SMOKELESS TOBACCO

1. Description of Smokeless Tobacco Practices

1.1 Historical overview

The tobacco plant is thought to have originated on the mainland between North and South America. Its cultivation probably dates back at least 5000 years; tobacco seeds were discovered during archaeological excavations in both Mexico and Peru around 3500 BC, which shows that tobacco was an article of value to the inhabitants (Voges, 1984).

American Indians were probably the first people to smoke, chew and snuff tobacco, as early as the 1400s (Christen *et al.*, 1982). The Indians inhaled powdered tobacco through a hollow Y-shaped piece of cane or pipe by placing the forked ends into each nostril and the other end near the powdered tobacco. This instrument was called a '*tobago*' or '*tobaca*'. The word was later changed by the Spaniards to 'tobacco' (Christen *et al*., 1982).

1.1.1 *Tobacco chewing*

In 1499, Amerigo Vespucci found Indians on Margarita Island, off the coast of Venezuela, who chewed a green herb known as tobacco in order to quench their thirst, since it produced an increase in salivation; he also reported that the Indians chewed tobacco leaves to whiten their teeth and to alleviate hunger (Heimann, 1960; Stewart, 1967; Voges, 1984).

The practice of tobacco chewing was widespread in parts of Central and South America in the late 1500s (Voges, 1984). Columbus, in 1571, observed men in Veragua, later known as Costa Rica, who put a dry herb in their mouths and chewed it (Heimann, 1960). Use of plug tobacco was reported in Santo Domingo during the sixteenth century. Tobacco chewing seems to have been a common practice among the American Indians, especially when long distances had to be covered; it has been reported that tobacco was the support against hunger, thirst and fatigue when an American Indian would trek for 2 or 3 days with no other support. Several American tribes mixed either lime or finely-powdered and burned, fresh- or saltwater molluscs with their chewing tobacco (Curtis, 1935).

Among native Americans, chewing tobacco was thought to have several medicinal uses, such as to alleviate toothache, to disinfect cuts by spitting the tobacco juice and

saliva mixture onto the wound, and to relieve the effects of snake, spider and insect bites (Axton, 1975).

By 1531, the Spaniards were growing tobacco commercially in the West Indies and maintained a monopoly over the European markets until 1575, at which time the Portuguese began to grow large quantities of the commodity. Tobacco was soon grown in Europe as both a decorative and medicinal plant. In 1559, Jean Nicot, in whose honour the genus *Nicotiana* was named, was ambassador to Sebastian, King of Portugal. He grew tobacco and promoted the product in Europe for its magic 'cure-all' properties. By the early seventeenth century, tobacco had become one of the major exports of the American colonies (Christen *et al.*, 1982) and its use in various forms had spread throughout Europe, Turkey, Russia, Arabia, China, Alaska and the world (Axton, 1975). Portugese and Spanish sailing crews who were addicted to tobacco carried seeds, and planted them at ports.

When smoking was forbidden on British naval vessels because of the fire hazard, sailors turned to chewing tobacco and snuff. In Europe, tobacco was regarded as a prophylactic during the plague and, for those who did not like smoking, chewing was an alternative. Tobacco chewing was recommended for cleaning the teeth of women and children (Brooks, 1952). Chewing tobacco became popular in the USA only during the first half of the nineteenth century (Gottsegen, 1940). In spite of two centuries of pipe smoking and snuff use, by the mid-1850s, North Americans rejected the European practices in general, and British practices in particular, that entailed snuff boxes and formality; in addition, tobacco chewing was more convenient for Americans who trekked westward in their wagons. During the 1860s, tobacco was chewed in the form of either a plug or a twist. Of the 348 tobacco factories listed in the 1860 Census for Virginia and North Carolina, only seven manufactured smoking products (Heimann, 1960). American pioneers resorted to the use of a home-made sweet plug, so-named because the leaf was wadded into a hole in a log and laced with a sweetening agent (usually brandy or cane sugar), which, after removal of the fermented leaf, resulted in a tasty chew (Axton, 1975).

In 1797, Adam Clarke, a famous Methodist minister, appealed to all tobacco consumers and religious followers to avoid the use of tobacco for the sake of their health and their souls. This plea was also due to the fact that it had become unsafe to kneel when praying because chewers had made the floors unsanitary (Brooks, 1952).

During the latter part of the nineteenth century, the 'germ theory of infection' changed the course of chewing in America, and it was felt that expectorating on the floor and into a brass cuspidor could be a source of contamination and the spread of disease. By the 1890s, public outcry made tobacco chewing socially unacceptable behaviour and unlawful in most public places (Christen *et al.*, 1982). Anti-spitting laws were passed in New York and Philadelphia, USA, in 1896 and in Toronto, Canada, in 1904 (Kozlowski, 1981).

The market for chewing tobacco passed its peak in 1890, when some 3 lb (about 1.5 kg) of plug, twist or fine-cut chewing tobacco were chewed annually per capita in the USA (Heimann, 1960). Nevertheless, chewing remained the dominant form of tobacco use in America until the expansion of the cigarette industry in 1918 (Maxwell, 1980). In 1945, cuspidors were removed from all federal buildings by order of the US District Court

in Washington DC (Brooks, 1952). The apparent decline in tobacco chewing is exemplified by a memorandum of 14 September 1955 to the American Tobacco Company, stating, “It has become impossible to hire persons in the New York area to clean and maintain cuspidors ... it will be necessary to remove them promptly from the premises” (Heimann, 1960). During the second half of the 1960s through to the 1970s, however, a resurgence in tobacco chewing occurred in the USA (Christen & Glover, 1981).

1.1.2 *Snuff taking*

The native populations of Brazil were the first people known to use snuff. Using a cup and a pestle made from rosewood, the tobacco leaves were ground into a powder and acquired the delicate aroma of the wood. The resulting snuff was placed in ornately decorated bone tubes, one end of which was plugged to preserve the fragrance (Curtis, 1935). The American Indians inhaled powdered tobacco through a hollow Y-shaped piece of cane or pipe by placing the forked ends into each nostril and the other end near the powdered tobacco (Christen *et al.*, 1982).

Friar Ramón Pané, a Franciscan monk who travelled with Christopher Columbus on his second voyage to the New World in 1493, reported that the Caribbean Indians of the lesser Antilles used snuff (Christen *et al*., 1982). In Haiti, snuff powder was used by medicine men for clearing nasal passages and as an analgesic (Stewart, 1967). Friar Pané’s return to Spain with snuff signalled the arrival in Europe of a practice that was to last for several centuries.

In 1519, Ocaranza found that Mexican Indians used tobacco powder to heal burns and wounds and, in 1525, Herrera observed that Mexican Indians held tobacco powder in their mouth to send them to sleep and reduce pain (Stewart, 1967).

The Dutch, who named the powdered tobacco ‘snuff’, were using the product by 1560 (Christen *et al*., 1982). By the early 1600s, snuff had become an expensive commodity and its use had spread throughout South America, China, Japan and Africa. The origin of the process terms ‘carotte’ and ‘rappee’ goes back to the 1600s when tobacco for snuff was prepared in the form of a carrot to be rasped in the quantity desired for use (Curtis, 1935). In 1620, the Royal Snuff Factory was established in Seville, and this became the centre of the manufacture and development of this product (Voges, 1984). Snuff use expanded through Japan to China (Ching Dynasty) in the 1650s: palace artisans produced exquisitely carved, inlaid enamelled or painted snuff bottles with a tiny spoon attached to the bottle stopper; a small portion of snuff was placed on the left thumbnail and inhaled through the nose. The Chinese believed that snuff cured pains in the eyes and teeth, alleviated throat ailments, constipation and cold symptoms, and promoted sweating (Christen *et al.*, 1982).

By 1650, snuff use had also spread from France to England, Scotland and Ireland. The Irish called snuff ‘powder’ or ‘smutchin’; the Scots called it ‘sneeshin’ (Harrison, 1964). Jean Nicot is credited with introducing snuff to Catherine de Medici, Queen of France, to cure her headaches (Christen *et al*., 1982).

Snuff use reached a peak in England during the reign of Queen Anne (1702–14), and was called the 'final reason for the human nose'. It was at this time that ready-made snuff became available in England. It continued to be popular during the reign of George III, and his wife, Charlotte (1760–1820), referred to as 'Snuffy Charlotte', had an entire room in Windsor Castle devoted to her snuff stock. Lord Nelson, the Duke of Wellington, Marie Antoinette, Disraeli, Alexander Pope and Samuel Johnson all used snuff (Harrison, 1964). In diplomatic intrigue, poisons were sometimes placed in snuff. The aristocratic popularity of snuff led to a minor art form, in that snuff boxes became symbols that reflected the wealth and rank of their owner. The dandy, Lord Petersham, was said to own an annual set of 365 snuff boxes (Christen *et al.*, 1982).

The leading snuff supplier of the time provided King George IV with his own special blends, King's Morning Mix, King's Plain and King's Carotte (Ryan, 1980). Home-made snuff was common. The tightly-rolled tobacco leaves (carotte) were often soaked in cinnamon, lavender or almond oils; tobacco was dried and ground by means of an iron hand-grater that resembled a modern cheese-grater. The proper manner of inhaling snuff was to place a small quantity on the back of the hand and sniff it up the nostrils to induce a sneeze (Christen *et al.*, 1982).

Although hundreds of varieties of snuff existed in Europe by the 1800s, these consisted of three basic types: Scotch snuff, which was a dry, strong, unflavoured and finely ground powder; Maccaboy, a moist and highly scented snuff; and Rapee, also known as Swedish snuff, a coarsely grated snuff (Heimann, 1960).

Snuff was introduced into Sweden in the middle of the seventeenth century, but its popularity among aristocrats reached a height during the eighteenth century, when use of nasal snuff became the highest fashion at the court of King Gustav III, among both men and women. The practice subsequently spread to the general Swedish population.

In many Swedish cities, snuff has been manufactured since the beginning of the eighteenth century. In Gothenburg, which is considered to be the centre of snuff production, manufacture started in about 1650 (Loewe, 1981). In 1795, Samuel Fiedler established a snuff mill in Gothenburg and began a small business, which later developed into three separate companies. At the end of the nineteenth century, the leading producer was Jacob Ljunglöf in Stockholm; his leading brand 'Ettan' became well known throughout Europe (Loewe, 1981). In 1914, the production of snuff in Sweden was taken over by the Swedish tobacco monopoly, which restored Gothenburg as its centre. A large factory was built around 1920, and expanded in 1979, for the production of snuff and chewing tobacco.

Since the beginning of the twentieth century, snuff has been used mainly orally in Sweden. In the 1950s and 1960s, use of moist snuff was prevalent predominantly among older men and was heading towards a 'natural death': the median age of consumers in 1969–70 was over 40 years (Nordgren & Ramström, 1990). However, the development of new products and intensive advertisement and promotion by Swedish Match, the country's primary snuff manufacturer, starting in the late 1960s, led to a surge in the use of moist snuff among young men. By 1972–73, the median age of moist snuff users had dropped to 30 years (Nordgren & Ramström, 1990). More recently, Swedish Match has

been representing its moist snuff products as less harmful tobacco products than cigarettes (Henningfield & Fagerström, 2001). As discussed later in this section, the prevalence of smokeless tobacco use continues to increase in Sweden, particularly among young men.

Commercially manufactured snuff made its way to North America in 1611 by way of John Rolfe, husband of Pocahontas. Rolfe introduced the better Spanish variety of tobacco to ensure the survival of the Jamestown Colony in Virginia. Although most of the colonists in America never fully accepted the English style of snuff use, American aristocrats used snuff, and Dolly Madison was known to distribute samples of snuff to White House guests. During the 1800s until the mid 1930s, a communal snuff box was installed for members of the US Congress. The colonists also found it more to their taste to place snuff in their mouths rather than to sniff it (Christen *et al*., 1982).

The first snuff mills in America were constructed in Virginia in about 1730 (Heimann, 1960). The snuff was made from New England tobacco and its quality was said to equal that of the native Scottish varieties (Robert, 1949). Pierre Lorillard, a Huguenot, established a snuff mill in New York in 1760 and carefully guarded the secret of the ingredients and blends of his products (Christen *et al*., 1982).

Between 1880 and 1930, the production of snuff in the USA increased from 4 million lb (1.8 million kg) to more than 40 million lb (18 million kg) per year (Garner, 1951). By 1945, the American Snuff Company in Memphis, TN, claimed to be the largest snuff manufacturer in the world (Christen *et al*., 1982). Snuff was made predominantly from dark, air- and fire-cured leaves. Stems and leaves were aged in hogsheads and conditioned before being cut into strips of 1–2 in (2.5–5 cm) in width. The chopped leaves underwent further fermentation for about 2 months, during which time the tobacco lost its creosote-like odour and became more aromatic. It was next dried by passing it through steam-heated containers and then ground to a fine powder in a revolving steel drum. The powder was passed over silk cloth that contained as many as 96 threads per in (38 per cm). The coarse residue was returned to the mill for additional grinding before being packed into 100-lb (45-kg) bags for storage prior to repacking in smaller containers for retail sale. The dry and moist snuffs were used for dipping and placing in the mouth. Rappee or French snuff was used for inhaling, and Maccaboy snuff was both sucked and inhaled (Garner, 1951).

The use of smokeless tobacco products in the USA was widespread throughout the nineteenth century. Dental snuff was advertised to relieve toothache; to cure neuralgia, bleeding gums and scurvy; and to preserve and whiten teeth and prevent decay (Christen *et al*., 1982). With the advent of anti-spitting laws, loss of social acceptability and increased popularity of cigarette smoking, its use declined rapidly during the twentieth century.

Beginning in the mid-1970s, the US Tobacco Company (later renamed the US Smokeless Tobacco Co.), the leading manufacturer of smokeless tobacco products in the USA, developed new products, new images and an aggressive marketing campaign to expand its market (Connolly *et al*., 1986; Connolly, 1995). The marketing campaign included a ‘graduation’ marketing strategy that was designed to recruit new, young users with low-dose nicotine ‘starter’ moist snuff products and move them to higher-dosage products as they developed tolerance and addiction to nicotine (Connolly, 1995). The result was a nine-

fold increase in the prevalence of snuff use among young adult men (< 24 years old) between 1970 and 1987 (Giovino *et al*., 1994; Giovino, 1999). The United States Smokeless Tobacco Company continues to market its products for young men (Myers, 2003) and, in recent years, has also been marketing products for smokers as an alternative tobacco product, particularly for use when faced with smoking restrictions (Henningfield *et al*., 2002).

Tobacco was introduced into South Asia in the 1600s as a product to be smoked and was gradually used in many different forms (Bhonsle *et al*., 1992; Gupta & Ray, 2003). The chewing of betel quid (*pan*) was a popular practice that existed for over 2000 years and extended eastwards as far as the South Pacific Islands. After its introduction, tobacco soon became a new ingredient in betel quid, which has become the most commonly used form of smokeless tobacco in South Asia (Gupta & Ray, 2003; IARC, 2004a).

In Sudan, the introduction of *toombak* is historically attributed to a Koranic (Islamic) teacher, who came from Egypt, Timbuktu in Mali, Morocco, Turkey or Arabia, and dates back several centuries (Idris *et al.*, 1998a). Another popular name for *toombak* is *sute*, which means 'sniffing of the product' in the local language, and indicates nasal usage when it was first introduced.

1.1.3 *Attitudes and beliefs regarding smokeless tobacco use*

The use of tobacco, including smokeless tobacco, has been controversial since its introduction. Therefore, a history of smokeless tobacco use is not complete without a discussion of the attacks on tobacco by various groups. In 1590 in Japan, tobacco was prohibited, and users lost their property or were jailed. James VI of Scotland, who became King James I of England and Ireland in 1603, was a strong anti-smoking advocate and increased taxes on tobacco by 4000% in an attempt to reduce the quantity imported into England. In 1633, the Sultan Murad IV of Turkey made any use of tobacco a capital offence, punishable by death from hanging, beheading or starvation, and maintained that tobacco caused infertility and reduced the fighting capabilities of his soldiers. The Russian Czar Michael Fedorovich, the first Romanov (1613–45), prohibited the sale of tobacco, and stated that users would be subject to physical punishment; persistent users would be killed. A Chinese law in 1638 threatened that anyone who possessed tobacco would be beheaded (Christen *et al*., 1982).

During the mid 1600s, Pope Urban VIII banned the use of snuff in churches, and Pope Innocent X attacked its use by priests in the Catholic Church. Other religious groups banned snuff use: John Wesley (1703–91), the founder of Methodism, attacked its use in Ireland; similarly, the Mormons, Seventh-Day Adventists, Parsees and Sikhs of India, Buddhist monks of Korea, members of the Tsai Li sect of China, and some Ethiopian Christian sects forbade the use of tobacco (Christen *et al.*, 1982).

In Bavaria, Germany, in 1652, tobacco was available only on a doctor's prescription; Frederick the Great, King of Prussia, prevented his mother, the Dowager Queen of Prussia,

from using snuff at his coronation in 1790. Louis XV, ruler of France from 1723 to 1774, banned the use of snuff from the Court of France (Christen *et al.*, 1982).

In 1761, John Hill, a London physician and botanist, concluded that nasal cancer could develop as a consequence of snuff use. He reported five cases of 'polypusses, a swelling in the nostril that was hard, black and adherent with the symptoms of an open cancer' (Redmond, 1970).

1.2 Manufacture and use of smokeless tobacco products

Smokeless tobacco is consumed without burning the product, and can be used orally or nasally. Oral smokeless tobacco products are placed in the mouth, cheek or lip and sucked (dipped) or chewed. Tobacco pastes or powders are used in a similar manner and applied to the gums or teeth. Fine tobacco mixtures are usually inhaled and absorbed in the nasal passages. Table 1 lists smokeless tobacco products according to their mode of use.

Table 1. Classification of smokeless tobacco products by mode of use

Oral use			Nasal use (sniffing)
Sucking	Chewing	Other oral uses	
Chimó	Betel quid	Creamy stuff	Dry snuff
Dry snuff	*Gutka*	*Gudhaku*	Liquid snuff
Gutka	*Iq'mik*	*Gul*	
Khaini	*Khaini*	*Mishri*	
Loose-leaf	*Khiwam*	Red tooth powder	
Maras	Loose-leaf	*Tuibur*	
Mishri	*Mawa*		
Moist snuff	Plug		
Naswar	Tobacco chewing gum		
Plug	Twist or roll		
Shammah	*Zarda*		
Snus			
Tobacco tablets			
Toombak			

Smokeless tobacco products are used throughout the world (National Cancer Institute/Centers for Disease Control, 2002; Gupta & Ray, 2003). Table 2 presents an overview of their use by WHO region. It is worth noting that some products are known to be used by immigrants from certain regions where a product is used to other regions.

There are many different botanical classifications for tobacco plants. The genus *Nicotiana* is classified into three main subgenera, *N. rustica*, *N. tabacum* and *N. petuniodes*. Smokeless tobacco products use *N. tabacum*, and sometimes *N. rustica*. In the USA, tobacco is also classified by the curing method (e.g. flue-cured, air-cured, dry air-cured

tobacco) and by production areas (Virginia, North Carolina, Tennessee, Wisconsin) (Tso, 1990).

Table 2. Use of smokeless tobacco products by WHO region

Tobacco product	WHO Region[a]					
	AFRO	AMRO	EMRO	EURO	SEARO	WPRO
Oral use						
Betel quid with tobacco			X		X	X
Chimó		X				
Creamy snuff					X	
Dry snuff	X	X		X		
Gul					X	
Gudhaku					X	
Gutka					X	
Iq'mik		X				
Khaini					X	
Khiwam					X	
Loose leaf		X		X		
Maras				X		
Mawa					X	
Mishri					X	
Moist snuff		X		X		
Naswar	X		X	X		
Plug chewing tobacco		X				
Red tooth powder					X	
Shammah			X	X		
Tobacco chewing gum						X
Tobacco tablet		X				
Toombak	X					
Tuibur					X	
Twist/roll chewing tobacco		X				
Zarda			X		X	
Nasal use						
Dry snuff	X		X	X	X	
Liquid snuff	X					

[a] The countries included in each region are available at: http://www.who.int/about/regions/en/

Notes:
Some of these products are known to be used by immigrants from certain regions where a product is used to other regions of the world.
This table was compiled by the experts present at the meeting and is based on individual knowledge about use of these products and is not intended to be exhaustive or complete.

1.2.1 *Oral use*

Oral use of smokeless tobacco is practised in Africa, North America, South-East Asia, Europe and the Middle East, and consists of placing a piece of tobacco or tobacco product in the mandibular groove and either chewing or sucking it for a certain period of time: a 'chaw', which refers to a portion of tobacco the size of a golf ball, is generally chewed, whereas a 'quid' is usually a much smaller portion and is held in the mouth rather than chewed (Pindborg *et al*., 1992).

(*a*) *Betel quid with tobacco*

Betel quid with tobacco, commonly known as *paan* or *pan*, consists of four main ingredients: (i) betel leaf (*Piper betle*), (ii) areca nut (*Areca catechu*), (iii) slaked lime and (iv) tobacco. Of these, tobacco is the most important ingredient for regular users. Betel quid can be prepared by the vendor or at home. Various tobacco preparations are used in unprocessed, processed or manufactured forms. Tobacco may be used in raw, sun-dried or roasted form, then finely chopped or powdered and scented. Alternatively, tobacco may be boiled, made into a paste and scented with rosewater or perfume. The final product is placed in the mouth and chewed. Betel quid with tobacco is used in Central, East, South and South-East Asia, in the western Pacific and in migrant communities arising therefrom (Bhonsle *et al*., 1992; Gupta & Ray, 2003). Exposure to and the health effects of betel quid with or without tobacco are described in detail in a previous monograph (IARC, 2004a).

