. In fact, none of the past or current users of tobacco products commented on the social ill-effects of tobacco use. This observation is important as the social reasons (perceived association of tobacco use with indecency, bad character, insincerity, etc.) constituted the third major factor that prevented students from taking up tobacco use.

Appropriate interventions are needed to reduce tobacco use among students in India. Such interventions should raise awareness of the social and economic implications of tobacco use and equip students to overcome peer influence, while at the same time providing help to quit tobacco use.

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454