(*b*) Chimó

Chimó is specific to Venezuela. It contains tobacco leaf, sodium bicarbonate, brown sugar, ashes from the Mamón tree (*Melicocca bijuga*), and vanilla and anisette flavourings. The ingredients vary according to the region within Venezuela. Tobacco leaves are crushed and boiled for several hours, during which starch and fibre are discharged. The remaining portion becomes a concentrated product: 10 kg of tobacco yield 1 kg of 'pasta'. For maturation, *chimó* is then placed in natural containers or 'taparas' (the dried fruit from the Tapara tree) or is wrapped in banana leaves. The matured paste is 'seasoned' with the ingredients listed above. Finally, it is packaged in small tins or candy-like wrapped cylinders. A small amount of *chimó* is placed between the lip or cheek and the gum and left there for some time, usually 30 min. The mixture of *chimó* and saliva is spat out.

(*c*) *Creamy snuff*

Creamy snuff consists of finely ground tobacco mixed with aromatic substances, such as clove oil, glycerin, spearmint, menthol and camphor, salts, water and other hydrating agents. It is often used to clean teeth. The manufacturer recommends letting the paste linger in the mouth before rinsing. Creamy snuff is manufactured commercially and marketed as a dentifrice, and is commonly used as such by women in South Asia.

(*d*) *Dry snuff*

In Europe and the USA, tobacco (primarily Kentucky and Tennessee tobacco) is fire-cured, then fermented and processed into a dry, powdered form. The moisture content of the finished product is less than 10%. Dry snuff is packaged and sold in small metal or glass containers. Typically, in the USA, a pinch (called a 'dip') is held between the lip or cheek and gum. In Europe, it is commonly inhaled into the nostrils (see Section 1.2.2 Nasal use).

In India, dry snuff was once commonly used nasally, but is now used mainly orally. It is frequently prepared at home by roasting coarsely cut tobacco on a griddle and then powdering it. This pyrolysed snuff-like preparation, mainly used in Goa, Maharastra, Gujarat and eastern parts of India, is widely used by the poorer classes as a dentifrice (applied to the teeth and gums), especially by women, but tends to be used many times a day, due to its addictive properties. It is known as *bajjar* or *tapkir*/*tapkeer*.

In many regions of the world, dry snuff is used both orally and nasally.

In northern Africa, dry snuff is known as *naffa*, *tenfeha* or *nufha*.

(*e*) Gudhaku

Gudhaku is a paste made of powdered tobacco and molasses. It is available commercially and is stored in a metal container. *Gudhaku* is applied to the teeth and gums with the finger, predominantly by women in India in the States of Bihar, Orissa, Uttar Pradesh and Uttaranchal.

(*f*) Gul

Gul contains tobacco powder, molasses and other ingredients and is manufactured commercially. It is applied to the teeth for the purpose of cleaning and then to the gums many times during the day. *Gul* is used in South Asia, including the Indian Subcontinent.

(*g*) Gutka

Gutka is manufactured commercially and consists of sun-dried, roasted, finely chopped tobacco, areca nut, slaked lime and catechu mixed together with several other ingredients such as flavourings and sweeteners. The product is sold in small packets or sachets. It is held in the mouth, sucked and chewed. Saliva is generally spat out, but is sometimes swallowed. *Gutka* is used in South Asia, including the Indian Subcontinent, and by Asian expatriates in several parts of the world, especially Canada, the United Kingdom and the USA (IARC, 2004a).

(*h*) Iq'mik

Fire-cured tobacco leaves are mixed with punk ash, which is generated by burning a woody fungus that grows on the bark of birch trees. The separate ingredients are available at grocery stores and retail outlets, but are generally combined by the user before use. Users pinch off a small piece and chew the *iq'mik*. The user may pre-chew the *iq'mik* and

place it in a small box for later use by others, including children and sometimes teething babies. *Iq'mik* is used by native Americans in the northwestern parts of North America.

(*i*) Khaini

Khaini is made from sun-dried or fermented coarsely cut tobacco leaves. The tobacco used for *khaini* is from *N. rustica* and/or *N. tabacum*. The tobacco leaves are crushed into smaller pieces. A pinch of tobacco is taken in the palm of the hand, to which a small amount of slaked lime paste is added. The mixture is then rubbed thoroughly with the thumb. *Khaini* is usually prepared by the user at the time of use, but is also available commercially. It is held in the mouth and sucked or chewed. Areca nut may sometimes be added to *khaini* by the user. *Khaini* is used in South Asia, including the Indian Subcontinent.

(*j*) Khiwam

Khiwam (or *qimam*) consists of tobacco extract, spices and additives. The tobacco used for *khiwam* is from *N. rustica* and/or *N. tabacum*. Tobacco leaves are processed by removing their stalks and stems, then boiling and soaking them in water flavoured with spices (e.g. saffron, cardamom, aniseed) and additives such as musk. The resulting pulp is mashed, strained and dried into a paste. The paste is placed in the mouth and chewed. *Khiwam* may also be used in betel quid (IARC, 2004a). It is used in South Asia, including the Indian Subcontinent.

(*k*) *Loose-leaf*

Loose-leaf tobacco is manufactured commercially and consists of loose cigar tobacco leaves from Pennsylvania and Wisconsin that are air-cured, stemmed, cut or granulated, and loosely packed to form small strips of shredded tobacco. Most brands are sweetened and flavoured with liquorice, and are typically sold in pouches weighing about 3 oz. Loose-leaf tobacco is high in sugar content (approximately 35%). A piece of tobacco 0.75–1 in in diameter is placed between the cheek and lower lip, typically toward the back of the mouth. It is either chewed or held in place. Saliva is spat or swallowed. Loose-leaf is used in Europe and North America.

(*l*) Maras

In Turkey, a type of smokeless tobacco called *maras* is widely used in the south-eastern region, especially in the cities of Kahramanmaras and Gaziantep. First, sun-dried leaves of the tobacco plant species *N. rustica* L. — known locally as 'crazy tobacco' — are powdered and mixed with the ash of wood, in particular oak, walnut or grapevine, in 1:2 or 1:3 proportions (tobacco and oak, respectively). Then, water is sprinkled onto the mixture for humidification. A small amount of the mixture (approximately 1 g) is applied between the lower labial mucosa and gingiva for 4–5 min. This procedure is repeated many times during the day; some people even sleep with the powder in their mouth.

(*m*) Mawa

Mawa is a mixture of small pieces of sun-cured areca nut with crushed tobacco leaves and slaked lime. The resulting mixture is about 95% areca nut by weight. It is placed in the mouth and chewed for 10–20 min. *Mawa* is used in South Asia, including the Indian Subcontinent.

(*n*) Mishri

Mishri is made from tobacco that is baked on a hot metal plate until toasted or partially burnt, and then powdered. It is applied to the teeth and gums as a dentifrice, usually twice a day and more frequently in some cases. Users then tend to hold it in their mouths. *Mishri* is used in South Asia, including the Indian Subcontinent.

(*o*) *Moist snuff*

The tobacco is either air- or fire-cured, then processed into fine particles (‘fine-cut’) or strips (‘long-cut’). Tobacco stems and seeds are not removed. The final product may contain up to 50% moisture. Moist snuff is sold either loose or packaged in small, ready-to-use pouches called packets or sachets. A pinch (called a dip) or a pouch is placed and held between the lip or cheek and gum. Saliva may be swallowed or, more commonly, spat out. Moist snuff is used in Europe and North America, and is the most common form of smokeless tobacco in the USA (see Section 1.4.2).

Swedish-type moist snuff (*snus*) consists of finely ground dry tobacco (Kentucky and Virginia tobacco), mixed with aromatic substances, salts (sodium chloride), water, humidifying agents and chemical buffering agents (sodium carbonate). A pinch (called a dip) is placed between the gum and upper lip. The average user keeps snuff in the mouth for 11–14 h per day. In Sweden, the portions come in two doses, regular and ‘mini-portions’ (1.0 g and 0.5 g tobacco, respectively), or loose.

(*p*) Naswar

Naswar (or *nass*) is a mixture of sun-dried, sometimes only partially cured, powdered local tobacco (*N. rustica*), ash, oil, flavouring agents (e.g. cardamom, menthol), colouring agents (indigo) and, in some areas, slaked lime. It is made by pouring water into a cement-lined cavity to which lime is added, followed by tobacco. Colouring and flavouring agents are then added. The ingredients are then pounded and mixed with a heavy wooden mallet. The type of oil varies by region. Water is added and the mixture is rolled into balls. It is then usually placed under the tongue (in the floor of the mouth) and then sucked. *Naswar* is used widely in Afghanistan, Iran, Pakistan and the central Asian Republics, and in South Africa.

(*q*) *Plug chewing tobacco*

Plug is the oldest form of chewing tobacco. It is produced from the heavier grades of Burley and bright tobacco or cigar tobacco leaves harvested from the top of the plant.

Once the stems are removed, the leaves are immersed in a mixture of liquorice or sugar, pressed into a plug, covered by a wrapper leaf and re-shaped into bricks or flat blocks. Moist plug tobacco has at least 15% moisture content; plug or 'firm plug' tobacco has less than 15% moisture content. Sugar content is approximately 25%. Moist plug is chewed, or held between the cheek or lower lip and gum. Saliva is spat or swallowed. Moist plug is used primarily in North America.

(*r*) *Red tooth powder*

Red tooth powder is a fine tobacco powder that is red in colour and contains many additional ingredients including herbs and flavouring agents. It is manufactured commercially and marketed as a herbal product. Red tooth powder is used in South Asia as a dentifrice.

(*s*) Shammah

Shammah is a mixture of powdered tobacco, lime, ash, black pepper, oils and flavourings. The greenish-yellow powder is placed in the buccal or lower labial vestibule of the mouth. The user spits out insoluble debris. It is used in the Middle East, including some parts of southern Saudi Arabia and Yemen.

(*t*) *Snuff*

Two types of snuff are used orally: dry snuff and moist snuff; these are discussed under (*d*) and (*o*), respectively. Dry snuff may also be used nasally (see Section 1.2.2(*a*)).

(*u*) *Tobacco chewing gum*

Tobacco chewing gum was developed by the company Swedish Match in 2003 and marketed under the brand name 'Fire' as an alternative tobacco product and test marketed in Tokyo, Japan.

(*v*) *Tobacco tablets*

Tobacco tablets were introduced on the market in 2002 in the form of 10-piece blister card. They are made of compressed powdered tobacco, mint and eucalyptus and melt in the mouth. Each tablet contains approximately 1.3 mg nicotine (Nguyen *et al.*, 2002). Tobacco tablets are also known by the brand names Ariva® and Cigalett®.

(*w*) Toombak

Toombak is a moist tobacco product used primarily in Sudan. It consists of tobacco (*N. rustica* and/or *N. glauca*) and sodium bicarbonate. Tobacco leaves are harvested and left in a field to dry uniformly. The leaves are then tied into bundles, sprinkled with water and stored for a couple of weeks at 30–45 °C to allow fermentation. They are then ground and matured for up to 1 year. After maturation, *toombak* vendors (in *toombak* shops) place the product in bowls and gradually add sodium bicarbonate until the mixture is approxi-

mately four parts of tobacco to one part of sodium bicarbonate. The mixture is blended by hand and constantly tested with the tips of the fingers until it becomes moist and hardened. The *toombak* is then placed in an air-tight container shortly before sale.

Toombak is rolled into a ball that weighs about 10 g and is called a *saffa*. The *saffa* is held between the gum and the lip or cheek, or under the tongue on the floor of the mouth. It is sucked slowly for 10–15 min. Male users periodically spit, while female users typically swallow the saliva generated. The user usually rinses his/her mouth with water after the *saffa* is removed. Commercial names for *toombak* include El-Sanf (of high quality), Wad Amari (accrediting the person who was believed to have introduced it) and Sultan El-Khaif (the power to improve one's state of mind) (Idris *et al*., 1998a).

(*x*) Tuibur

Tuibur (or *hidakphu*) is tobacco water for oral use. Tobacco smoke is passed through water and the water is used for gargling or sipping. *Tuibur* is commonly used in the north-eastern states of India (Manipur, Mizoram, Sikkim, Tripura) (Mahanta *et al*., 1998).

(*y*) *Twist/roll chewing tobacco*

Twist/roll chewing tobacco is hand-made by commercial manufacturers. Dark, air- or fire-cured leaf Burley tobacco is treated with a tar-like tobacco leaf extract and flavours, and twisted into rope-like strands that are dried. The product is sold by the piece in small (about 50 g) or larger sizes based on the number of leaves in the twist. Twist/roll is used in North America.

(*z*) Zarda

Zarda consists of tobacco, lime, spices and vegetable dyes. Tobacco leaves are broken up and boiled with lime and spices until dry. The mixture is dried and coloured with vegetable dyes. *Zarda* is generally chewed mixed with finely chopped areca nuts and spices. It is often used as an ingredient in betel quid. *Zarda* is commonly used in India and the Middle East, and is known as *dokta* in West Bengal.

1.2.2 *Nasal use*

(*a*) *Dry snuff*

Tobacco (primarily Kentucky and Tennessee tobacco) is fire-cured, then fermented and processed into a dry, powdered form. The moisture content of the finished product is less than 10%. It is packaged and sold in small metal or glass containers. In Europe, dry snuff is commonly inhaled into the nostrils. In many regions of the world, it is used both orally and nasally.

(*b*) *Liquid snuff*

Liquid snuff was reported to be used by the Nandi tribe in East Africa. It is used nasally (Hou-Jensen, 1964).

1.3 Chemical composition of smokeless tobacco

1.3.1 *General overview*

The type of tobacco used in a particular product has a decisive influence on its chemical composition. That of leaf tobacco varies with genetic make-up, environmental conditions and every step of production and handling (Tso, 1990). The classification of leaf tobacco commonly used in smokeless tobacco products is primarily based on curing methods (e.g. air-, flue- and fire-cured tobacco) and tobacco types (e.g. Burley, Wisconsin, Pennsylvania air-cured tobacco, dark fire-cured tobacco, Virginia flue-cured tobacco).

The first summary of chemical components found in tobacco and tobacco smoke was prepared by Stedman in 1968. Since then, frequent additions have been made to the list and, in 1988, the number of compounds identified in tobacco totaled 3044 (Roberts, 1988). The latter count has not been confirmed by independent research. Moreover, Roberts (1998) does not list many of the constituents that are currently known to be present in tobacco (e.g. volatile *N*-nitrosamines, tobacco-specific *N*-nitrosamines, *N*-nitrosamino acids). Hoffman *et al.* (2001) expanded the list to include 23 *N*-nitrosamines and 28 pesticides, which brought the number to 3095 constituents in tobacco. The identification of each single compound is an arduous task and requires a vigorous confirmation protocol that uses state-of-the-art instrumentation as well as synthesis.

During preparation for product manufacture, tobacco leaves, stems and other ingredients are blended to achieve a specific nicotine content, pH, taste, flavour and aroma. These features are critical for acceptance of the product by the user. For cigarettes, it has been demonstrated that the type of tobacco blend significantly affects these features as well as the toxicity of the product (Abdallah, 2003; Baker & Smith, 2003). The pH strongly influences the concentration of unprotonated nicotine, the bioavailable form of nicotine (Djordjevic *et al.*, 1995; Henningfield *et al*., 1995; Richter & Spierto, 2003), while the nitrite content influences the levels of nitrosamines in the product (Fischer *et al*., 1989; Burton *et al*., 1994; Hoffmann *et al*., 1995).

A choice of 60 *N. tabacum* species and 100 varieties of tobacco can be blended. However, the majority of commercial tobacco products use *N. tabacum* species, which are grown in North America and throughout the world. The alkaloid content in *N. tabacum* species varies greatly. From a random examination of 152 cultivated varieties, a range of alkaloid content between 0.17 and 4.93% was found. Tobacco types, plant parts, cultural practices, degree of ripening and fertilizer treatment are among some prominent factors that determine the level of alkaloids in *Nicotiana* plants. Every step in tobacco production that affects plant metabolism influences the level of alkaloid content to a certain degree. Cured tobacco lines can contain between 0.2 and 4.75% nicotine by weight, depending on

plant genetics, growing conditions, degree of ripening, fertilizer treatment and leaf position on the stalk (Tso, 1990; Stratton *et al.*, 2001).

N. rustica species is cultivated in some parts of eastern Europe, Asia Minor and Africa, and the cured leaves may contain up to 12% nicotine. In greenhouse-grown plants, *N. rustica* can accumulate up to 5.3 mg nicotine/g tobacco (98.2% of total alkaloids) and in field-grown plants up to 24.8 mg nicotine (97.1% of total alkaloids) (Sisson & Severson, 1990). *Toombak*, which contains *N. rustica* tobacco, was reported to contain the highest levels of nicotine (up to 102.4 mg/g dry wt) and nicotine-derived tobacco-specific nitrosamines ever measured in consumer products (Idris *et al.*, 1991; Prokopczyk *et al.*, 1995).

The chemical composition of tobacco undergoes substantial changes during growing, curing, processing and storing (Burton *et al.*, 1983, 1989a,b; Peele *et al.*, 1995; Walton *et al.*, 1995; Wiernik *et al.*, 1995; Peele *et al.*, 2001; Bush *et al.*, 2001). The purpose of curing is to produce a dried leaf of suitable physical properties and chemical composition. At the beginning of curing, a tobacco leaf is metabolically active and continues to live until biochemical processes are arrested by thermal effects or desiccation. In curing, the starch content of the leaves declines drastically, while the amount of reducing sugars increases by 100%. Protein and nicotine contents decrease slightly. The bulk of the processed tobacco leaf before fermentation consists of carbohydrates (about 50%) and proteins. Fermentation of cured tobacco causes the contents of carbohydrates and polyphenols in the leaves to diminish. Other major components are alkaloids (0.5–5.0%), which include nicotine as the predominant compound (85–95% of total alkaloids), terpenes (0.1–3.0%), polyphenols (0.5–4.5%), phytosterols (0.1–2.5%), carboxylic acids (0.1–0.7%), alkanes (0.1–0.4%), aromatic hydrocarbons, aldehydes, ketones, amines, nitriles, *N*- and *O*-heterocyclic hydrocarbons, pesticides, alkali nitrates (0.01–5%) and at least 30 metallic compounds (Brunnemann & Hoffmann, 1992; IARC, 2004b).

Because of the disappearance of carbohydrates and polyphenols during fermentation, heavy casings [additives applied during processing] such as molasses, liquorice and fruit extracts are added to tobacco to meet the consumer's requirements (e.g. they improve taste, flavour and aroma, and prolong shelf-life). Many smokeless tobacco formulations use plant extracts or chemicals as flavouring agents (Mookherjee & Wilson, 1988; Roberts, 1988; Sharma *et al.*, 1991). Tobacco additives may include methyl or ethyl salicylate, β-citronellol, 1,8-cineole, menthol, benzyl benzoate, eugenol and possibly coumarin, among others (LaVoie *et al.*, 1989; Stanfill *et al.*, 2006). Eugenol (ranging from < 0.00005 to 25 706 μg/g in Dentobac Creamy Snuff sold in India; Gupta, 2004) and menthol are used to numb the throat and facilitate tobacco use (Ahijevych & Garrett, 2004; Wayne & Connolly, 2004). Ascorbic acid is added to tobacco as an antimicrobial agent whereas the addition of sodium propionate serves as a fungicide. Other additives, such as ammonia, ammonium carbonate and sodium carbonate, are applied to control nicotine delivery by raising pH and subsequently the level of unprotonated nicotine which is the form of nicotine that is most readily absorbed through the mouth into the bloodstream (Djordjevic *et al.*, 1995; Henningfield *et al.*, 1995). However, the formulation of most of the additives, including flavours, remains a trade secret.

1.3.2 *Carcinogenic compounds in smokeless tobacco*

To date, 28 carcinogens have been identified in smokeless tobacco (Table 3; adapted from Brunnemann & Hoffmann, 1992). The major and most abundant group of carcinogens are the non-volatile alkaloid-derived tobacco-specific *N*-nitrosamines (TSNA) and *N*-nitrosoamino acids. Other carcinogens reportedly present in smokeless tobacco include volatile *N*-nitrosamines, certain volatile aldehydes, traces of some polynuclear aromatic hydrocarbons such as benzo[*a*]pyrene, certain lactones, urethane, metals, polonium-210 and uranium-235 and -238 (see Brunnemann & Hoffmann, 1992 for review).

There are three major types of nitroso compounds in smokeless tobacco: (*a*) non-volatile TSNA, including 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK) and *N*′-nitrosonornicotine (NNN); (*b*) *N*-nitrosamino acids, including *N*-nitrososarcosine (NSAR), 3-(methylnitrosamino)propionic acids (MNPA) and 4-(methylnitrosamino)butyric acids (MNBA); and (*c*) volatile *N*-nitrosamines, including *N*-nitrosodimethylamine (NDMA), *N*-nitrosopyrrolidine (NPYR), *N*-nitrosopiperidine (NPIP) and *N*-nitrosomorpholine (NMOR).

TSNA are present in fresh green tobacco leaves in *N. tabacum* species, at levels of up to 0.39 μg/g NNN and 0.42 μg/g NNK in the top leaves of tobacco (flue-cured type) grown in the USA (Djordjevic *et al*., 1989a), up to 0.035 μg/g NNN and 0.0115 μg/g NNK in *N. tabacum* grown in India (Bhide *et al*., 1987a) and up to 46.1 μg/g NNN and 2.34 μg/g NNK in *N. rustica* species grown in India (Bhide *et al*., 1987a). However, TSNA are formed primarily during tobacco curing, fermentation and ageing, from their alkaloid precursors (namely, nicotine, nornicotine, anatabine and anabasine) and from nitrite/nitrate. The nitrate or nitrite content, the mode of curing and the various steps of processing are therefore the determining factors for the yields of TSNA in tobacco (Burton *et al*., 1989a,b; Fischer *et al*., 1989; Chamberlain & Chortyk, 1992; Djordjevic *et al*., 1993a; Burton *et al*., 1994; Peele *et al*., 2001; Li & Bush, 2004). NNN, *N*′-nitrosoanatabine (NAT) and *N*′-nitrosoanabasine (NAB) are formed primarily from the corresponding secondary amines in the early stages of tobacco processing; some NNN and the majority of NNK are formed from the tertiary amine nicotine at the later stage of tobacco curing and fermentation (Spiegelhalder & Fischer, 1991).

In addition to these three groups of compounds, smokeless tobacco contains *N*-nitrosodiethanolamine (NDELA), which is formed from diethanolamine, a residual contaminant in tobacco. In 1981, the levels of NDELA were up to 224 ng/g in chewing tobacco and up to 6840 ng/g in fine-cut moist snuff. Treatment of Burley leaves with the sucker growth inhibitor maleic hydrazide significantly increased the hydrazine content. Although a tolerance of 80 ppm for maleic hydrazide was established in at least three European countries and the USA, concentrations up to 269 ppm were reported for the flue-cured tobacco harvested in Georgia, USA, in 1990 (Sheets, 1990). As the use of maleic hydrazide–diethanolamine as a sucker growth-controlling agent was gradually reduced, the concentration of NDELA decreased to less than 100 ng/g in 1990 (Brunnemann & Hoffmann, 1991).

Table 3. Chemical agents identified in smokeless tobacco products

Agent	Type of tobacco where it has been detected	Concentration (ng/g)	*IARC Monographs* evaluation of carcinogenicity			*Monographs* volume, year
			In animals	In humans	IARC Group	
Benzo[*a*]pyrene	NT, MS, DS, MI[a]	> 0.1–90	S	I	1	Vol. 92 (in prep.)
α-Angelica lactone	NT	Present	–	–	–	–
β-Angelica lactone	NT	Present	–	–	–	–
Coumarin	NT	600	L	I	3	Vol. 77 (2000)
Ethyl carbamate (urethane)	CT	310–375	S	I	2A	Vol. 96 (in prep.)
Volatile aldehydes						
Formaldehyde	NT, MS, DS	1600–7400	S	S	1	Vol. 88 (2006)
Acetaldehyde	NT, MS, DS	1400–27 400	S	I	2B	Vol. 71 (1999)
Crotonaldehyde	MS, DS	200–2400	I	I	3	Vol. 63 (1995)
Volatile N-*nitrosamines*						
N-Nitrosodimethylamine (NDMA)	CT, MS	ND–270	S	I	2A	Suppl. 7 (1987)
N-Nitrosopyrrolidine (NPYR)	CT, MS	ND–860	S	I	2B	Suppl. 7 (1987)
N-Nitrosopiperidine (NPIP)	CT, MS	ND–110	S	I	2B	Suppl. 7 (1987)
N-Nitrosomorpholine (NMOR)	CT, MS	ND–690	S	I	2B	Suppl. 7 (1987)
N-Nitrosodiethanolamine (NDELA)	CT, MS	40–6800	S	I	2B	Vol. 77 (2000)
N-*Nitrosamino acids*						
N-Nitrososarcosine (NSAR)	MS	ND–6300	S	I	2B	Suppl. 7 (1987)
3-(*N*-methylnitrosamino) propionic acid (MNPA)	CT, MS	200–70 000	–	–	–	–
4-(*N*-methylnitrosamino) butyric acid (MNBA)	CT, MS	ND–17 500	–	–	–	–
Nitrosoazetidine-4-carboxylic acid (NAzCA)	CT, MS	4–140	–	–	–	–

Table 3 (contd)

Agent	Type of tobacco where it has been detected	Concentration (ng/g)	*IARC Monographs* evaluation of carcinogenicity			*Monographs* volume, year
			In animals	In humans	IARC Group	
Tobacco-specific N-*nitrosamines (TSNA)*						
N′-Nitrosonornicotine (NNN)	CT, MS	400–3 085 000	S	–	1	Vol. 89
4-(Methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK)	CT, MS	ND–7 870 000	S	–		Vol. 89
4-(Methylnitrosamino)-1-(3-pyridyl)-1-butanol (NNAL)	MS	0.07–22 900	–	–	–	Vol. 89
N′-Nitrosoanabasine (NAB)	ST, MS	Present–2 370 000	L	I	3	Vol. 89
Inorganic compounds						
Arsenic	NT	500–900	L	S	1	Suppl. 7 (1987)
Nickel compounds	ST, MS	180–2700	S	S	1	Vol. 49 (1990)
Radioelements		*(pCi/g)*				
Polonium-210	NT, MS, DS	0.16–1.22	S	I	1[b]	Vol. 78 (2001)
Uranium-235	MS	2.4	L	I		Vol. 78 (2001)
Uranium-238	MS	1.91	L	I		Vol. 78 (2001)
Beryllium	NA	NA	S	S	1	Vol. 58 (1993)

Updated from Bhide *et al.* (1984a); Nair, U.J. *et al.* (1987); Idris *et al*. (1991); Brunnemann & Hoffmann (1992)
CT, chewing tobacco; DS, dry snuff; I, inadequate; L, limited; MI, *mishri*; MS, moist snuff; NA, not available; ND, not detected; NT, natural tobacco; S, sufficient; ST, smoking tobacco
[a] Concentrations up to 119 000 ng/g in *mishri* (Nair, U.J. *et al.*, 1987)
[b] Evaluation of internally deposited α-particle-emitting radionuclides

Polycyclic aromatic hydrocarbons (PAHs) originate primarily from polluted air and perhaps from fire-curing of some tobaccos.

Formaldehyde, acetaldehyde and crotonaldehyde, which are themselves probable or known human carcinogens, probably contribute to the carcinogenic potential of smokeless tobacco. It is known that tobacco contains a large spectrum of alkyl aldehydes that contribute to its aroma and are formed from amino acids and sugars by heating during tobacco processing (Coleman & Perfetti, 1997).

The α- and β-angelica lactones have been reported in natural tobacco (Weeks *et al*., 1989). A minor group of polyphenols in tobacco are coumarins, of which scopoletin is the major representative. The presence of urethane in fermented Burley tobacco (up to 400 ng/g) is not unexpected since the fermentation of food and beverages leads to the formation of this compound. Both air- and flue-cured tobaccos contain hydrazines.

Radioactive polonium-210, which decays to radon, originates from soil that is fertilized with phosphates rich in radium-226 (Tso *et al*., 1966).

1.3.3 *Smokeless tobacco products*

(*a*) *Nicotine, pH and unprotonated nicotine*

All smokeless tobacco products contain nicotine as a major constituent, which is addictive (Henningfield *et al*., 1997; Hatsukami & Severson, 1999). The level of unprotonated nicotine affects the rate and degree of nicotine absorption (see Section 4.1).

Djordjevic *et al*. (1995) analysed 17 brands of moist snuff purchased in Westchester County, New York (USA) in 1994. In addition, samples of the five leading brands were purchased in six areas of the USA (Alameda, CA; Boston, MA; Denver, CO; Lansing, MI; Lexington, KY; Westchester, NY) and analysed separately to determine geographic variations. The nicotine content in 17 brands ranged from 0.47% dry wt (in Hawken Wintergreen) to 3.43% (in Skoal Long Cut Mint), which corresponds to 3.4 mg/g and 14.5 mg/g, respectively; the pH ranged from 5.39 (in Skoal Bandits Classic) to 7.99 (in Kodiak Wintergreen); unprotonated nicotine ranged from 0.23% of total nicotine (in Skoal Bandits Classic) to 48.3% (in Kodiak Wintergreen). The average values for the five best-selling brands of moist snuff in the USA in 1994 are summarized in Table 4.

Similar findings were reported by Henningfield *et al*. (1995) for products purchased at three locations (Baltimore, MD; Boston, MA; Lansing MI; Table 4). Both studies show that nicotine-dosing capability varies remarkably between products and that it is governed predominantly by nicotine content and pH level.

The Centers for Disease Control and Prevention (CDC) carried out an analysis of 18 smokeless tobacco products (eight brands of moist snuff and 10 of loose-leaf chewing tobacco) (Richter & Spierto, 2003). Among moist snuff brands, Timber Wolf Long Cut Straight contained the highest amount of nicotine (13.54 mg/g) followed by Copenhagen snuff and Skoal (12.71 mg/g and 12.94 mg/g, respectively). Consistent with the findings by Djordjevic *et al*. (1995), the highest pH was measured for Kodiak Wintergreen (pH, 8.28), which also had the highest quantity of unprotonated nicotine (64.5%; 5.81 mg/g).

Table 4. Nicotine content and pH of the five leading brands purchased at different locations in the USA

Constituents	Skoal Bandits Straight	Hawken Wintergreen	Skoal Original Fine Cut Wintergreen	Copenhagen Snuff	Kodiak Wintergreen
Djordjevic et al. *(1995)*[a]					
pH	5.37 ± 0.12	5.71 ± 0.1	7.46 ± 0.14	8.00 ± 0.31	8.19 ± 0.11
Nicotine (% dry wt)	2.29 ± 0.46	0.46 ± 0.02	2.81 ± 0.34	2.91 ± 0.18	2.5 ± 0.22
Nicotine (mg/g)	10.1 ± 0.8	3.2 ± 0.2	11.9 ± 1.3	12.0 ± 0.7	10.9 ± 0.8
Unprotonated nicotine (%)[b]	0.23 ± 0.05	0.5 ± 0.11	22.0 ± 5.73	49.0 ± 16.7	59.7 ± 6.01
Henningfield et al. *(1995)*	Skoal Bandits Wintergreen				
pH	6.9		7.6	8.6	
Nicotine (mg/g)	7.5		10.4	11.4	
Unprotonated nicotine (%)[b]	7.05		27.55	79.17	
Unprotonated nicotine (mg/g)	0.53		2.87	9.03	

[a] All values are mean ± standard deviation.
[b] The percentage of unprotonated nicotine was calculated according to the Henderson-Hasselbach equation and by using a pKa value of 8.02 for nicotine (Henningfield *et al*., 1995).

The lowest pH and amount of free nicotine were reported for Hawken Wintergreen (pH, 5.35; 0.20% free nicotine or 0.01 mg/g).

Another CDC study (CDC, 1999a) also reported that Copenhagen snuff and Kodiak Wintergreen had the highest pH (8.18 and 8.35, respectively) and the highest concentration of unprotonated nicotine (6.23 and 5.83 mg/g tobacco, respectively); Skoal Bandits Straight and Hawken Wintergreen had the lowest pH (5.52 and 5.24, respectively) as well as the lowest concentration of unprotonated nicotine (0.025 and 0.007 mg/g tobacco, respectively).

In 1996, Massachusetts enacted a tobacco product disclosure law which required manufacturers of cigarettes and smokeless tobacco products to disclose the ingredients and nicotine content by brand for average consumers. The Massachusetts Department of Public Health (MDPH) promulgated regulations in 1996 that required cigarette and smokeless tobacco manufacturers to file annual reports on nicotine yield by brand (MDPH, 2004). The requirements for reporting on smokeless tobacco were based on federal rules published by the CDC, adopted in 1996 and revised in 1999 (CDC, 1999b). Unlike Massachusetts, where disclosure of nicotine is a public record, data reported to the CDC remain private. Annual reports submitted by all smokeless tobacco manufacturers who sold products in Massachusetts from 1997–2003 contributed the most comprehensive data base on the levels of total nicotine (expressed as % and mg/g adjusted for moisture), tobacco pH and the levels of unprotonated nicotine (expressed as % of total nicotine and mg/g dry wt) in smokeless tobacco. Tables 5–7 list the pH, and total and unprotonated nicotine content of individual brands of, respectively, chewing tobacco, dry snuff and moist snuff sold in the Common-

Table 5. Chemical composition of chewing tobacco sold in Massachusetts (USA) in 2003

Manufacturer	Brand name	Sub-brand	Moisture content (%)	Nicotine (% dry wt)	Nicotine (mg/g)	pH	% unprotonated nicotine	Total unprotonated nicotine (mg/g)
Conwood Company	Bloodhound	Plug	21.10	1.72	13.54	5.37	0.22	0.03
	Bull of the Woods	Plug	20.73	2.12	16.78	5.16	0.14	0.02
	Cannon Ball	Plug	20.62	1.68	13.37	5.23	0.16	0.02
	Cotton Bowl Twist	Chewing Tobacco	14.57	4.65	39.74	5.21	0.15	0.06
	Cumberland Twist	Chewing Tobacco	22.35	1.56	12.12	5.70	0.48	0.06
	Hawken	Wintergreen Smokeless Tobacco	28.57	0.60	4.31	5.77	0.56	0.02
	HB Scott	Loose Leaf	23.95	0.60	4.53	6.09	1.16	0.05
	Levi Extra	Loose Leaf	23.85	0.67	5.13	6.13	1.27	0.07
	Levi Garrett	Plug	22.48	0.84	6.51	5.93	0.81	0.05
		Loose Leaf	24.13	0.71	5.40	6.02	0.99	0.05
	Lieberman's	Loose Leaf	19.58	1.12	8.99	6.76	5.21	0.47
	Mammoth Cave Twist	Chewing Tobacco	16.77	3.88	32.28	5.10	0.12	0.04
	Morgan's	Loose Leaf	23.97	0.45	3.41	6.00	0.95	0.03
	Peachey	Loose Leaf	24.02	0.62	4.68	5.73	0.51	0.02
	Taylor's Pride	Plug	22.15	0.79	6.18	5.94	0.82	0.05
		Loose Leaf	23.82	0.62	4.76	5.79	0.59	0.03
	Union Workman	Loose Leaf	23.53	0.52	3.97	5.89	0.74	0.03
National Tobacco	Beech-Nut	Regular	24.36	0.77	7.71	5.83	0.64	0.05
		Wintergreen	25.25	0.55	5.54	5.97	0.88	0.05
	Durango	Regular	24.61	0.59	5.93	5.96	0.86	0.05
	Havana Blossom	NR	22.43	1.64	16.37	5.95	0.84	0.14
	Trophy	NR	24.04	0.56	5.58	6.02	0.99	0.06
RBJ Sales Inc.	24-C	Course Cut	23.34	0.49	4.93	5.70	0.51	0.02
	757	Sweet Chew	22.71	0.56	5.59	5.94	0.82	0.05
	Black Wild Cherry	Loose Leaf	24.32	0.49	4.85	5.64	0.42	0.02
	Butternut	Loose Leaf	22.75	0.53	5.25	5.99	0.53	0.05

Table 5 (contd)

Manufacturer	Brand name	Sub-brand	Moisture content (%)	Nicotine (% dry wt)	Nicotine (mg/g)	pH	% unprotonated nicotine	Total unprotonated nicotine (mg/g)
RBJ Sales Inc. (contd)	Fred's Choice	Chewing Tobacco	27.79	0.50	5.05	5.78	0.59	0.03
	L-50	Mellow Chew	22.11	0.50	4.98	5.62	0.41	0.02
	Stoker's	Apple Loose Leaf	24.10	0.51	5.14	5.67	0.74	0.35
		Peach Loose Leaf	22.47	0.54	5.43	5.96	0.88	0.05
		Red Course Cut	25.31	0.49	4.89	5.72	0.55	0.03
		Tequila Sunrise Chew	26.96	0.49	4.87	5.76	0.57	0.03
	Tennessee	Chew	25.31	0.49	4.89	NR	0.55	0.03
	Tropical Chew	Chewing Tobacco	25.13	0.46	4.63	5.87	0.73	0.03
Swedish Match North America	Apple	Thick Plug	16.98	1.45	12.00	5.33	0.21	0.03
		Thin Plug	16.81	1.36	11.28	5.28	0.18	0.02
	Browns	Mule Plug	20.89	1.23	9.73	5.34	0.21	0.02
	Cup	Plug	23.83	2.68	20.43	5.07	0.11	0.02
	Day's Work	Plug	21.40	1.53	12.00	5.24	0.17	0.02
	Exalt Original Snuff	NR	23.87	3.32	25.30	6.80	6.13	1.54
	Exalt Peppermint Snuff	NR	20.46	2.22	17.65	6.91	9.52	1.77
	Granger	Select Loose Leaf	24.35	0.74	5.60	6.07	1.13	0.06
	J.D.'s Blend	Loose Leaf	27.16	0.61	4.48	6.41	2.47	0.11
	Original Natural Leaf	Plug	17.99	1.51	12.35	5.70	0.49	0.06
	Pay Car	Loose Leaf	25.41	1.13	8.45	5.90	0.76	0.06
	Red Horse	Loose Leaf	25.68	1.06	7.85	5.94	0.82	0.07
	Red Man	Plug	21.45	1.00	7.87	5.89	0.74	0.06
		Loose Leaf	25.83	1.17	8.70	6.01	1.01	0.09
		Select Loose Leaf	26.27	0.52	3.83	6.35	2.11	0.08
		Golden Blend Loose Leaf	25.84	1.05	7.75	6.22	2.12	0.17
		Golden Blend Totems	19.45	0.51	4.10	6.33	2.25	0.10
	Southern Pride	Loose Leaf	25.76	0.75	5.55	6.23	2.20	0.13
	Spark	Plug	20.07	1.18	9.45	5.95	0.85	0.08
	Tinsley	Plug	18.82	1.48	12.05	5.52	0.31	0.04
	Union Standard	Plug	16.88	0.98	8.18	5.80	0.67	0.06
		Loose Leaf	25.22	1.11	8.30	5.94	0.84	0.07
	WNT	Thick Plug	18.10	1.50	12.30	5.56	0.35	0.04
	Work Horse	Loose Leaf	25.24	1.10	8.23	5.86	0.71	0.06

Table 5 (contd)

Manufacturer	Brand name	Sub-brand	Moisture content (%)	Nicotine (% dry wt)	Nicotine (mg/g)	pH	% unprotonated nicotine	Total unprotonated nicotine (mg/g)
Swisher International	Best Buy	Chewing Tobacco	25.04	0.94	7.06	5.83	0.67	0.05
	Bowie	Chewing Tobacco	24.60	0.91	6.88	5.86	0.71	0.05
	Chattanooga	Chewing Tobacco	24.88	1.06	7.97	5.77	0.69	0.05
	Earl Caulfield's Country Flavors	Classic Bourbon	24.44	0.97	7.30	5.57	0.41	0.03
		Orchard Blend	24.60	0.91	6.88	5.86	0.71	0.05
	Jackson's Apple Jack	NR	25.29	0.91	6.81	5.74	0.54	0.04
	Lancaster Premium	NR	25.04	0.94	7.06	5.83	0.67	0.05
	Old Reliable Elephant Butts	NR	19.22	2.96	23.97	5.79	0.59	0.14
	Penn Cigar Clippings	NR	18.65	3.23	26.23	5.71	0.50	0.13
	Silver Cup	NR	21.88	1.69	13.17	5.62	0.41	0.05
	Standard Clippings	NR	20.07	2.08	16.65	5.81	0.62	0.10
	Starr Value	Chewing Tobacco	25.04	0.94	7.06	5.83	0.67	0.05
	Superior	Quality Chew	25.04	0.94	7.06	5.83	0.67	0.05
	Swisher Sweets	Chewing Tobacco	25.04	0.94	7.06	5.83	0.67	0.05
	Whalen Plain Scrap	NR	18.65	3.23	26.23	5.71	0.50	0.13
	XX Black	NR	18.65	3.23	26.23	5.71	0.50	0.13

NR, not reported
From MDPH (2004)

Table 6. Chemical composition of dry snuff sold in Massachusetts (USA) in 2003

Manufacturer	Brand name	Sub-brand	Moisture content (%)	Nicotine (% dry wt)	Nicotine (mg/g)	pH	% unprotonated nicotine	Total unprotonated nicotine (mg/g)
Conwood Company	Dental	Scotch Dry Snuff	6.00	1.82	17.12	6.27	1.75	0.30
		Sweet Dry Snuff	6.11	1.70	15.99	5.82	0.63	0.10
	Honest	Scotch Dry Snuff	5.93	1.94	18.27	6.25	1.67	0.31
	Peach	Sweet	6.10	1.31	12.29	6.05	1.06	0.13
	Tube Rose	Sweet Dry Snuff	6.61	1.59	14.82	5.89	0.74	0.11
	W.E. Garrett	Sweet	6.13	1.66	15.58	5.79	0.59	0.09
		Dry Scotch Snuff	5.38	2.25	21.33	5.92	0.79	0.17
Swisher International	Buttercup[a]	Sweet Scotch Snuff	7.30	1.57	14.54	5.96	0.89	0.13
	Dixie[a]	Sweet Snuff	8.20	1.36	12.45	5.41	0.24	0.03
	Ladies Choice	Extra Strong Scotch Snuff	7.84	2.51	23.17	6.22	1.58	0.36
	Lorillard	High Toast Scotch Snuff	7.00	1.88	17.53	6.39	2.31	0.41
		Sweet Scotch Snuff	7.17	1.61	14.88	6.09	1.20	0.18
	Navy	Sweet Scotch Snuff	7.59	1.83	16.91	6.28	1.80	0.31
		Plain Scotch Snuff	7.61	2.69	24.84	6.60	3.87	0.97
	Railroad Mills	Sweet Scotch Snuff	7.12	1.79	16.61	6.28	1.81	0.30
		Plain Scotch Snuff	7.61	2.69	24.84	6.60	3.87	0.97
	Ralph's	Scotch Snuff	8.56	2.34	21.42	6.16	1.41	0.30
	Society	Sweet Scotch Snuff	7.30	1.57	14.54	5.96	0.89	0.13
	Square	Snuff	8.56	2.34	21.42	6.16	1.41	0.30
	Starr	Scotch Snuff	7.70	1.14	10.48	7.51	29.56	3.08
	Strawberry	Sweet Snuff	7.17	1.61	14.88	6.09	1.20	0.18
	Superior	Scotch Snuff	7.84	2.51	23.17	6.22	1.58	0.36
	Three Thistles	Sweet Scotch Snuff	7.12	1.79	16.61	6.28	1.81	0.30
		Strong Scotch Snuff	8.56	2.34	21.42	6.16	1.41	0.30
	Tops	Sweet Snuff	7.35	1.55	14.31	5.99	1.08	0.15
		Mild Scotch Snuff	8.38	1.78	16.30	5.50	0.31	0.05
	Wild Cherry	Sweet Scotch Snuff	8.15	2.55	23.38	6.20	1.48	0.35

Table 6 (contd)

Manufacturer	Brand name	Sub-brand	Moisture content (%)	Nicotine (% dry wt)	Nicotine (mg/g)	pH	% unprotonated nicotine	Total unprotonated nicotine (mg/g)
US Tobacco	Bruton	White Label	7.55	1.20	11.14	7.61	28.48	3.12
	Carhart's Choice	NR	7.20	1.33	12.38	7.23	14.07	1.74
	Devoe	Sweet	7.20	1.33	12.38	7.23	14.07	1.74
		Eagle	7.55	1.20	11.14	7.61	28.48	3.12
	Red Seal	Scotch	7.44	1.47	13.70	7.29	19.76	2.51
	Revel[a]	Mild	5.89	0.49	4.70	7.96	46.46	2.18
		Regular	5.71	1.06	10.11	7.67	30.91	3.13
	Rooster	Scotch	7.23	1.33	12.51	6.82	5.92	0.74

From MDPH (2004)

[a] Reported as moist snuff in original article

Table 7. Chemical composition of moist snuff sold in Massachusetts (USA) in 2003

Manufacturer	Brand name	Sub-brand	Moisture content (%)	Nicotine (% dry wt)	Nicotine (mg/g)	pH	% unprotonated nicotine	Total unprotonated nicotine (mg/g)
Conwood Company	Cougar	Fine Cut Natural	55.12	2.35	10.53	8.14	56.86	5.99
		Long Cut Natural	55.17	2.30	10.32	8.13	56.30	5.81
		Long Cut Wintergreen	55.48	2.64	11.75	8.03	50.58	5.94
		Wintergreen	55.72	3.04	13.46	7.98	47.70	6.42
	Grizzly	Fine Cut Natural	54.73	3.39	15.35	7.83	39.23	6.02
		Long Cut Wintergreen	53.85	2.56	11.81	8.23	61.86	7.31
	Kodiak	Wintergreen	53.90	2.30	10.60	8.33	67.12	7.12
		Ice	54.30	2.49	11.36	8.09	54.02	6.14
		Straight	54.30	2.49	11.36	[8.19][a]	59.66	6.78
	Xtreme	Wintergreen	54.47	2.52	11.49	8.38	69.61	8.00
RBJ Sales Inc.	Stoker's	Smokeless Regular Moist	45.67	2.29	22.93	5.49	0.44	0.10
	Yukon	Fine Cut	49.52	2.06	20.55	7.06	10.27	2.13
		Long Cut	51.30	1.86	18.55	6.85	6.57	1.22
Swedish Match North America	Longhorn Fine Cut	Natural	51.18	3.35	16.35	8.08	53.39	8.57
	Longhorn Long Cut	Wintergreen	53.45	3.14	14.60	7.94	45.26	6.71
	Renegades	Moist Snuff	54.22	3.31	15.18	7.35	17.60	2.73
	Sequoia	Cinnamon Ice Snuff	51.62	3.13	15.15	7.44	20.84	3.15
		Mountain Cider Snuff	51.90	3.04	14.60	7.08	11.00	1.58
	Sequoia Artic Wintergreen	Wintergreen Snuff	54.63	2.82	12.80	8.09	54.02	6.92
	Timberwolf	Fine Cut Natural	52.41	3.66	17.43	7.84	39.90	6.98
		Long Cut Natural	52.03	3.46	16.60	7.91	43.94	7.36
		Long Cut Wintergreen	54.72	3.64	16.50	7.94	45.60	7.59
		Cool Wintergreen	53.91	3.46	15.95	7.89	42.49	6.79
		Fine Cut Wintergreen	54.83	3.65	16.47	7.96	46.42	7.88
		Long Cut Mint	54.09	3.50	16.08	7.77	36.15	5.83
		Long Cut Straight	54.58	3.70	16.83	7.87	41.40	7.02

Table 7 (contd)

Manufacturer	Brand name	Sub-brand	Moisture content (%)	Nicotine (% dry wt)	Nicotine (mg/g)	pH	% unprotonated nicotine	Total unprotonated nicotine (mg/g)
Swisher International	Best Buy	Wintergreen	54.80	2.16	9.75	7.35	19.88	1.94
		Natural	54.48	2.83	12.96	7.91	44.46	5.75
		Long Cut Straight	54.86	2.29	10.30	7.33	18.86	1.98
		Long Cut Cherry	54.20	2.17	9.94	7.64	30.48	2.93
	Bowie	Long Cut Wintergreen	54.80	2.16	9.75	7.35	19.88	1.94
		Natural	54.48	2.83	12.96	7.91	44.46	5.75
	Cheyenne	Long Cut Wintergreen	54.80	2.16	9.75	7.35	19.88	1.94
		Natural	54.48	2.83	12.96	7.91	44.46	5.75
	Cooper	Long Cut Wintergreen	54.93	2.21	9.93	7.15	13.04	1.33
	Finest Quality	Long Cut Wintergreen	54.93	2.21	9.93	7.15	13.04	1.33
		Natural	54.50	2.80	12.74	8.01	49.78	6.38
		Long Cut Mint	53.40	2.09	9.71	7.23	17.10	1.65
		Long Cut Cherry	54.10	2.27	10.42	7.52	24.74	2.56
	Gold River[b]	NR	23.92	1.50	11.41	5.71	0.58	0.06
	Hunter	Long Cut Wintergreen	55.40	2.43	10.84	7.59	27.51	2.98
		Natural	54.50	2.80	12.74	8.01	49.78	6.38
	Kayak	Fine Cut Natural	54.50	2.80	12.74	8.01	49.78	6.38
		Long Cut Wintergreen	55.31	2.40	10.71	7.62	28.87	3.08
	Lorillard	Maccoboy Snuff	41.70	2.13	12.42	6.80	5.76	0.73
	Mail Pouch	NR	21.58	1.76	13.80	5.73	0.56	0.08
		Country Blend	25.04	0.94	7.06	5.83	0.67	0.05
		Select	25.04	0.94	7.06	5.83	0.67	0.05
	Our Best	Long Cut Wintergreen	54.80	2.16	9.75	7.35	19.88	1.94
		Natural	54.48	2.83	12.96	7.91	44.46	5.75
		Fine Cut Wintergreen	54.04	2.58	11.86	7.49	24.60	2.88
	Our Pride	Natural	54.48	2.83	12.96	7.91	44.46	5.75
		Fine Cut Wintergreen	54.04	2.58	11.86	7.49	24.60	2.88

Table 7 (contd)

Manufacturer	Brand name	Sub-brand	Moisture content (%)	Nicotine (% dry wt)	Nicotine (mg/g)	pH	% unprotonated nicotine	Total unprotonated nicotine (mg/g)
Swisher International (contd)		Long Cut Straight	54.86	2.29	10.30	7.33	18.86	1.98
	Railroad Mills	Maccoboy Snuff	41.82	2.08	12.14	6.73	4.94	0.59
		Checkerberry Snuff	40.80	1.21	7.18	7.21	18.57	1.33
	Redwood	Fine Cut	54.48	2.83	12.96	7.91	44.46	5.75
		Long Cut	54.63	2.64	11.96	7.75	38.17	4.53
	Silver Creek	Long Cut Wintergreen	54.80	2.16	9.75	7.35	19.88	1.94
		Fine Cut Wintergreen	54.04	2.58	11.86	7.49	24.60	2.88
		Long Cut Straight	54.86	2.29	10.30	7.33	18.86	1.98
		Long Cut Cherry	54.20	2.17	9.94	7.64	30.48	2.93
	Silverado	Natural Pouches	48.90	2.47	12.58	6.95	8.23	1.03
		Wintergreen Pouches	50.87	2.42	11.87	7.08	10.91	1.29
	Starr Value	Long Cut Wintergreen	54.80	2.16	9.75	7.35	19.88	1.94
		Natural	54.48	2.83	12.96	7.91	44.46	5.75
	Superior Value	Long Cut Wintergreen	54.80	2.16	9.75	7.35	19.88	1.94
		Natural	54.48	2.83	12.96	7.91	44.46	5.75
		Long Cut Cherry	54.20	2.17	9.94	7.64	30.48	2.93
	Swisher Sweets	Long Cut Wintergreen	54.80	2.16	9.75	7.35	19.88	1.94
		Long Cut Straight	54.86	2.29	10.30	7.33	18.86	1.98
	Tub[b]	NR	20.07	2.08	16.65	5.81	0.62	0.10
US Tobacco	Copenhagen	Fine Cut	54.35	2.87	13.12	7.87	43.03	5.56
		Long Cut	54.60	2.95	13.42	7.54	26.12	3.51
		Long Cut Black	54.17	2.91	13.42	7.18	13.35	1.79
		Pouch	53.78	2.16	9.99	7.63	31.04	3.01
	Husky	Long Cut Wintergreen	54.75	3.14	13.96	7.33	16.80	2.35
		Natural	54.37	3.04	13.70	7.71	32.88	4.50
	Red Seal	Long Cut Natural	55.76	3.01	13.50	7.51	24.71	3.33
		Long Cut Wintergreen	54.43	2.95	13.62	7.42	20.61	2.82

Table 7 (contd)

Manufacturer	Brand name	Sub-brand	Moisture content (%)	Nicotine (% dry wt)	Nicotine (mg/g)	pH	% unprotonated nicotine	Total unprotonated nicotine (mg/g)
US Tobacco (contd)		Natural	55.01	2.93	13.35	7.52	25.61	3.40
		Fine Cut Wintergreen	54.59	2.90	13.37	7.44	21.35	2.86
		Long Cut Mint	55.10	3.05	13.89	7.51	24.85	3.42
		Long Cut Straight	54.81	3.02	13.84	7.35	17.83	2.48
	Rooster	Wintergreen	55.77	2.81	12.62	7.43	20.79	2.62
		Berry	55.24	2.75	12.47	7.44	21.34	2.67
		Mint	55.73	2.80	12.51	7.54	25.19	3.16
	Skoal	Long Cut Wintergreen	54.52	3.00	13.82	7.48	22.75	3.15
		Fine Cut Wintergreen	54.45	2.81	12.98	7.38	19.17	2.47
		Long Cut Mint	54.62	2.97	13.69	7.44	21.06	2.88
		Long Cut Straight	54.84	2.99	13.69	7.54	25.64	3.52
		Long Cut Cherry	54.03	2.90	13.51	7.44	21.00	2.85
		Pouch	55.53	2.62	11.68	7.60	27.96	3.25
		Bandits Mint	49.00	1.75	8.96	7.00	8.79	0.79
		Bandits Straight	48.60	1.94	9.99	5.50	0.31	0.03
		Bandits Wintergreen	48.56	1.77	9.11	6.80	5.72	0.52
		Fine Cut Key	54.88	3.00	13.68	7.64	32.42	4.40
		Fine Cut Straight	54.56	2.88	13.29	7.41	20.42	2.71
		Long Cut Berry	54.27	2.94	13.59	7.16	12.29	1.67
		Long Cut Classic	55.18	3.18	14.45	8.03	49.96	7.18
		Long Cut Spearmint	54.68	3.08	13.79	7.33	18.03	2.50
		Long Cut Vanilla	55.16	2.92	12.93	7.50	23.61	3.05
		Pouch Berry	54.55	2.96	13.29	7.40	19.81	2.63
	WB Cut	Long Cut Cherry	34.61	3.68	24.29	5.50	0.30	0.07

From MDPH (2004)

[a] Reported as 0.0819 in original document

[b] Reported as dry snuff in original document

wealth of Massachusetts in 2003; Table 8 presents the mean values for each type of tobacco product.

Table 8. Ranges of pH and nicotine concentration in smokeless tobacco products sold in Massachusetts (USA) in 2003

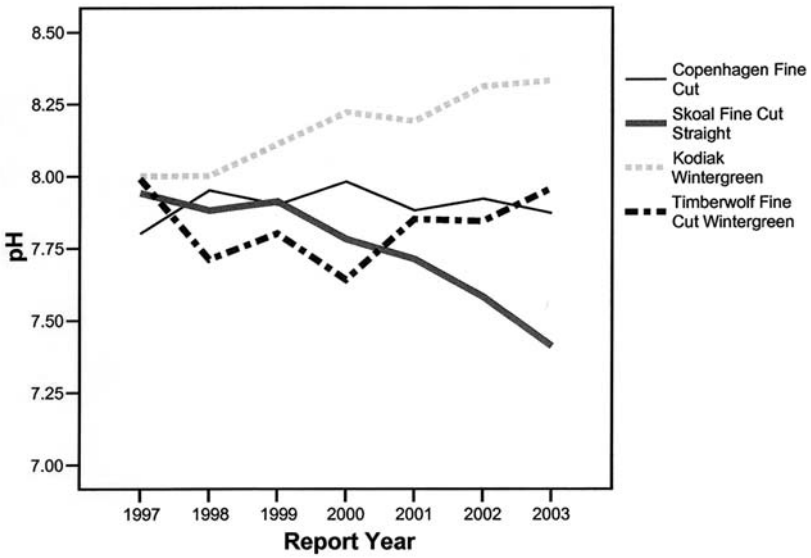
Constituent	Chewing tobacco (*n* = 74) Mean (range)	Dry snuff (*n* = 33) Mean (range)	Moist snuff (*n* = 106) Mean (range)
Moisture (%)	22.8 (14.57–28.57)	8.2 (5.38–23.9)[a]	52.6 (21.58–55.77)[b]
Nicotine (%, dry wt)	1.22 (0.45–4.65)	1.82 (1.14–2.69)	2.58 (0.49–3.70)
Nicotine (mg/g product)	9.9 (3.41–39.74)	16.8 (10.48–24.84)	12.6 (4.70–24.29)
pH	5.82 (5.07–6.91)	6.36 (5.50–7.61)	7.43 (5.41–8.38)
Unprotonated nicotine (mg/g product)	0.11 (0.02–1.77)	0.71 (0.05–3.12)	3.52 (0.03–8.57)

From MDPH (2004)
[a] Two Swisher International products contained over 20% moisture.
[b] Four moist snuff brands contained 5.71–8.2% moisture and were therefore excluded from the statistical analysis.

On average, moist snuff contained the highest percentage of moisture (mean, 52.6%; range, 21.58–55.77%) and nicotine (mean, 2.58% dry wt; range, 0.49–3.7%) (Table 8). Dry snuff had the lowest moisture content (mean, 8.2%; range, 5.38–23.9%) but middle range of nicotine (mean, 1.82%; range, 1.14–2.69%). Chewing tobacco had the lowest nicotine content (mean, 1.22%; range 0.45–4.65%). Moist snuff had, on average, the highest pH (7.43 versus 6.36 and 5.82 in dry snuff and chewing tobacco, respectively). Because of the high pH, the levels of unprotonated nicotine in moist snuff averaged 3.52 mg/g product (range, 0.03–8.57 mg/g); this is fivefold higher than that in dry snuff and 32-fold higher than that in chewing tobacco. The highest concentration of unprotonated nicotine was reported for Longhorn Fine Cut Natural, which is marketed by Swedish Match North America (Table 7).

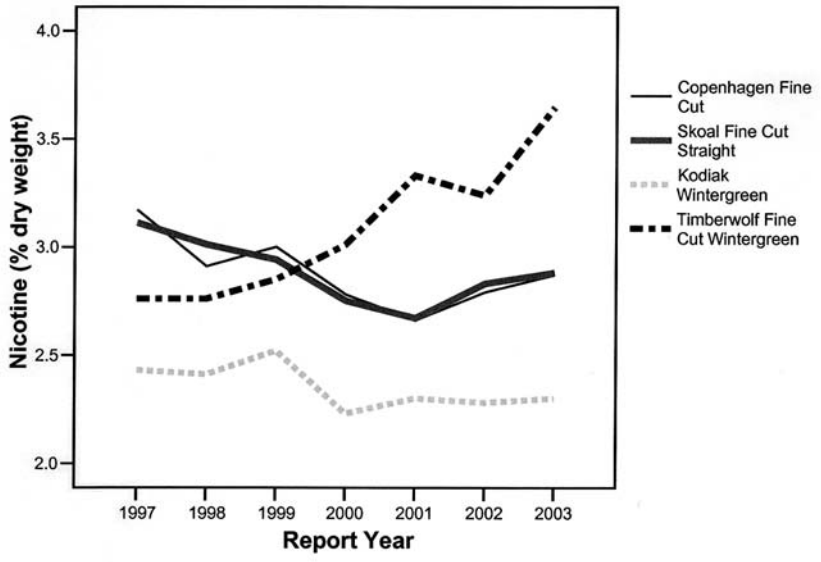
Regular and comprehensive reporting on the chemical composition of smokeless tobacco products to the MDPH enables analysis of trends in chemical composition over time and comparison of the levels of specific constituents between different brands or types of products. The trends for pH and nicotine content (both total and unprotonated) in the four leading brands of moist snuff in the USA (Copenhagen Fine Cut, Skoal Straight Fine Cut, Kodiak Wintergreen and Timberwolf Fine Cut Wintergreen) (Maxwell Tobacco Facts Book, 2002) from 1997 to 2003 are presented in Figures 1–3 (MDPH, 2004). Nicotine content (% dry wt) in three of the brands did not change notably between 1997 and 2003, while it increased steadily in Timber Wolf from 2.8 to 3.6% during the same period.

Figure 1. The pH of leading US moist snuff products (1997–2003)



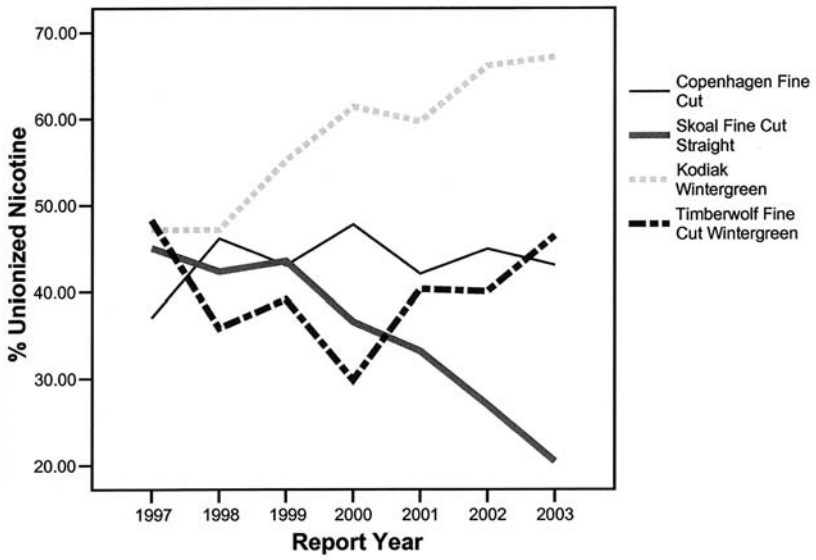
From MDPH (2004)

Figure 2. The nicotine content (% dry weight) in leading US moist snuff products (1997–2003)



From MDPH (2004)

Figure 3. The unprotonated nicotine content (% of the total nicotine) in leading US moist snuff brands (1997–2003)



From MDPH (2004)

The pH values for Copenhagen fine cut were constant between 1997 and 2003 (Figure 2), while the pH of Skoal Fine Cut Straight dropped significantly during the same period. Of the four brands, Kodiak has had the highest pH since 1999, and the pH of the Timber Wolf fluctuated between 7.6 and 8.0. The latter observation underlines the importance of monitoring the composition of all products rather than using one brand as a proxy for different types of smokeless tobacco product, or sub-brands of a brand family.

As shown in Figure 3, the levels of unprotonated nicotine were the highest in Kodiak Wintergreen, and increased from 35.19% total nicotine in 1997 to 60.27% total nicotine in 2003. This pattern parallels the trend in pH. On average, the levels of unprotonated nicotine in Copenhagen and Skoal brand families decreased steadily overtime. However, for the individual brands, this trend was only true for Skoal Fine Cut Straight, and not for Copenhagen Fine Cut, similar to the observation regarding pH. The percentage of unprotonated nicotine for Timberwolf also parallels the pH (Figures 2 and 3). As a result of the constant interplay of pH, nicotine content and moisture in tobacco products, the levels of unprotonated nicotine vary from product to product and from year to year.

In summary, the data from the MDPH show that pH and unprotonated nicotine content are brand- and company-specific. pH appears to be the primary determinant of nicotine absorption (Tomar & Henningfield, 1997). Among the 562 components reported on the list of additives for smokeless tobacco products (House of Representatives, 1994), several salts (e.g. ammonium, sodium and potassium salts) may alter the pH of smokeless

tobacco. Moreover, smokeless tobacco contains components that are intended to control delivery of nicotine to the body (Food and Drug Administration, 1996). However, exposure of users to tobacco toxins does not depend only on their concentration in a particular product but also how the product has been used. Smokeless tobacco users who dip or chew eight to 10 times a day may be exposed to the same amount of nicotine as individuals who smoke 30–40 cigarettes a day (DHHS, 1986). Lemmonds *et al.* (2005) examined the relationship between topographical measures of oral smokeless tobacco and biomarkers of exposure to tobacco and carcinogens. The major finding of the study was that frequency and duration measures of smokeless tobacco use are significantly correlated with total cotinine, a major metabolite of nicotine. Fifty-four male snuff users of 2.8 tins/week (6.1 dips/day) excreted on average 20.1 nmol cotinine/mg creatinine (or 3.3 nmol cotinine per dip) in urine compared with 27 nmol cotinine/mg creatinine excreted by smokers who consumed on average 27.9 cigarettes/day (or 1.07 nmol creatinine per cigarette) (Hecht *et al.*, 2005). Thus, snuff dippers are exposed to 3.08-fold higher amounts of nicotine than cigarette smokers. This high exposure to nicotine needs to be taken into consideration when recommending nicotine replacement therapy to those who contemplate quitting snuff use. Moreover, it has been shown that increasing the nicotine concentration in the presence of alcohol significantly increases the penetration of NNN across the oral mucosa (Du *et al.*, 2000).

The latest information on the chemical composition of 14 varieties of smokeless tobacco products used in India, including pH and nicotine content, was made available in a report to the WHO South-East Asian Regional Office (Gupta, 2004; Table 9). Some products had a pH of up to 10.1 and a nicotine content of up to 10.2 mg/g.

Ayo-Yusuf *et al.* (2004) reported on the pH and nicotine content of moist snuff products consumed in South Africa. The pH ranged from 7.1 to 10.1, the nicotine content from 0.8 to 1.6% wet wt [11.6–29.3 mg/g dry wt, as adjusted for moisture content] and from 10.1 to 99.1% in the unprotonated form.

A new product that is on the market, tobacco tablets, also referred to as Ariva® or Cigalett®, contain 1.3 mg nicotine per tablet and have a pH of 8.4. The 'buffering capacity' of Ariva® is sufficient to control the acidic pH of human saliva (Nguyen *et al.*, 2002).

(*b*) *Tobacco-specific* N-*nitrosamines (TSNA)*

Hoffmann *et al.* (1995) provided the most comprehensive insight into the levels of major tobacco carcinogens in the leading brands of moist snuff sold in the USA. The purpose of the study was threefold: (*a*) to determine the concentrations of major carcinogenic TSNA and *N*-nitrosamino acids in each of the five most popular brands of moist snuff (Table 10); (*b*) to analyse quantitative differences in selected snuff components (e.g. NNK and NNN) between two major categories of moist snuff: a category that comprised those brands known to have high levels of unprotonated nicotine (Copenhagen, Skoal Fine Cut and Kodiak) versus a category that comprised those brands known to have low levels (Hawken and Skoal Bandits); and (*c*) to compare the concentration of nicotine, NNN, NNK and total TSNA between these two categories. Concentrations (mean ± standard deviation

Table 9. Chemical composition of smokeless tobacco products used in India

Constituent	Minimum value	Brand	Maximum value	Brand
pH	5.21	Baba Zarda 120	10.1	Lime Mix – Miraj Tobacco
Ammonia (μg/g)	4.04	Baidhyanath Red Tooth Powder	5280	Gai Chhap Zarda
Total carbonate (μg/g)	140	Dabur Red Tooth Powder	2040	Baba Zarda 120
Nicotine (mg/g)	1.24	Raja Khaini[a]	10.16	Dentobac Creamy Snuff
NNN (μg/g)	ND	Click Eucalyptus[b]	7.36	Baba Zarda 120
NNK (μg/g)	ND	Click Eucalyptus[b]	4.88	IPCO Creamy Snuff
Benzo[*a*]pyrene (μg/g)	< 0.0001	Click Eucalyptus	0.94	IPCO Creamy Snuff
Cadmium (μg/g)	0.03	Click Eucalyptus	0.5	Baba Zarda 120
Arsenic (μg/g)	0.07	Click Eucalyptus	1.53	Shahin Mishri
Nitrate (μg/g)	< 0.1	Dabur Red Tooth Powder	13.85	Lime Mix – Miraj Tobacco

From Gupta (2004)
ND, not detected; NNK, 4-(*N*-methyl-*N*-nitrosamino)-1-(3-pyridyl)-1-butanone; NNN, *N*′-nitrosonornicotine
[a] *Tuibur* contained no detectable amounts of nicotine.
[b] Click Eucalyptus and six other compounds in this report contained nitrosamines other than tobacco-specific *N*-nitrosamines.

[SD]) of nicotine, NNN, NNK and total TSNA in the two categories were as follows: nicotine, 11.6 ± 1.06 mg/g versus 6.96 ± 3.62 mg/g ($p = 0.0017$); NNN, 7.74 ± 1.70 μg/g versus 4.17 ± 1.35 μg/g ($p < 0.0001$); NNK, 1.23 ± 0.68 μg/g versus 0.61 ± 0.41 μg/g ($p = 0.012$); and total TSNA (including NNN, NNK, NAB and NAT), 14.3 ± 3.82 μg/g versus 6.3 ± 2.56 μg/g ($p < 0.001$). In another study, moist snuff with a high pH and high unprotonated nicotine content, purchased in 2000, contained 15.4 μg/g dry wt NNN and 2.5 μg/g dry wt NNK (Brunnemann *et al*., 2002). The brand Conwood's Grizzly contained 70.8 μg/g NNN and 10.1 μg/g NNK (Brunnemann *et al*., 2004).

Table 11 shows an international comparison of the concentrations of two carcinogenic TSNA, NNN and NNK, as well as of tobacco pH (as determined in an aqueous tobacco suspension). The ranges for all three measures are wide and are product-specific and country-specific. The highest values of pH were measured in *naswar* from Uzbekistan (Brunnemann *et al.*, 1985), *toombak* from Sudan (Idris *et al.*, 1998a) and new moist snuff brands recently introduced in South Africa (Ayo-Yusuf *et al.*, 2004). The highest concentrations of NNN and NNK were measured in some moist snuff brands in the USA (135 and 17.8 μg/g tobacco, respectively). However, values as high as 3085 and 7870 μg/g dry wt tobacco, respectively, have been measured in home-made *toombak*.

Although there has been a decline in the concentrations of nitrosamines in some smokeless tobacco products in Sweden and the USA since the 1980s (Djordjevic *et al*., 1993b; Brunnemann *et al*., 2004; Österdahl *et al*., 2004), the trend may not apply to other

Table 10. Levels of tobacco-specific *N*-nitrosamines and *N*-nitrosamino acids in the five leading brands sold in the USA, 1994

Constituents (μg/g dry wt)	Skoal Bandits Straight	Hawken Wintergreen	Skoal Original Fine Cut Wintergreen	Copenhagen Snuff	Kodiak
Tobacco-specific N-*nitrosamines (TSNA)*					
NNN	5.09 ± 1.03	3.07 ± 0.3	8.18 ± 1.33	8.73 ± 1.44	6.3 ± 1.06
NNK	0.92 ± 0.26	0.23 ± 0.04	1.25 ± 0.13	1.89 ± 0.62	0.55 ± 0.15
Total TSNA	8.19 ± 1.72	4.08 ± 0.44	14.9 ± 2.5	17.24 ± 2.97	10.96 ± 2.44
Nitrite nitrogen	1.3 ± 0.4	1.4 ± 0.8	64.5 ± 41.9	672.0 ± 296.8	2.77 ± 1.13
N-*Nitrosamino acids (NNAC)*					
NSAR	0.02 ± 0.01	0.07 ± 0.01	0.04 ± 0.0	0.06 ± 0.01	0.04 ± 0.01
MNPA	10.96 ± 1.80	5.62 ± 0.71	2.39 ± 0.34	2.62 ± 0.62	2.23 ± 0.32
MNBA	0.1 ± 0.08	0.33 ± 0.06	0.23 ± 0.06	0.34 ± 0.1	0.19 ± 0.04
NPRO	1.9 ± 0.42	4.89 ± 0.52	4.6 ± 0.8	5.67 ± 1.29	2.39 ± 0.63
Iso-NNAC	0.07 ± 0.02	0.14 ± 0.03	0.13 ± 0.07	0.31 ± 0.12	0.14 ± 0.02
Total NNAC	13.45 ± 2.07	11.56 ± 1.28	8.15 ± 1.3	10.47 ± 2.7	5.7 ± 1.07

From Hoffmann *et al.* (1995)
MNBA, 4-(*N*-methylnitrosamino)butyric acids; MNPA, 3-(*N*-methylnitrosamino)propionic acids; NNK, 4-(*N*-methyl-*N*-nitrosamino)-1-(3-pyridyl)-1-butanone; NNN, *N*′-nitrosonornicotine; NPRO, *N*-nitrosoproline; NSAR, *N*-nitrososarcosine

products and countries. For example, the concentrations of NNN and NNK in the two leading snuff brands in the USA were reduced significantly by 70–90% from 1980 to 1992, based on dry weight (Djordjevic *et al*., 1993b). However, samples of a new brand of moist snuff introduced on the US market in the 1990s contained very high amounts of NNN and NNK (up to 57.1 and 16.4 μg/g dry wt, respectively) (Hoffmann *et al*., 1991). Moreover, the commercial brand Conwood's Grizzly, purchased in the USA in 2003, contained 70.8 μg/g dry wt NNN and 10.1 μg/g dry wt NNK (Brunnemann *et al*., 2004). In Sweden, the concentrations of NNN and NNK in moist snuff decreased, respectively, from 3.8 and 0.8 μg/g in 1983 to 0.49 μg/g and 0.19 μg/g wet wt in 2002 (87% and 76% decrease, respectively; Österdahl *et al*., 2004). Values for NNN and NNK of up to 3085 and 7870 μg/g, respectively, were reported in *toombak* (Idris *et al*., 1991, 1998a). The latest report by Stepanov *et al.* (2006) shows the wide range of TSNA concentrations in 19 brands of new and conventional smokeless tobacco products purchased in retail stores in the USA or online from Snus Worldwide, Sweden. Levels of NNN ranged from 0.019 μg/g wet wt in Ariva® hard snuff to 4.5 μg/g in Skoal Long Cut; those of NNK ranged from 0.032 μg/g in Revel to 1.6 μg/g in Copenhagen Long Cut; and those of NAT ranged from 0.12 μg/g in Ariva® to 4.1 μg in Skoal Long Cut Straight. Stepanov *et al.* (2005) also reported a wide range of TSNA concentrations in smokeless tobacco products from India: NNN concentrations ranged from not detected in *supari* and a sample of a

Table 11. International comparison of the pH and concentration ranges of *N*-nitrosonornicotine (NNN) and 4-(*N*-methyl-*N*-nitrosamino)-1-(3-pyridyl)-1-butanone (NNK) in smokeless tobacco products (μg/g tobacco)

Country	Type of product	pH	Concentration (μg/g tobacco)			References
			Reported as[a]	NNN	NNK	
Belgium	Chewing tobacco		Dry	7.38	0.13	Ohshima *et al*. (1985)
Canada	Moist snuff	7.5–8.23	Dry	50.4–79.1	3.2–5.8	Brunnemann *et al*. (1985)
	Chewing tobacco	5.28	Dry	2.09	0.24	
Denmark	Chewing tobacco		Wet	0.08–1.6	0.02–1.9	Österdahl *et al*. (2004)
Germany	Chewing tobacco	5.01–5.05	Dry	1.4–2.3	0.03–0.30	Brunnemann *et al*. (1985); Tricker *et al*. (1988)
	Dry snuff		Dry	2.4–18.8	0.58–6.4	
			Wet	0.68	0.10	Tricker & Preussmann (1991); Österdahl *et al*. (2004)
India	Moist snuff		Wet	0.56	0.24	Stepanov *et al*. (2005)
	Chewing tobacco	4.36–6.42	Dry	0.47–0.85	0.13–0.60	Brunnemann *et al*. (1985); Tricker *et al*. (1988)
			Wet	15.3–24.4	2.7–6.5	Nair *et al*. (1989)
	Dry snuff		Wet	137–1 356	110–245	Nair *et al*. (1989)
	Khaini		Dry	25.8–40.0	0.11–5.3	Stich *et al*. (1992)
			Wet	39.4–76.9	2.3–28.4	Stepanov *et al*. (2005)
	Khiwam		Dry	2.5–8.95	0.1–1.03	Tricker & Preussmann (1989)
	Gutka		Wet	0.09–1.1	0.04–0.43	Stepanov *et al*. (2005)
			NR	1.9–5.7	10.7–11.5	Gupta (2004)
	Mishri		Dry	0.3–7.0	0.29–1.1	Nair, U.J. *et al*. (1987); Tricker *et al*. (1988)
			Wet	4.21	0.87	Stepanov *et al*. (2005)
			NR	4.02–4.47		Gupta (2004)

Table 11 (contd)

Country	Type of product	pH	Concentration (μg/g tobacco)			References
			Reported as[a]	NNN	NNK	
India (contd)	*Supari*		Wet	ND	ND	Stepanov *et al*. (2005)
			NR	1.9–2.5	4.9–11.6	Gupta (2004)
	Creamy snuff/ toothpaste		Wet	2.5–48.7	1.3–12.5	Nair *et al*. (1989); Stepanov *et al*. (2005)
					4.4–4.9	Gupta (2004)
	Tooth powder		Wet	ND–0.04	ND	Stepanov *et al*. (2005)
	Tuibur		NR	19.7–20.1		Gupta (2004)
	Zarda		Dry	0.4–79	0.22–24.1	Tricker & Preussmann (1988); Tricker *et al*. (1988)
			Wet	4.8–19.9	1.1–3.1	Stepanov *et al*. (2005)
			NR	6.6–7.4		Gupta (2004)
	Other		Wet	1.74–19.2	0.08–2.6	Stepanov *et al*. (2005)
Norway	Moist snuff		Wet	21	3.3	Österdahl *et al*. (2004)
Uzbekistan	*Nass*	11.0–11.8	Dry	0.12–0.52	0.02–0.13	Brunnemann *et al*. (1985)
South Africa	Low-TSNA moist snuff	7.1–10.1	Dry	1.05–2.07	0.27–0.29	Ayo-Yusuf *et al*. (2004); Brunnemann *et al*. (2004)
Sudan	*Toombak*	8.0–11	Dry	141–3 085	188–7 870	Idris *et al*. (1991); Prokopczyk *et al*. (1995)
Sweden	Moist snuff	7.3–8.68	Dry	1.12–154[b]	0.19–2.95	Brunnemann *et al*. (1985); Ohshima *et al*. (1985); Tricker *et al*. (1988); Hoffmann *et al*. (1991); Tricker & Preussmann (1991); Brunnemann & Hoffmann (1992); Djordjevic *et al*. (1993b); Connolly (2001)
			Wet	0.49–4.4	0.19–1.3	Österdahl & Slorach (1988); Österdahl *et al*. (2004)

Table 11 (contd)

Country	Type of product	pH	Concentration (μg/g tobacco)			References
			Reported as[a]	NNN	NNK	
Sweden (contd)	Low-TSNA moist snuff		Wet	0.15–2.3	0.03–0.36	Österdahl *et al*. (2004); Stepanov *et al*. (2006)
	Chewing tobacco		Wet	0.7–1.7	0.01–0.46	Österdahl *et al*. (2004)
Thailand	Chewing tobacco		Dry	0.5	0.1	Tricker *et al*. (1988)
United Kingdom	Moist snuff		Dry	1.1–52.0	0.4–13.0	Hoffmann *et al*. (1988); Brunnemann & Hoffmann (1992)
	Chewing tobacco		Dry	0.9	0.3	Tricker *et al*. (1988)
	Dry snuff		Dry	2.4–16.0	0.58–4.3	Tricker & Preussmann (1991); Brunnemann & Hoffmann (1992)
			Wet	1.8	0.26	Österdahl *et al*. (2004)
USA	Moist snuff	5.2–8.88	Dry Wet	ND–147 0.71–63	ND–17.8 0.06–13	Brunneman *et al*. (1985); Ohshima *et al*. (1985); Hoffmann *et al*. (1986); Adams *et al*. (1987); Brunnemann *et al*. (1987a,b); Chamberlain *et al*. (1988); Hoffmann *et al*. (1988); Tricker *et al*. (1988); Andersen *et al*. (1989); Djordejvic *et al*. (1989a); Hoffmann *et al*. (1991); Brunnemann & Hoffmann (1992); Prokopczyk *et al*. (1992a); Djordjevic *et al*. (1993b); Hoffmann *et al*. (1995); Prokopczyk *et al*. (1995); Connolly (2001); Brunnemann *et al*. (2002, 2004); Österdahl *et al*. (2004); Stepanov *et al*. (2006)
	Low-TSNA moist snuff		Wet	0.62–0.64	0.032–0.033	Stepanov *et al*. (2006)

Table 11 (contd)

Country	Type of product	pH	Concentration (µg/g tobacco)			References
			Reported as[a]	NNN	NNK	
USA (contd)	Chewing tobacco	0.6–6.37	Dry	0.67–6.5	ND–1.05	Brunnemann *et al*. (1985); Chamberlain *et al*. (1988); Andersen *et al*. (1989); Djordjevic *et al*. (1989a); Brunnemann & Hoffmann (1992)
			Wet	0.25–1.1	0.08–0.11	Österdahl *et al*. (2004)
	Dry snuff	5.8–6.3	Dry	9.4–116.1	0.88–84.4	Adams *et al*. (1987); Brunnemann *et al*. (1987a); Andersen *et al*. (1989); Djordjevic *et al*. (1989a)
	Hard snuff/ lozenges		NR	0.02–0.06	0.037–0.043	Stepanov *et al*. (2006)

ND, not detected; NR, not reported; TSNA, tobacco-specific *N*-nitrosamines

[a] Reported as ng/g of dry wt (Dry) or wet wt (Wet) of tobacco

[b] The Working Group was doubtful about the validity of this value; the next highest value was 20 900 ng/g (Ohshima *et al*., 1985).

tooth powder to 76.9 μg/g wet wt in *khaini*; those of NNK ranged from not detected to 28.4 μg/g in *khaini*.

In recent years, the Swedish Match Company has developed a new method for manufacturing oral snuff that uses select blends of tobacco as well as a new processing method. Instead of the dark fire-cured tobacco commonly used in US snuff, Swedish Match uses tobacco with a low nitrate content, which itself reduces TSNA levels. In addition, the tobacco is processed in a heated closed system that resembles pasteurization of milk, which eliminates bacteria that may be indirectly responsible for the formation of the nitrosamines (Parsons *et al*., 1986; Gothia, 2004). The company also encourages retailers to refrigerate packages to prevent the formation of TSNA during storage (see below).

In 2001, the MDPH initiated a study aimed at comparing traditional snuff brands with PREPs (Stratton *et al*., 2001). The study found that the levels of NNN, NNK, NAT and NAB in moist snuff produced by the new manufacturing process (Swedish Match brand Ettan) were up to 45 times lower than those in leading products manufactured under standard processes in the USA (Table 12).

Table 12. Levels of tobacco-specific *N*-nitrosamines (TSNA) in the five leading brands in the USA versus PREP

Company	Brand[a]	NNN (μg/g)	NNK (μg/g)	Total TSNA[b] (μg/g)
Conwood Company	Kodiak	7.4	0.97	16.6
Swedish Match North America	Timber Wolf	3.0	0.95	7.5
Swisher International	Silver Creek	41.4	17.8	127.9
US Tobacco	Copenhagen	14.3	3.4	41.1
	Skoal	20.8	14.3	64.0
Swedish Match	Ettan (PREP)	1.12	0.53	2.8

From Connolly (2001)
NNK, 4-(*N*-methyl-*N*-nitrosamino)-1-(3-pyridyl)-1-butanone; NNN, N′-nitrosonornicotine; PREP, potential reduced exposure product
[a] Snuff manufactured in the USA was purchased in the Commonwealth of Massachusetts; Ettan was purchased in Sweden.
[b] Total TSNA includes NNN, NNK, *N*-nitrosoanatabine and *N*-nitrosoanabasine.

In Sweden, all moist snuff brands on the market in 2002 contained low amounts of TNSA: NNN, 0.15–0.61 μg/g wet wt; and NNK, 0.03–0.36 μg/g wet wt. NNN concentrations in moist snuff decreased consistently from 1983 to 2002 from 3.8 to 0.49 μg/g wet wt and those of NNK from 0.80 to 0.19 μg/g wet wt (Österdahl *et al*., 2004).

Levels of TSNA in new oral snuff brands do not always parallel nicotine content (see Table 7 for the nicotine content and Table 12). For example, Taxi, a very high nicotine-delivery product manufactured by Swedish Match for the South African market, contains low

levels of TNSA: NNN, 2.07 μg/g dry wt; and NNK, 0.29 μg/g dry wt (Brunnemann *et al*., 2004).

(*c*) N-*Nitrosamino acids*

The amino acids present in tobacco, and probably also the proteins with secondary amino groups, are amenable to *N*-nitrosation. Since 1985, numerous studies have reported the presence of nitrosamino acids in smokeless tobacco products. Levels of *N*-nitrosoamino acids in smokeless tobacco products worldwide are presented in Table 13. To date, 11 *N*-nitrosamino acids have been identified in smokeless tobacco: NSAR, *N*-nitrosoazetidine-4-carboxylic acid (NAzCA), MNPA, MNBA, *N*-nitrosoproline (NPRO), *N*-nitrosohydroxyproline (NHPRO), *N*-nitrosopipecolic acid (NPIC), *N*-nitrosothiazolidine- 4-carboxylic acid (NTCA), *N*-nitroso-2-methylthiazolidine-4-carboxylic acid (MNTCA), 4-(methylnitrosamino)-4-(3-pyridyl)butyric acid (*iso*-NNAC) and 2-(methylnitrosamino)-3-phenylpropionic acid (MNPhPA) (Ohshima *et al*., 1985; Tricker & Preussmann, 1988; Djordjevic *et al*., 1989b; Tricker & Preussmann, 1989, 1991; Hoffmann *et al*., 1995). Of these, the following have been established as carcinogens in experimental animals: NSAR, MNPA, MNBA and NAzCA. The concentration of the nitrosamino acids depends on the nitrate or nitrite content of the tobacco; in addition, they are formed during prolonged storage, particularly under adverse conditions of temperature and relative humidity (Djordjevic *et al*., 1993a).

The highest concentrations of *N*-nitrosamino acids in moist snuff purchased in the USA were found in Skoal Bandits Straight and Hawken Wintergren (13.45 and 11.56 μg/g, respectively) and the lowest in Kodiak (5.7 μg/g), which is opposite to the trend observed for TNSA (Hoffmann *et al*., 1995).

(*d*) *Volatile* N-*nitrosamines*

Volatile *N*-nitrosamines are formed from volatile amines and nitrosating agents. The levels of volatile *N*-nitrosamines in smokeless tobacco products worldwide are presented in Table 14. The highest amounts were found in moist snuff (NDMA up to 265 ng/g dry wt and NPYR up to 860 ng/g dry wt; see also Table 3). The presence of NMOR (see IARC, 1987) indicates contamination with morpholine either from additives or from diffusion of containers coated with morpholine-containing wax (Brunnemann *et al*., 1985; Brunnemann & Hoffmann, 1991).

(*e*) *Other carcinogenic compounds*

In smokeless tobacco products from the USA, the levels of benzo[*a*]pyrene ranged from < 0.1 to 63 ng/g in moist snuff (Hoffmann *et al*., 1986) and up to 90.5 ng/g in dry snuff (Brunemann & Hoffmann, 1992; Table 3). Bhide *et al*. (1984a) reported on the whole range of PAHs in Indian smokeless tobacco products such as *mishri* and snuff: benzo[*a*]pyrene, 7.6–66 ng/g; benzofluoranthenes (*b* + *j* + *k*), 35–231 ng/g; indeno[1,2,3-*cd*]pyrene, 4.3–24 ng/g; benz[*a*]anthracene, 19–79 ng/g; chrysene and triphenylene, 37–

Table 13. Comparison of the major carcinogenic *N*-nitrosamino acids in smokeless tobacco (μg/g dry wt) across countries

Country	Type of product	NSAR	MNPA	MNBA	Reference
Belgium	Chewing tobacco	NE	1.63	0.09	Ohshima *et al.* (1985)
Germany	Nasal snuff	ND–0.085	0.49–4.26	0.08–0.41	Tricker & Preussmann (1991); Brunnemann & Hoffmann (1992)
India	*Zarda* *Khiwam*	ND–0.35 0.01–0.04	0.02–18.0 0.26–1.38	ND–2.04 0.01–0.19	Tricker & Preussmann (1988, 1989, 1991)
Sweden	Moist snuff	0.01–0.68	0.38–4.40	0.03–0.26	Ohshima *et al.* (1985); Hoffmann *et al.* (1991); Tricker & Preussmann (1991); Brunnemann & Hoffmann (1992)
United Kingdom	Moist snuff Nasal snuff	0.03–1.1 ND–0.04	1.36–19.0 1.0–2.8	0.06–8.0 0.1–0.28	Tricker & Preussmann (1991); Brunnemann & Hoffmann (1992)
USA	Moist snuff Chewing tobacco Dry snuff	ND–6.3 NE NE	0.15–70.0 0.6 1.2–4.5	ND–17.5 0.03 0.14–0.46	Ohshima *et al.* (1985); Djordjevic *et al.* (1989b); Hoffmann *et al.* (1991); Brunnemann & Hoffmann (1992); Djordjevic *et al.* (1993a,b, 1994); Hoffmann *et al.* (1995)

MNBA, 4-(*N*-methylnitrosamino)butyric acids; MNPA, 3-(*N*-methylnitrosamino)propionic acids; ND, not detected; NE, not evaluated; NSAR, *N*-nitrososarcosine

Table 14. Comparison of the major carcinogenic volatile *N*-nitrosamines in smokeless tobacco (ng/g dry wt) across countries

Country	Type of product	NDMA	NPYR	NMOR	Reference
Canada	Moist snuff Chewing tobacco	23–72.8 ND	321–337 ND	21.9–32.8 ND	Brunnemann *et al.* (1985)
Denmark	Chewing tobacco	5.5	16	ND	
Germany	Nasal snuff Chewing tobacco	2.0–82 ND	1.5–75 ND	ND ND	Brunnemann *et al.* (1985); Tricker & Preussmann (1991); Brunnemann & Hoffmann (1992)
India	*Zarda* *Khiwam* Chewing tobacco *Mishri*	2.0–31 1.5–28 ND–0.56 12–80	6.0–69 11–250 1.55–4.48 21–99	ND NE ND NE	Brunnemann *et al.* (1985); Nair, U.J. *et al.* (1987); Tricker & Preussmann (1988, 1989, 1991)
Norway	Moist snuff	130	8.9	32.0	Brunnemann & Hoffmann (1992)
Sweden	Moist snuff Chewing tobacco	ND–63 0.2	ND–155 0.8	ND–44 0.4	Brunnemann *et al.* (1985); Hoffmann *et al.* (1991); Tricker & Preussmann (1991); Brunnemann & Hoffmann (1992); Djordjevic *et al.* (1993a)
United Kingdom	Moist snuff Nasal snuff	6.0–212 4.5–82	64–860 1.5–130	ND–1.5 ND	Hoffmann & Brunnemann (1988); Tricker & Preussmann (1991); Brunnemann & Hoffmann (1992)
USA	Moist snuff Chewing tobacco Dry snuff	ND–265 4.12–64 ND–19	ND–575 ND–0.8 72–148	ND–690 ND–0.6 ND–39	Brunnemann *et al.* (1985); Hoffmann *et al.* (1986, 1987); Hoffmann & Brunnemann (1988); Brunnemann & Hoffmann (1991); Hoffmann *et al.* (1991); Brunnemann & Hoffmann (1992)
Former USSR (Central Asian Republics)	*Nass*	ND	1.74–8.82	ND	Brunnemann *et al.* (1985)

ND, not detected; NDMA, *N*-nitrosodimethylamine; NE, not evaluated; NMOR, *N*-nitrosomorpholine; NPYR, *N*-nitrosopyrrolidine

192 ng/g; benzo[*e*]pyrene, 10–110 ng/g; pyrene, 60–169 ng/g; fluoranthene, 55–218 ng/g; and benzo[*ghi*]perylene, 5.6–17 ng/g.

Hoffmann *et al*. (1987) reported the levels of select volatile aldehydes in smokeless tobacco products: formaldehyde, 3.9–6.8 μg/g in moist snuff and 1.6–7.4 μg/g in dry snuff; acetaldehyde, 2.4–7.4 μg/g in moist snuff and 1.4–3.9 μg/g in dry snuff; and crotonaldehyde, 1.0–2.4 μg/g in moist snuff and 0.2–0.6 μg/g in dry snuff.

Uranium was reported in five samples of Indian snuff at a concentration of about 3 pCi/g tobacco (Sharma *et al*., 1985). Hoffmann *et al*. (1987) reported 0.16–1.22 pCi/g polonium-210 in commercial moist snuff and 0.23–0.39 pCi/g in commercial dry snuff in the USA.

(*f*) *Effect of storage conditions on the levels of* N-*nitrosamines*

The effect of storage conditions on the formation of TSNA in smokeless tobacco was studied in moist and dry snuff and in chewing tobacco.

In a study of the effects of ageing and storage on the levels of TSNA, *N*-nitrosamino acids and volatile *N*-nitrosamines in commercial moist snuff from the USA, it was found that during storage at 4 °C none of these compounds increased significantly (Djordjevic *et al*., 1993a). However, at higher temperatures, the levels of *N*-nitrosamines and nitrite in the moist snuff increased significantly over time. After 8 weeks of storage at 37 °C, the levels of NNN and NNK had risen threefold (from 6.24 to 18.7 μg/g), those of the *N*-nitrosamino acids MNPA and MNBA had risen 5.2-fold (from 3.13 to 16.3 ppm) and those of volatile *N*-nitrosamines had risen 10-fold (from 0.02 to 0.2 μg/g); moist snuff stored for 8 weeks at 37 °C contained 0.0386 μg/g NDMA, 0.0714 μg/g NPYR and 0.0176 μg/g NMOR. The concentration of 4-(methylnitrosoamino)-1-(3-pyridyl)-1-butanol (NNAL), a metabolite of NNK, doubled during storage at 37 °C from 0.29 to 0.65 μg/g. In a study conducted by the MDPH (Connolly, 2001), the effect of ageing of snuff was examined over 2, 4 and 6 months. Levels of total TSNA, including NNN, NNK, NAT and NAB, in the leading US brand Copenhagen increased 137%. No significant changes were observed in TSNA levels in Ettan, the Swedish Match moist snuff brand, when subjected to storage under adverse conditions. An earlier study revealed that levels of both NNN and NNK in moist snuff increased 21 and 12-fold, respectively, within the first 24 weeks of storage; in contrast, levels of nicotine decreased 1.3-fold during the same period. Concentrations of NNN and NNK in chewing tobacco and dry snuff during 24 weeks of storage increased 1.5- and 1.8-fold, respectively (Andersen *et al*., 1989).

1.3.4 *Kentucky (KY) reference smokeless tobacco products*

For research purposes, a series of reference smokeless tobacco products was developed and manufactured by the Tobacco and Health Research Institute (1987) at the University of Kentucky, Lexington, KY (USA) in the late 1980s. Each reference product, i.e. moist snuff, dry snuff and loose-leaf chewing tobacco, was custom made to mimic the chemical composition of commercial products in the respective category. However, speci-

fic flavourings and additives, including those used by manufacturers to influence levels of unprotonated nicotine, were not included in KY reference products. KY reference smokeless tobacco products contain the following ingredients:

Loose-leaf chewing tobacco (**1S1)**: Wisconsin air-cured tobacco, 17.4%; Pennsylvania air-cured tobacco, 15.47%; crushed Burley tobacco stems, 5.8%; glycerin, 3.75%; sucrose, 23.01%; dextrose, 1.7%; maltose, 1.3%; other corn syrup solids, 6.21%; salt, 1.6%; sodium propionate, 0.28%; water, 23.48%.

Dry snuff (**1S2)**: dark-fired tobacco, 22.75%; fire-cured Virginia tobacco, 19.66%; air-cured stems, 33.03%; fire-cured stems, 15.2%; salt, 0.36%; water, 9.0%.

Moist snuff (1S3): dark-fired tobacco, 25.73%; air-cured tobacco, 7.83%; Burley stems, 3.73%; sodium carbonate, 0.51%; sodium chloride, 7.4%; water, 54.80%.

As the blending recipe for KY reference products shows, loose-leaf chewing tobacco and moist snuff contain about 30% of tobacco by weight whereas dry snuff contains 75% of tobacco. The chemical composition of these reference products is shown in Table 15. In addition to data on nicotine, total nitrogen, nitrate nitrogen, total sugars, reducing sugars, moisture, pH, ash, potassium, sodium and calcium (Tobacco and Health Research Institute, 1987), the levels of selected TSNA and *N*-nitrosamino acids are also presented (Djordjevic *et al*., 1989b; Brunnemann *et al*., 2002).

1.3.5 *Pesticide residues*

Maximum allowable limits for pesticides on tobacco (e.g. maleic hydrazide, chlordane, dichlorodiphenyltrichloroethane, dichlorodiphenyldichloroethylene, dieldrin, endrine, heptachlor) in Germany, Italy, Spain and the USA are summarized by Sheets (1990).

1.4 Production, consumption and prevalence of use of smokeless tobacco products

This section presents data on sales, consumption and prevalence of use of smokeless tobacco products. Where possible, data are presented separately for each product type. In some countries and surveys, consumption was not measured or reported separately and thus overall consumption or prevalence of use of smokeless tobacco is reported. In most countries, surveys do not specify which type of snuff is used, but the overwhelming majority of snuff is of the moist variety and is taken orally.

Data on prevalence of smokeless tobacco use among youths in South America (Section 1.4.2(*c*)), South Asia (Section 1.4.3) and Africa (Section 1.4.4) rely primarily on the Global Youth Tobacco Survey (GYTS). The GYTS project was developed by WHO and the CDC in the USA. It is an international surveillance project designed to enhance the capacity of countries to monitor tobacco use among youths, and to guide the implementation and evaluation of tobacco prevention and control programmes. The GYTS has been completed in 120 countries. It uses a two-stage cluster sample survey design that produces representative samples of students in grades associated with the ages of 13–15 years.

Table 15. Chemical composition of Kentucky reference smokeless tobacco products

Constituent (%)	Chewing tobacco (loose-leaf) (1S1)	Dry snuff (1S2)	Moist snuff (1S3)
Nicotine	0.76, 0.95[a]	1.49, 1.6[a]	1.25, 2.51[a], 2.52[b]
Total nitrogen	1.20	2.59	1.33
Nitrate nitrogen	0.20	0.74	0.28
Total sugars	26.5	0.67	0.2
Reducing sugars	4.18	0.52	0.04
Moisture	23.2, 18.8[a]	8.79, 10.0[a]	55.0, 58.7[a], 52.0[b]
pH	6.42, 6.3[a]	6.37, 6.5[a]	8.01, 7.7[a], 6.93[b]
Ash	11.0	22.1	17.3
Potassium	2.09	5.91	1.78
Sodium	0.78	0.28	2.8
Calcium	1.37	2.93	1.44
Tobacco-specific N-*nitrosamines (TSNA)*			
NNN (μg/g)[c]	2.4[a]	81.3[a]	10.9[a], 12.6[b], 8.8[d]
NNK (μg/g)[c]	0.17[a]	20.3[a]	0.82[a], 2.2[b], 2.1[d]
Total TSNA (μg/g)[c]	3.6[a]	137.5[a]	19.6[a], 20.8[b]15.8[d]
N-*Nitrosamino acids (NNAC)*			
MNPA (μg/g)[c]	1.0[a]	13.1[a]	4.6[a]
MNBA (μg/g)[c]	0.05[a]	1.54[a]	0.4[a]
NPRO (μg/g)[c]	0.7[a]	15.4[a]	6.6[a]
Iso-NNAC (μg/g)[c]	0.03[a]	0.95[a]	0.13[a]
Total NNAC (μg/g)[c]	1.8[a]	31.9[a]	11.9[a]

From Tobacco and Health Research Institute (1987), unless otherwise stated
MNBA, 4-(*N*-methylnitrosamino)butyric acids; MNPA, 3-(*N*-methylnitrosamino)-propionic acids; NNK, 4-(*N*-methyl-*N*-nitrosamino)-1-(3-pyridyl)-1-butanone; NNN, *N*′-nitrosonornicotine; NPRO, *N*-nitrosoproline
[a] From Djordjevic *et al*. (1989b)
[b] From Brunneman & Hoffmann (2002)
[c] Per dry weight
[d] From Connolly (2001)

The prevalence measures used in this study included: current cigarette smoking — defined as ‘The percentage of students who smoked cigarettes on 1 or more days during the past 30 days’ and current other tobacco use — defined as ‘The percentage of students who had used any form of tobacco products other than cigarettes during the past 30 days’. Thus, other tobacco products include smokeless tobacco products as well as other smoking products.

1.4.1 *Europe*

Trends on sales of chewing tobacco in six European countries and of snuff in 13 countries are given in Tables 16 and 17, respectively. For three of these countries (Austria, Finland and France), the reports combined sales of chewing tobacco and snuff.

For many countries, no data were available on the consumption of smokeless tobacco products. For most countries included in Tables 16 and 17, no additional information was available on the use of smokeless tobacco other than annual sales, and those countries are not listed separately in this section, which includes a discussion of available data for those countries for which data on the prevalence of smokeless tobacco use were available. Estimates of annual per-capita consumption and prevalence of use of smokeless tobacco in these countries are given in Table 18 and 19, respectively.

(*a*) *Denmark*

Sales of chewing tobacco in Denmark have been declining since the early 1900s (Table 16). In 1995, snuff and chewing tobacco comprised 0.5% of all tobacco sales by weight in Denmark (Forey *et al*., 2002). There are few recent reports on prevalence of use. Among employed men who participated in the Copenhagen Male Study in 1985–86 (mean age, 63 years; range, 53–74 years), an estimated 3.5% reported chewing tobacco or using snuff without smoking (Suadicani *et al*., 1997).

(*b*) *Finland*

Per-capita consumption of moist snuff was relatively constant in Finland from 1970 to 1987 at 6–8 g per person aged 15 years and older, after which it increased to 22–29 g per person for the period 1988–94 (Wicklin, 2005) (Table 18). A 1987 survey of 14–18-year-olds found that use of snuff varied widely among regions in Finland: the proportion of boys who had tried snuff ranged from 17% in eastern and central Finland to 41% in Lapland, and regular use of snuff was reported by 2% of boys in eastern and central Finland, 4% in western Finland, 7% in Uusimaa and 10% in Lapland (Karvonen *et al*., 1993). Although the proportion of girls who had tried snuff ranged from 5 to 15% among the regions, regular use was reported by no more than 1% in any region.

A survey of 793 first- and second-year students in four senior high schools in the Turku region (mean age, 16.6 years) was conducted in December 1994, before the ban on snuff sales was enacted in Finland on 1 March 1995 (Merne *et al*., 1998). A cross-sectional survey was conducted in the same schools 1 year later, in December 1995. The study showed a prevalence of snuff use of 9% in 1994 (19% of the boys and 1% of the girls) and of 8% in 1995 (sex-specific prevalence not reported). Of students who reported the use of snuff before the ban, 10% reported to have quit because of the ban, 20% reported reducing their use, 12% reported switching to cigarettes and 5% reported switching to other drugs.

In 2002, 1.2% of adult men in Finland used snuff daily, and prevalence of daily use was highest among men aged 25–34 years (2.3%) (Patja & Vartianen, 2003). Occasional use of snuff was reported by 6% of men and boys aged 15–24 years. Among women, 1.1%

Table 16. Sales of chewing tobacco in selected European countries (tonnes)

Year	Austria	Denmark[a]	Finland	France	Norway[a]	Sweden[a]
	Chewing tobacco (includes snuff after 1985)	Chewing tobacco	Chewing tobacco and snuff	Chewing tobacco (includes snuff after 1970)	Chewing tobacco	Chewing tobacco
1920		1410				360
1925	320	1130				230
1930	360	950			910	140
1935	270	730		860	640	90
1940	320	590		540	540	90
1945	50	360		450	180	50
1950	140	410		590	320	50
1955	90	320		540	230	50
1960	50	270		590	180	50
1965	50	180		500	140	0
1970	0	140		500	90	0
1975	9	93	27	685	63	14
1976	9	82	28	691	69	14
1977	6	76	28	671	69	15
1978	2	47	31	655	59	15
1979	2	65	31	581	60	18
1980	2	61	23	516	57	18
1981	1	58	27	427	55	22
1982	1	52	27	416	48	23
1983	1	49	25	416	43	24
1984	1	44	25	391	42	22
1985	1	43	27	404	40	20
1986	8	39	28	372	36	19
1987	7	37	23	374	31	18
1988	8	32	116	382	30	16
1989	8	29	104	380	26	15
1990	8	26	87	397	24	14
1991	9	25	92	394	20	13
1992	9	22	109	404	19	13
1993	10	19	94	391	20	13
1994	10	16	91	370	18	13
1995	10	14	91	381	17	12
1996		13			16	12
1997		10			15	12
1998		9			14	14
1999		8			14	14

Table 16 (contd)

Year	Austria	Denmark[a]	Finland	France	Norway[a]	Sweden[a]
	Chewing tobacco (includes snuff after 1985)	Chewing tobacco	Chewing tobacco and snuff	Chewing tobacco (includes snuff after 1970)	Chewing tobacco	Chewing tobacco
2000		7			12	14
2001		7			12	13
2002		6			12	13
2003		6			12	13
2004		6			13	13

From Forey *et al*. (2002), unless otherwise specified
[a] Data after 1995 from Wicklin (2005)

used snuff occasionally and 0.6% used it daily. Among 16-year-olds, 3.3% of boys used snuff daily and 9% reported occasional use; 1% of girls used snuff occasionally but none reported daily use.

(*c*) *Norway*

Data on use of snuff in Norway has been collected by Statistics Norway since 1985 (Kraft & Svendsen, 1997). Most recent data from national surveys indicate that, in 2004–05, 10% of boys and men aged 16–74 years used snuff: 5% used it daily and 5% occasionally (Directorate of Health and Social Affairs, 2006a).

Among boys and men aged 16–24 years, the prevalence of daily or occasional snuff use increased from 9% in 1985 to 15% in 1994 (Kraft & Svendsen, 1997), and to 33% in 2004–05, the highest of any age group (Table 20) (Directorate of Health and Social Affairs, 2006a). Between 1983 and 2001, the prevalence of daily smoking by boys and men aged 16–24 years remained relatively constant at 28–32% (Directorate of Health and Social Affairs, 2006b), which suggests that the rise in snuff use among young men in Norway was not accompanied by a decline in smoking. The prevalence of occasional or daily use of snuff in men aged 16–44 years has increased steadily since 1988 and has more than doubled between 1985 and 2003 (Directorate of Health and Social Affairs, 2006a). Among men aged 65–74 years, the prevalence of daily or occasional snuff use declined from 12 to 6% between 1985 and 1994 (Kraft & Svendsen, 1997) and was 1% in 2004–05 (Directorate of Health and Social Affairs, 2006a).

The National Council on Tobacco and Health of Norway conducts surveys of tobacco use among Norwegian lower secondary school youths corresponding to the ages of 13–15 years (Braverman *et al*., 2001; Directorate of Health and Social Affairs, 2003, 2006c). The surveys are administered at 5-year intervals, and items on snuff were added in 1985.

Table 17. Sales of snuff in selected European countries (tonnes)

Year	Austria	Bulgaria	Denmark[a]	Finland	France	Iceland[a]	Ireland	Italy	Norway[a,b]	Poland	Portugal	Sweden[a,b]	United Kingdom
	Snuff (includes chewing tobacco and snuff after 1986)	Snuff	Snuff	Snuff (includes chewing tobacco and snuff after 1970)	Snuff (includes chewing tobacco and snuff after 1970)	Snuff (dry snuff used nasally)	Snuff	Snuff	Snuff	Snuff	Snuff	Snuff	Snuff
1920		3	180	50			140					6530	
1925	140	1	270	90			140	2090		390		5310	
1930	140	0	360	90			140	1720	450			4850	410
1935	90		450	50	2180	32	90	1320	410			4490	450
1940	90		500	50	1410	18	90	1090	540		50	3900	450
1945	0		540	0	860	32	90	730	270		50	3490	500
1950	50		500	50	770	36	50	540	540		50	3130	320
1955	0		450	50	590	36	50	540	540		0	2860	320
1960	0		450	0	410	32	50	450	450		0	2680	270
1965	0		360	50	320	32	0	320	410		0	2490	230
1970	0		270	50	180	27	0	180	320		0	2490	180
1975	5		223	27	685	17		130	263			2943	180
1976	6		207	28	691	17		120	267			3189	140
1977	7		198	28	671	16		110	283			3361	140
1978	6		185	31	655	14		100	268			3442	180
1979	6		170	31	581	14		100	260			3550	90
1980	7		159	23	516	15		90	263			3665	90
1981	8		149	27	427	15		80	270			3759	90
1982	8		142	27	416	15		80	248			3929	100
1983	8		131	25	416	15		70	247			4029	100
1984	8		117	25	391	15			274			4332	100
1985	7		107	27	404	13			292			4560	100
1986	8		98	28	372	12			279			4673	0
1987	7		84	23	374	13			270			4695	0
1988	8		76	116	382	12			279			4594	0

Table 17 (contd)

Year	Austria	Bulgaria	Denmark[a]	Finland	France	Iceland[a]	Ireland	Italy	Norway[a,b]	Poland	Portugal	Sweden[a]	United Kingdom
	Snuff (includes chewing tobacco and snuff after 1986)	Snuff	Snuff	Snuff (includes chewing tobacco and snuff after 1970)	Snuff (includes chewing tobacco and snuff after 1970)	Snuff (dry snuff used nasally)	Snuff	Snuff	Snuff	Snuff	Snuff	Snuff	Snuff
1989	8		75	104	380	12			285			4606	0
1990	8		70	87	397	12			286			4632	0
1991	9		62	92	394	13			283			4836	0
1992	9		52	109	404	13			263			5007	0
1993	10		48	94	391	12		36	295			5034	0
1994	10		40	91	370	13			301			5238	0
1995	10		37	91	381	12			314			5407	0
1996			36			13			346			5637	
1997			35			11			354			5328	
1998			33			12			343			5349	
1999			31			10			361			5691	
2000			31			10			358			6229	
2001			30			10			386			6462	
2002			30			11			419			6752	
2003			29			12			468			6813	
2004			28			13			550			6850	

From Forey *et al.* (2002), unless otherwise specified

[a] Data after 1995 from Wicklin (2005). Figures for 2003 and 2004 have not been validated (returns not available).

[b] Data after 1995 also available from Directorate of Health and Social Affairs (2005)

Table 18. Estimated per-capita consumption of smokeless tobacco in selected European countries (g per person aged ≥ 15 years)

Year	Denmark	Finland	Norway	Sweden
	Smokeless tobacco[a]	Moist snuff	Moist snuff	Moist snuff
1970	76	7	107	393
1971	70	8	108	409
1972	66	6	99	414
1973	61	6	94	420
1974	58	7	94	434
1975	57	7	86	452
1976	53	8	87	488
1977	50	8	92	511
1978	47	8	86	520
1979	42	8	83	533
1980	39	6	83	547
1981	37	7	85	558
1982	35	7	77	580
1983	32	6	76	593
1984	28	6	84	635
1985	26	7	88	666
1986	23	7	84	679
1987	20	6	80	679
1988	18	29	82	661
1989	18	26	83	658
1990	16	22	83	658
1991	15	23	82	684
1992	12	27	76	707
1993	11	23	85	708
1994	9	22	86	732
1995	9		90	754
1996	8		98	785
1997	8		100	741
1998	8		96	742
1999	7		101	788
2000	7		99	859
2001	7		107	887
2002	7		115	921
2003	7		128	924
2004	6		149	922

From Wicklin (2005)

[a] See Tables 16 and 17 for relative contributions of chewing tobacco and moist snuff.

Table 19. Prevalence (%) of daily use of moist snuff in three Nordic countries[a]

Age (years)	Sweden		Norway 2001–2003	Finland
	Men	Women	Men	Men
16–24	26.5	4.7	10.9	4
25–34	32.6	3.2	11.8	7.4
35–44	31.4	4.4	10.9	2.3
45–54	24.4	4	3.5	0
55–64	18.2	0.8	2.2	0.3
65–74	9	0.6	0.5	NR
75–84	4.5	0.4	NR	NR
Total	23	3	7.3	2.5

From Wicklin (2005)
NR, not reported
[a] Data for Denmark not available

Table 20. Prevalence (%) by age of men who use snuff in Norway, 2004–2005

Age (years)	Daily	Occasionally	Any current use
16–24	16	17	33
25–34	17	11	28
35–44	10	5	15
45–54	4	7	11
55–64	2	5	7
65–74	0	1	1

From Directorate of Health and Social Affairs (2006a)

Experimental use and current use of snuff declined between 1985 and 1990 for boys and girls and then increased slightly between 1990 and 2000 (Table 21). In 2000, 15.7% of boys and 1.9% of girls aged 13–15 years reported current snuff use. The prevalence of current use increased with increasing grade in school in both sexes.

Cross-sectional surveys of military personnel in the late 1980s found a very high prevalence of snuff use relative to the general male population. A 1986 survey of Norwegian Army conscripts found that 33% used snuff (10% daily and 23% occasionally); 82% of snuff users also smoked (Schei *et al.*, 1990). Similarly, prevalence was relatively high among military officers in a 1989 survey, with 23% reporting current use (15% daily and 8% occasionally) (Schei, 1992).

Table 21. Prevalence (%) by sex, grade and year of survey of youths in Norway who have tried snuff or use it currently

Parameter[a]	1985	1990	1995	2000[b]	2005[c]
Have tried snuff					
Boys, total	39.5	24.9	27.3	30.8	31.1
Grade 8	27.1	15.0	15.8	18.8	15.4
Grade 9	39.7	24.9	26.0	32.9	31.6
Grade 10	51.7	34.9	40.1	40.8	47.0
Girls, total	15.6	9.4	9.3	10.6	16.5
Grade 8	9.0	3.4	4.0	6.1	7.0
Grade 9	14.1	8.4	8.3	10.3	16.6
Grade 10	23.8	16.5	15.5	16.0	25.8
Total	27.6	17.2	18.3	20.8	24
Currently use snuff [d]					
Boys, total	17.3	9.8	11.9	15.7	16.2
Grade 8	9.9	4.5	4.5	7.1	4.9
Grade 9	17.0	9.6	11.5	17.3	15.1
Grade 10	25.1	15.2	19.7	22.8	29.2
Girls, total	3.2	2.2	2.5	1.9	5.2
Grade 8	1.5	0.7	1.3	1.4	1.4
Grade 9	3.1	2.0	2.0	1.8	4.4
Grade 10	4.9	3.8	4.2	2.6	9.8
Total	10.3	6.0	7.2	8.9	10.9

From Braverman *et al*. (2001), unless otherwise specified
[a] Based on school start at age 6 years
[b] From Directorate of Health and Social Affairs (2001, 2003)
[c] From Directorate of Health and Social Affairs (2006c) [data added after meeting as it became available]
[d] Includes daily or occasional use

(*d*) *Sweden*

After declining from 6500 tonnes to 2500 tonnes between 1920 and 1967, annual sales of moist snuff (*snus*) in Sweden increased back to 6800 tonnes in 2002 (Table 17). Accordingly, per-capita consumption of moist snuff between 1970 and 2004 increased steadily from 393 to 922 g per person (Table 18) (Wicklin, 2005).

The most recent official Swedish national survey on the prevalence of moist snuff use among adults was conducted in 2004–05. In 1996–97, 20.0% of men and 0.9% of women aged 16–84 years used moist snuff daily and 5.4% of men and 1.1% of women used it occasionally (Wicklin, 2006) (Table 22). The prevalence of daily moist snuff use among men increased from 16.7% in 1988–89 to 20.0% in 1996–97 and 22% in 2004.

The most recent age-specific official data on moist snuff use among men in Sweden (Wicklin, 2006) show that, in 2004, the prevalence of daily moist snuff use was highest among men aged 35–44 years (29%) and lowest among men aged 75–84 years (6%). This

Table 22. Prevalence (%) of use of *snus* among persons aged 16–84 years in Sweden, 1980–1997 (SCB/ULF surveys[a])

Year	Daily	Occasionally	Any current use
Men			
1980–81	[b]	[b]	16.6
1988–89	16.7	4.5	21.2
1996–97	20.0	5.4	25.4
Women			
1988–89	0.7	0.7	1.4
1996–97	0.9	1.1	2.0

From Wicklin (2006)

[a] SCB/ULF (living condition) surveys are conducted annually. Questions concerning *snus* use are included every seventh and eighth year. Questions concerning *snus* use are scheduled for inclusion in 2004–05. ULF surveys are conducted using personal and telephone interviews. Every year, approximately 6000 interviews are conducted. The results are reported as an average of two years' survey results.

[b] In 1980–1981, respondents were asked "Do you use *snus*?" but were not asked about daily or occasional use.

pattern is slightly different from that seen in 1988–89 and 1996–97 (Table 23), when the prevalence was highest among men aged 25–34 years and was lowest among men aged 55–64 years and 65–74 years, respectively. Between 1989 and 2004, the prevalence among men aged 16–24 years remained at 21–23% and increased among men aged 35–64 years. Moist snuff use was most prevalent among skilled and unskilled workers of all occupational groups; the survey showed some regional variations of moist snuff use.

Although unofficial trends of the prevalence of moist snuff use in Sweden are also available from the mail-based TEMO surveys conducted by the Statistical Bureau VECA^{HB} and sponsored by the Swedish Match Company (Wicklin, 2006). The sample size in 2004 was about 12 000, but response rates were not reported; 20.4% of men aged 16–75 years reported daily use of snuff and 4.0% reported occasional use (Table 24). Daily moist snuff use was reported by 3.4% of women in that age range and 2.9% of women reported using it occasionally.

Data on daily use of moist snuff among young people in Sweden have been collected since 1981 during the School Children's Drug Habits surveys conducted by the Swedish Council for Information on Alcohol and Other Drugs (Wicklin, 2006). The prevalence of daily snuff use in 2003 was 2% among 12–13-year-old boys and was not reported for girls at that age. Among students aged 15–16 years, daily use of moist snuff remained relatively constant among boys aged 15–16 years, in the range of 11–14% until 1998, with a possible trend toward increasing moist snuff use in more recent years. Moist snuff use among 15–16-year-old girls remained relatively constant over time and was in the range of 0–2%.

Table 23. Prevalence (%) by selected demographic characteristics of daily use of *snus* among men aged 16–84 years in Sweden, 1988–89 and 1996–97 (SCB/ ULF surveys[a])

	1988–89	1996–97
Age (years)		
16–24	23.0	21.2
25–34	25.0	29.4
35–44	18.6	24.8
45–54	10.9	19.1
55–64	8.9	10.0
65–74	10.5	7.8
75–84	12.6	10.2
Profession		
Unskilled workers	21.7	22.4
Skilled workers	23.6	25.6
Total workers	22.6	24.1
Office staff, low	11.7	19.0
Office staff, all others	10.9	14.9
Total staff	11.0	15.9
Entrepreneurs	15.3	20.2
Farmers	14.6	12.4
Students	13.3	16.1
Others	11.6	12.9
Geographical region		
Stockholm	13.0	15.3
Göteborg/Malmö	12.7	16.8
Större kommuner	16.7	20.2
Södra mellanbygden	19.1	21.4
Norra tätbygden	21.7	17.5
Norra glesbygden	24.0	27.4
Overall	16.7	20.0

From Wicklin (2006)

[a] SCB/ULF (living condition) surveys are conducted annually. Questions concerning *snus* use are included every seventh and eighth year. Questions concerning *snus* use are scheduled for inclusion in 2004–2005. ULF surveys are conducted using personal and telephone interviews. Every year, approximately 6000 interviews are conducted. The results are reported as an average of survey results of 2 years.

(*e*) *United Kingdom*

The use of chewing tobacco is relatively rare in the general population of the United Kingdom, although use of various forms of oral tobacco is common in some immigrant communities in the form of chewing betel quid with tobacco.

Table 24. Prevalence (%) of use of *snus* by sex in Sweden, 1970–2004 (TEMO surveys[a])

Year[b]	Age groups[c]	Use *snus* daily[d]	Use *snus* occasionally[d]	Total
Men				
1970	16–67	–	–	12.1
1972	15–67	–	–	15.4
1980	15–69	–	–	16.6
1990	15–70	–	–	20.9
2000	16–75	16.5	7.4	23.9
2004	16–75	20.4	4.0	24.4
Women				
1972	15–67	–	–	0.2
1980	15–69	–	–	0.5
1990	15–70	–	–	2.6
2000	16–75	2.2	1.9	4.1
2004	16–75	3.4	2.9	6.3

From Wicklin (2006)

[a] The surveys were conducted by mail. The number of replies (from both men and women) has been around 12 000. Response rates are not reported.

[b] Data for 1970 are based on surveys in the autumn of 1969 and the spring of 1970. Data for 1972 are based on surveys in the autumn 1971 and the spring of 1972.

[c] The age groupings have been changed several times.

[d] Questions concerning daily and occasional *snus* use were first introduced in the TEMO surveys in 1997.

1.4.2 *North and South America*

Data on sales of snuff and chewing tobacco are available for Canada and the USA (Table 25). The USA are the leading producer of snuff worldwide, and have experienced substantial increases in sales of snuff in recent decades, from 10 840 tonnes in 1980 to 33 520 tonnes in 2003 (209% increase) (Forey *et al.*, 2002; Department of Agriculture, 2003).

Estimates of annual per-capita consumption of smokeless tobacco are available for the USA only (Table 26).

(*a*) *Canada*

Recent Canadian national data on consumption of smokeless tobacco and prevalence of use are reported only in aggregate and not by product type (Table 25). Sales of smokeless tobacco products in Canada have remained relatively constant from 1989 to 2003 other than some fluctuation in 2000 and 2001 (Tobacco Control Programme, 2004). In 1992–97, chewing tobacco generally accounted for about 20–30% of the smokeless tobacco market by weight; the majority of the market was snuff (Wyckham, 1999).

Table 25. Sales of chewing tobacco and snuff in North America (tonnes)

Year	Canada[a]		USA[b]	
	Plug tobacco (includes all smokeless tobacco after 1975)	Snuff (includes all smokeless tobacco after 1975)	Chewing tobacco	Snuff
1920	2990	320		16 370
1925	3860	360		17 150
1930	2680	450		18 190
1935	1770	360		17 280
1940	1410	360		17 190
1945	1450	450		19 780
1950	1040	410	38 960	18 140
1955	680	360	35 150	17 690
1960	500	410	28 940	15 740
1965	410	410	28 980	13 380
1970	270	360	30 930	12 110
1975		NA	36 560	11 430
1976		938	38 100	11 700
1977		1207	40 230	11 070
1978		699	41 910	11 020
1979		741	45 770	10 840
1980		770	48 040	10 840
1981		750	48 310	11 570
1982		726	39 920	19 910
1983		713	39 280	20 730
1984		745	39 600	21 640
1985		695	38 560	22 040
1986		629	35 700	21 180
1987			34 610	20 460
1988			33 880	21 680
1989		284	33 070	22 320
1990		261	32 070	23 270
1991		228	32 340	24 220
1992		215	30 710	25 170
1993		224	28 940	25 760
1994		239	28 030	26 580
1995		250	28 210	26 940
1996		257	27 200	27 900
1997		252	25 800	28 200
1998		255	23 800	29 100
1999		259	22 800	29 700
2000		154	22 000	31 100
2001		312	21 100	31 600
2002		272	19 600	32 500
2003		236	18 300	33 500

Data from Forey *et al*. (2002), unless otherwise specified

[a] Data for 1976–86 from Millar (1989); data for 1989–2003 from Tobacco Control Programme (2004)

[b] Data after 1995 from Department of Agriculture (2006)

Table 26. Estimated[a] per-capita consumption of smokeless tobacco in the USA (g per person aged ≥ 15 years)

Year	USA	
	Chewing tobacco	Snuff
1970	212	83
1971	219	81
1972	216	76
1973	217	74
1974	224	70
1975	227	71
1976	232	71
1977	241	66
1978	246	65
1979	264	63
1980	273	62
1981	271	65
1982	221	110
1983	215	114
1984	215	117
1985	207	118
1986	189	112
1987	182	107
1988	177	113
1989	171	115
1990	164	119
1991	164	123
1992	154	127
1993	144	128
1994	138	131
1995	138	131
1996	131	134
1997	123	134
1998	112	137
1999	106	139
2000	99	141
2001	94	141
2002	86	143

From Department of Agriculture (2003); Department of Commerce (2004); DHHS (2004a)

[a] Data calculated by the Working Group

A 1994 survey on smoking in Canada found that about 1% of the male population aged 15 years and older used smokeless tobacco products currently, which was unchanged from the 1986 prevalence (Wyckham, 1999). In 1986, use of chewing tobacco was slightly more prevalent (0.7%) than that of snuff (0.4%) among men aged 15 years and older, with a prevalence of 1.8% for those over 65 years of age (Millar, 1989). Use of chewing tobacco was slightly more prevalent among men in the Atlantic region (2.0%) and Prairies (1.1%) than in other regions. More recently, the Canadian Tobacco Use Monitoring Surveys enquired whether respondents had ever tried chewing tobacco, pinch or snuff; in 1999–2003, 13–15% of men and 2–3% of women aged 15 years and older reported ever trying these products (Tobacco Control Programme, 2004).

Relatively high use of chewing tobacco and other smokeless tobacco products has been reported among some native populations in some localities, among college athletes and among some young people who use other forms of tobacco. A survey of native Canadians in northern Saskatchewan found that 15% of boys and men and 7% of girls and women aged 7–21 years used chewing tobacco and 23% and 14%, respectively, used snuff (Hoover *et al*., 1990). Similar findings were reported from a 1987 survey of 5–19-year-olds in the Canadian Arctic, in which 11% of boys and 2% of girls currently used chewing tobacco and 13% and 5%, respectively, used snuff; the prevalence was more than 10 times higher among Dene or Métis and Inuit children than among non-native children (Millar, 1990). In a 1989 random telephone survey of boys and girls aged 11–19 years in northeastern Ontario, 4.5% of respondents reported current use of chewing tobacco and 1.1% used snuff (Blackford *et al*., 1994). In a longitudinal panel survey in Calgary, the prevalence of smokeless tobacco use was 1.1% in grade 6 (boys, 1.6%; girls, 0.7%), 2.2% in grade 7 (boys, 3.1%; girls, 1.1%) and 4.2% in grade 8 (boys, 6.9%; girls, 1.6%) (Abernathy & Bertrand, 1992).

A survey of 754 athletes at 10 English Canadian universities found that, among men, smokeless tobacco was used by 47.2% of hockey players, 36.2% of football players, 22.0% of soccer players, 12.0% of volleyball players and 6.8% of track or cross-country athletes (Spence & Gauvin, 1996). Use among female university athletes in some sports was relatively high compared with the general Canadian population, including track or cross-country (6.2%), basketball (4.0%), soccer (3.3%) and volleyball (2.4%). A 1987 survey of Ontario students aged 13–19 years found that smokeless tobacco use was uncommon in the general student population (2.6% of boys, 0.6% of girls), but the prevalence was relatively high among students who currently smoked (9.6% of boys, 1.9% of girls) (Adlaf & Smart, 1988).

(*b*) *USA*

Information on sales and per-capita consumption of chewing tobacco and snuff in the USA between 1920 and 2003 are presented in Tables 25 and 26, respectively.

In 2000, 4.4% of men and 0.3% of women in the USA were current users of smokeless tobacco products (Table 27). Current use was more common among men aged 18–44 years (5.0–5.8%) than among men aged 45 years and older (2.8–3.1%). Non-Hispanic white men were more likely to be current users (5.5%) than were men in other racial or

Table 27. Prevalence by selected demographic characteristics of current use of smokeless tobacco in the USA, 2000 (National Health Interview Survey)

Characteristic	Men		Women		Total	
	%	(95% CI)	%	(95% CI)	%	(95% CI)
Age (years)						
18–24	5.0	(± 1.5)	0.0	(± 0.0)	2.5	(± 0.8)
25–44	5.8	(± 0.7)	0.2	(± 0.1)	2.9	(± 0.4)
45–64	3.1	(± 0.6)	0.4	(± 0.2)	1.7	(± 0.3)
≥ 65	2.8	(± 0.8)	0.7	(± 0.3)	1.6	(± 0.4)
Region[a]						
Northeast	2.2	(± 0.5)	0.1	(± 0.1)	1.1	(± 0.3)
Midwest	4.4	(± 0.7)	0.1	(± 0.1)	2.1	(± 0.3)
South	6.7	(± 0.8)	0.7	(± 0.2)	3.6	(± 0.4)
West	2.6	(± 0.9)	0.1	(± 0.1)	1.3	(± 0.5)
Education						
Less than high school diploma	5.7	(± 1.2)	1.1	(± 0.4)	3.4	(± 0.6)
High school or GED diploma	5.6	(± 0.8)	0.2	(± 0.1)	2.7	(± 0.4)
More than high school diploma	3.4	(± 0.5)	0.1	(± 0.1)	1.7	(± 0.2)
Race or ethnicity						
Hispanic	0.8	(± 0.5)	0.0	(± 0.0)	0.4	(± 0.2)
White, non-Hispanic	5.5	(± 0.5)	0.2	(± 0.1)	2.7	(± 0.3)
Black, non-Hispanic	1.3	(± 0.6)	1.3	(± 0.5)	1.3	(± 0.4)
Other	2.2	(± 1.5)	0.5	(± 0.6)	1.4	(± 0.8)
Location of residence[b]						
MSA	3.3	(± 0.4)	0.2	(± 0.1)	1.7	(± 0.2)
Non-MSA	9.0	(± 1.3)	0.6	(± 0.2)	4.5	(± 0.6)
Total	4.4	(± 0.4)	0.3	(± 0.1)	2.3	(± 0.2)

From Tomar (2003a)

CI, confidence interval; GED, General Educational Development

[a] Northeast: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania; Midwest: Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas; South: Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, Texas; West: Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Washington, Oregon, California, Alaska, Hawaii.

[b] MSA, metropolitan statistical area; an MSA is a county or group of contiguous counties that contain at least one city with a population of 50 000 or more or includes a Census Bureau-defined urbanized area of at least 50 000 with a metropolitan population of at least 100 000.

ethnic groups (0.8–2.2%), although the sample size was insufficient to permit meaningful national estimates for some racial and ethnic groups that may have high levels of use, such as American Indians. The prevalence of smokeless tobacco use was higher among men with a high school education or less (5.6–5.7%) than among those with at least some post-high school education (3.4%). Prevalence of smokeless tobacco use was higher among men in the South (6.7%) than in all other geographic regions (2.2–4.4%), and was much higher among men who lived outside of metropolitan statistical areas (9.0%) than among urban men (3.3%) (Tomar, 2003a).

Based on combined unpublished data from the January and May 2000 Current Population Survey Tobacco Use Supplements, the prevalence of smokeless tobacco use among adult men in 2000 was highest in West Virginia (13.9%), Montana (13.1%), Wyoming (13.3%), Mississippi (9.4%) and Tennessee (9.2%) and lowest in Massachusetts (0.2%), Rhode Island (0.5%), New Jersey (0.6%), Connecticut (1.0%) and Hawaii (0.8%).

Similar to the pattern observed among adults, adolescent smokeless tobacco users in the USA are predominantly boys. In 1986–87, 6.1% of boys and 0.1% of girls aged 12–17 years reported current use of smokeless tobacco (Tomar *et al*., 1997). All recent national surveys of young people report the prevalence of 'smokeless tobacco' use, which includes snuff or chewing tobacco, and generally do not enquire about the products separately. The prevalence of current smokeless tobacco use among male high-school students has declined from 20.4% in 1993 (Kann *et al*., 1995) to 11.0% in 2003 (Grunbaum *et al*., 2004) (Table 28). Use of smokeless tobacco ranged from 9.1 to 13.3% for boys in grades

Table 28. Prevalence by sex, race or ethnicity and grade of use[a] of smokeless tobacco among high school students in the USA, 2003 (Youth Risk Behavior Survey)

Characteristics	Girls	Boys	Total
	% (95% CI)	% (95% CI)	% (95% CI)
Race or ethnicity			
White, non-Hispanic	1.6 (± 1.2)	13.2 (± 3.3)	7.6 (± 1.9)
Black, non-Hispanic	2.0 (± 1.1)	4.1 (± 1.8)	3.0 (± 1.1)
Hispanic	3.3 (± 2.1)	6.1 (± 3.5)	4.7 (± 2.7)
Grade			
9	3.8 (± 2.4)	9.1 (± 3.7)	6.6 (± 2.5)
10	1.0 (± 0.7)	9.6 (± 3.1)	5.4 (± 1.6)
11	2.0 (± 1.6)	13.3 (± 3.1)	7.8 (± 2.2)
12	1.3 (± 0.8)	12.7 (± 3.5)	7.1 (± 1.8)
Total	2.2 (± 1.2)	11.0 (± 2.3)	6.7 (± 1.5)

From Grunbaum *et al*. (2004)
CI, confidence interval
[a] Used chewing tobacco, snuff or dip on at least 1 of the 30 days preceding the survey.

9 to 12, while among high-school girls it ranged from 1.0 to 3.8% across grades. The prevalence was substantially higher among male non-Hispanic white students (13.2%) than among male Hispanic (6.1%) or non-Hispanic black students (4.1%) (Grunbaum *et al*., 2004). A nationally representative cohort study conducted in the early 1990s estimated that, each day, 2200 young people in the USA first try smokeless tobacco and about 830 become regular users (Tomar & Giovino, 1998).

(i) *Chewing tobacco*

Detailed data for production of the three major forms of chewing tobacco in the USA during 1981–2003 are presented in Table 29. Loose-leaf chewing tobacco remained the predominant form throughout that period, and comprised 94% of the chewing tobacco market by weight. However, production declined for all chewing tobacco products during

Table 29. Production of chewing tobacco in the USA, by major category

Year	Output (millions of kg)			
	Plug	Twist	Loose-leaf	Total
1981	8.1	0.8	31.9	40.8
1982	7.1	0.8	33.1	41.0
1983	6.4	0.8	32.2	39.4
1984	5.7	0.8	33.7	40.3
1985	5.1	0.7	33.6	39.4
1986	4.7	0.6	31.6	36.9
1987	4.5	0.6	30.5	35.7
1988	4.0	0.6	29.8	34.4
1989	3.7	0.6	29.4	33.8
1990	3.3	0.6	29.2	33.1
1991	3.0	0.5	29.2	32.7
1992	2.7	0.5	27.9	31.2
1993	2.4	0.5	26.3	29.2
1994	2.1	0.5	25.8	28.4
1995	1.8	0.5	26.0	28.4
1996	1.8	0.5	25.4	27.7
1997	1.6	0.5	24.4	26.4
1998	1.4	0.5	22.3	24.2
1999	1.3	0.4	21.4	23.1
2000	1.2	0.4	20.9	22.4
2001	1.1	0.4	19.9	21.3
2002	1.0	0.4	18.7	20.0
2003	0.8	0.3	18.4	19.5

From Department of Agriculture (2006)

that time. Per-capita consumption followed the same trend, declining by 68% from 273 g per person aged 15 years or older in 1980 to 86 g per person in 2002 (Table 26).

Use of chewing tobacco in the USA is primarily practised by men although there are examples of subpopulations of women in which use is relatively prevalent, particularly some American Indian and Alaskan Native communities (Schinke *et al*., 1987; Lanier *et al*., 1990). Prevalence of tobacco chewing appears to be declining in the USA after having reached a peak of 4.1% in 1987 (Table 30). In 2000, current use of chewing tobacco was reported by 2.5% of men and 0.1% of women; it tended to be slightly higher for men aged 25–34 years than in other age groups. Table 31 presents more detailed characteristics of the prevalence of use of different types of smokeless tobacco among men in 2000 in the USA (unpublished data from the 2000 National Health Interview Survey). Use of chewing tobacco was more prevalent among non-Hispanic white men than among other racial or ethnic groups, among men with less than a high school education than among more educated men, and among rural men than among urban men. Approximately one-half of the men who reported current use of chewing tobacco used those products on a daily basis.

(ii) *Snuff*

Moist snuff is the predominant form of snuff sold in the USA. It comprised 95% of the snuff market by weight in 2001 (Federal Trade Commission, 2003). Sales of dry snuff declined steadily from 3678.7 tonnes in 1986 to 1526.2 tonnes in 2001, while moist snuff sales increased gradually from 16 391.0 to 28 980.0 tonnes during that period (Tables 25 and 32). Except for a slight decline in the mid-1980s, per-capita consumption of snuff (moist and dry) in the USA has increased every year since 1981 except for some decline in 1986–89 (Table 26).

Trends in the prevalences of use of smokeless tobacco between 1970 and 2000 by sex and age are given in Table 30. This includes only individuals who do not smoke cigarettes, but who may smoke cigar or pipes.

In 2000, current snuff use was highest among men aged 18–24 years (3.6%) and was more prevalent than chewing tobacco use among men aged 18–44 years (Table 31). Snuff use was more prevalent among men in southern regions of the USA than in other regions, among men with a high school diploma or equivalent than among those with a higher education, among non-Hispanic whites than among other racial or ethnic groups and among men who resided outside of metropolitan statistical areas (i.e. primarily rural areas) than those who lived in metropolitan areas. About 60–65% of men who were current snuff users used those products on a daily basis, except for the youngest age group (18–24 years) (unpublished data from the 2000 National Health Interview Survey).

(iii) *Population groups with a high prevalence of use*

There are groups within the USA with exceptionally high prevalences of use of smokeless tobacco. A review of studies of professional baseball players conducted between 1987 and 1998 reported a prevalence of smokeless tobacco use of 35–46%, including both chewing tobacco and snuff (Greene *et al*., 1998), although snuff is used much more com-

Table 30. Prevalence (%) by sex and age of current[a] use of chewing tobacco or snuff[b] among adults in the USA

	1970	1987	1991	2000
Chewing tobacco				
Men (age in years)				
18–24	1.8	5.5	4.1	2.9
25–34	2.2	3.3	3.1	3.5
35–44	3.3	3.1	2.5	2.6
45–64	4.2	3.9	2.4	1.8
≥ 65	9.4	5.4	3.9	2.0
Total	3.9	4.1	3.1	2.5
Women (age in years)				
18–24	0.3	0.1	0.1	0.0
25–34	0.3	0.1	0.0	0.2
35–44	0.5	0.3	0.1	0.0
45–64	0.6	0.2	0.4	0.1
≥ 65	1.0	0.7	0.6	0.2
Total	0.5	0.3	0.3	0.1
Snuff				
Men (age in years)				
18–24	0.7	6.4	6.2	3.4
25–34	0.5	3.6	4.8	3.7
35–44	0.8	2.5	2.9	3.0
45–64	1.8	1.6	1.4	1.7
≥ 65	4.0	2.2	2.2	0.9
Total	1.5	3.1	3.3	2.5
Women (age in years)				
18–24	0.2	0.3	0.2	0.0
25–34	0.3	0.1	0.1	0.1
35–44	0.6	0.2	0.1	0.2
45–64	1.8	0.4	0.3	0.3
≥ 65	4.0	1.5	1.3	0.5
Total	1.4	0.5	0.4	0.2
Chewing tobacco or snuff				
Men (age in years)				
18–24	2.2	8.9	8.4	5.0
25–34	2.5	6.0	6.9	6.6
35–44	3.9	4.8	4.9	5.1
45–64	5.8	5.0	3.7	3.1
≥ 65	12.7	6.9	5.6	2.8
Total	5.2	6.1	5.6	4.4

Table 30 (contd)

	1970	1987	1991	2000
Women (age in years)				
18–24	0.4	0.3	0.2	0.0
25–34	0.5	0.2	0.1	0.2
35–44	1.0	0.3	0.2	0.2
45–64	2.3	0.6	0.6	0.4
≥ 65	4.8	1.9	1.7	0.7
Total	1.8	0.6	0.6	0.3

From Giovino *et al*. (1994); unpublished data from 2000 National Health Interview Survey

[a] Current is defined as used at least 20 times and now used every day or on some days.

[b] The figures represent users of smokeless tobacco products who did not smoke cigarettes; they may have smoked cigars or pipes.

monly than chewing tobacco among this group (75%–90% of current users). In another study of professional baseball players conducted in 1988 (Ernster *et al*., 1990), 42% of players reported current use of any type of smokeless tobacco and, among users, 43% reported using both. In a study conducted in 1999, 31% of professional baseball players reported current use of smokeless tobacco, 82% of whom were using snuff (Cooper *et al*., 2003).

High rates of smokeless tobacco use have also been reported among college athletes (Levenson-Gingiss *et al*., 1989; Walsh *et al*., 1994; Hannam, 1997; Green *et al*., 2001). More than 20% of National Collegiate Athletic Association student athletes reported current use of smokeless tobacco in 1996, with a range of 6–55% among male teams and 1–22% among female teams (Green *et al*., 2001). Those studies of college athletes that examined product type reported that exclusive snuff use was more common than exclusive chewing tobacco use, but dual use of products was common (Levenson Gingiss & Gottlieb, 1991; Walsh *et al*., 1994; Chakravorty *et al*., 2000).

Elevated use of smokeless tobacco has also been reported among high-school athletes compared with non-athletes (Davis *et al*., 1997; Melnick *et al*., 2001; Castrucci *et al*., 2004). Similar to patterns among college athletes, high-school baseball players who used smokeless tobacco were much more likely to use exclusively snuff (40%) or to use both snuff and chewing tobacco (52%) than to use exclusively chewing tobacco (8%) (Walsh *et al*., 2000).

There are indications that the prevalence of smokeless tobacco use is also relatively high among military personnel in the USA and ranges from 15 to 46% (Ballweg & Bray, 1989; Forgas *et al*., 1996; Kenny *et al*., 1996; Grasser & Childers, 1997; Chisick *et al*., 1998; Kao *et al*., 2000). The few studies that examined product type reported at least a 3:1

ratio of use of snuff to use of chewing tobacco (Kenny *et al*., 1996; Grasser & Childers, 1997).

Table 31. Prevalence (%) by selected demographic characteristics of current use of smokeless tobacco among men aged 18 years and older in the USA, 2000 (National Health Interview Survey)

Characteristic	Smokeless tobacco		Chewing tobacco		Snuff	
	Any current use	Daily use	Any current use	Daily use	Any current use	Daily use
Age (years)						
18–24	5.3	2.3	3.0	0.9	3.6	1.5
25–44	5.9	3.5	3.2	1.4	3.4	2.2
45–64	3.3	2.0	1.9	1.0	1.7	1.1
≥ 65	3.0	1.9	2.2	1.4	1.0	0.6
Region[a]						
Northeast	2.4	1.4	1.5	0.6	1.2	0.8
Midwest	4.5	2.6	2.6	1.2	2.6	1.6
South	6.8	4.0	3.6	1.7	4.1	2.5
West	2.8	1.3	2.1	0.8	1.2	0.6
Education						
Less than high school diploma	5.8	3.6	3.9	2.0	2.8	1.7
High school or GED diploma	5.7	3.5	2.7	1.1	3.8	2.4
More than high school diploma	3.6	1.8	2.2	1.0	1.9	1.0
Race or ethnicity						
Hispanic	0.9	0.2	0.5	0.0	0.5	0.2
White, non-Hispanic	5.7	3.4	3.2	1.6	3.3	2.0
Black, non-Hispanic	1.4	0.6	1.0	0.4	0.4	0.3
Other	2.2	0.9	1.5	0.1	1.4	0.9
Location of residence[b]						
MSA	3.4	1.9	2.0	0.9	1.9	1.1
Non-MSA	9.3	5.3	5.2	2.4	5.4	3.3
Total	4.6	2.6	2.6	1.2	2.6	1.6

Unpublished data from the 2000 National Health Interview Survey
GED, General Educational Development
[a] Northeast: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania; Midwest: Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas; South: Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, Texas; West: Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Washington, Oregon, California, Alaska, Hawaii.
[b] MSA, metropolitan statistical area; an MSA is a county or group of contiguous counties that contain at least one city with a population of 50 000 or more or includes a Census Bureau-defined urbanized area of at least 50 000 with a metropolitan population of at least 100 000.

Table 32. Sales of snuff in the USA, by category[a] (tonnes)

Year	Dry snuff	Moist snuff
1986	3678.7	16 391.0
1987	3290.9	16 465.1
1988	3206.8	17 887.1
1989	3286.2	18 605.4
1990	2805.7	19 856.6
1991	2645.9	20 950.5
1992	2550.7	22 003.6
1993	2266.6	22 771.2
1994	2183.7	23 600.1
1995	2036.7	24 102.5
1996	1913.6	24 895.4
1997	1843.2	25 074.4
1998	1715.4	25 486.1
1999	1620.4	26 523.3
2000	1571.1	27 888.2
2001	1526.2	28 980.0

From Federal Trade Commission (2003)
[a] Includes sales by the five major US manufacturers.

(*c*) *South America*

Limited information is available from the GYTS on the prevalence of the use of smokeless tobacco and non-cigarette tobacco for selected countries in Latin America (Table 33).

In a cross-sectional survey in schools in Venezuela, *chimó* was used by 13.5% of boys in grades 6–9 (~13–16 years old), including 10% of boys in grade 6 (Granero *et al*., 2003).

1.4.3 *South Asia*

The prevalence of smokeless tobacco use is high in South Asia. Also, new forms of smokeless tobacco have been emerging over the last few decades to entice new consumers. Increasing use has been reported not only among men, but also among children, teenagers, women of reproductive age and immigrants of South Asian origin wherever they have settled (Gupta, 1992). In the WHO South-East Asia Region, over 250 million people use smokeless tobacco products, which represents 17% of the total population; of those, 95% live in India (82%) or Bangladesh (13%) (Sinha, 2004).

Data from national or sub-national surveys or data from studies with large sample sizes are presented in this section.

Table 33. Prevalence (%) of use of smokeless and non-cigarette tobacco products among 13–15-year-old schoolchildren in Latin America (Global Youth Tobacco Survey)

Country	Year of survey	Current use[a] of non-cigarette tobacco products (± 95% CI)
Antigua and Barbuda	2000	9.6 (± 2.2)
Argentina		
Buenos Aires	2003	8.2 (± 1.9)
Capital Federal	2003	6.2 (± 2.0)
Barbados	2002	10.3 (± 2.5)
Bolivia		
Cochabamba	2003	11.3 (± 2.5)
El Alto	2003	11.3 (± 1.4)
La Paz	2003	8.2 (± 1.3)
Oruro	2003	8.6 (± 1.9)
Santa Cruz	2003	9.7 (± 2.1)
Brazil		
Aracaju	2002	3.4 (± 1.6)
Curitiba	2002	3.4 (± 0.7)
Fortaleza	2002	3.4 (± 1.4)
Goiania	2002	5.7 (± 2.4)
Matto Grosso do Sul	2002	4.9 (± 1.5)
Paraiba	2002	3.5 (± 1.8)
Rio Grande do Norte	2002	4.9 (± 1.7)
Rio Grande do Sul	2002	6.0 (± 1.9)
Tocantins	2002	4.0 (± 2.3)
Chile		
Concepcion	2003	6.4 (± 2.4)
Coquimbo	2003	2.6 (± 0.9)
Santiago	2003	4.9 (± 1.3)
Valparaiso - Viña del Mar	2003	3.7 (± 1.2)
Columbia	2001	5.1 (± 1.0)
Costa Rica	2002	5.5 (± 0.8)
Cuba	2001	6.1 (± 1.2)
Dominica	2000	10.7 (± 2.3)
Ecuador		
Guayaquil	2001	8.2 (± 2.0)
Quito	2001	10.0 (± 1.8)
Zamora	2001	17.6 (± 3.1)
El Salvador	2003	8.4 (± 2.0)
Grenada	2000	8.7 (± 1.8)
Guatamala		
Chimal Tenago	2002	5.3 (± 2.0)
Guatamala City	2002	5.6 (± 1.4)
Guyana	2000	8.4 (± 2.2)
Haiti	2001	10.7 (± 4.6)

Table 33 (contd)

Country	Year of survey	Current use[a] of non-cigarette tobacco products (± 95% CI)
Honduras		
San Pedro Sula La Ceiba	2003	10.5 (± 3.1)
Tegucigalpa	2003	9.9 (± 1.7)
Jamaica	2001	7.8 (± 1.8)
Mexico		
Chetmul	2003	6.5 (± 1.7)
Cuernavaca	2003	6.9 (± 1.9)
Guadalajara	2003	5.5 (± 1.4)
Juarez	2003	10.8 (± 2.1)
Mexico City	2003	7.6 (± 1.5)
Nuevo Laredo	2003	5.0 (± 1.4)
Oaxaca	2003	7.6 (± 1.7)
Puebla	2003	8.6 (± 2.9)
Tapachula	2003	5.9 (± 1.5)
Tijuana	2003	7.4 (± 1.4)
Montserrat	2000	9.4
Nicaragua	2003	8.4 (± 1.4)
Panama	2002	9.8 (± 1.5)
Paraguay		
Alto Parana Ituapua	2003	12.4 (± 1.5)
Amambay Caaguazu	2003	13.2 (± 2.5)
Asuncion	2003	10.0 (± 2.0)
Central	2003	10.3 (± 1.4)
Peru	2003	7.2 (± 1.2)
St Kitts and Nevis	2002	13.7 (± 2.6)
St Lucia	2001	7.1 (± 2.1)
St Vincent and the Grenadines	2001	12.7 (± 2.8)
Suriname	2000	6.0 (± 1.7)
Trinidad and Tobago	2000	4.8 (± 1.0)
Uruguay		
Colonia	2001	6.5 (± 3.0)
Maldonado	2001	8.4 (± 2.3)
Montevideo	2001	10.2 (± 2.1)
Rivera	2001	7.3 (± 2.0)
Venezuela	1999	8.7 (± 1.5)
Virgin Islands (United Kingdom)	2001	8.2 (± 3.1)
Virgin Islands (USA)	2004	6.2 (± 1.4)

Updated from Global Youth Tobacco Survey Collaborative Group (2002). The values shown in this table may differ slightly from those available for individual countries. This results from the fact that data included in cross-country reports are limited to respondents 13–15 years of age. Materials that relate to a single country, such as the factsheets and single country reports available on the CDC website, include the full sample of students who completed the survey, and may include students aged 12 or 16 years.

[a] Current use is defined as used at least once in the 30 days preceding the survey.

(*a*) *Bangladesh*

Zarda, *khiwam* and *gul* are manufactured in Bangladesh and are also imported from India (Sinha, 2004).

In Bangladesh, 20–30% of women in rural areas are estimated to use smokeless tobacco, predominantly as part of a betel quid (Islam & Al-Khateeb, 1995). Among 638 respondents in a community-based intervention study on non-communicable diseases, 26% reported chewing tobacco products. Among users, 85% chewed daily and 15% occasionally (Table 34) (Rahman *et al*., 2001).

Table 34. Prevalence of chewing in Dhaka Metropolitan City, Bangladesh

Chewing frequency	Total	%
Total	638	100.0
No chewing	472	74.0
Chewing	166	26.0
Daily	141	85.0
Once a week at least	17	10.2
Less than once a week	8	4.8

From Rahman *et al.* (2001)

Among 11 409 respondents in a baseline community-based health behaviour surveillance study conducted in rural and urban areas, 169 (1.5%) reported current use of *gul* (urban 2%, rural 0.5%); application of *gul* was reported most frequently (5.2%) by urban women of lower socioeconomic classes. In addition, four people reported use of snuff (Rahman *et al.*, 2004).

A cross-sectional survey conducted among tobacco users in selected population groups in Bangladesh in 2003 showed use of treated tobacco leaf by 41.9%, raw dried tobacco leaf by 17.4% and powdered tobacco leaf by 3.9% (Table 35).

Among rickshaw pullers, 42.7% reported applying *gul* and 45% used betel quid with tobacco (Sinha, 2004).

(*b*) *Bhutan*

Tobacco consumption in Bhutan has changed from smoking to other forms such as oral use. Despite a total ban of sales of tobacco in Bhutan, packages of *zarda* used to be on sale in the Thimphu vegetable market. Many people, including young boys and monks, chew *zarda* and scented *khaini* (Sinha, 2004). A recent study showed that 8% of people in Bhutan chew or sniff tobacco (7% women, 10% men). Smoking prevalence is estimated to be 1% (Ugen, 2003).

Table 35. Type of tobacco product used among tobacco users in Bangladesh, 2003

Type of tobacco product	Individual[a]	Family[a]
Cigarette	382 (49.2%)	391 (39.5%)
Bidi	207 (26.4%)	225 (22.7%)
Hookah	6 (0.7%)	6 (0.6%)
Treated tobacco leaf [b]	326 (41.9%)	363 (36.7%)
Raw dried tobacco leaf [b]	135 (17.4%)	186 (18.8%)
Powdered tobacco leaf	30 (3.9%)	46 (4.6%)
Total	777 (100%)	990 (100%)

From WHO SEARO (2003)
[a] The modalities of tobacco use were documented by the subjects about themselves (individual) or by them about their family members (family).
[b] As constituents of betel quid

(*c*) *India*

India is one of the major producers of chewing tobacco in Asia. A specific feature of tobacco production in India is the variety in the types of tobacco produced. The presence of a strong domestic demand for tobacco product for chewing and application to a relatively large extent influences the cultivation of tobacco for these uses. Tobacco used for chewing and application is grown in Tamil Nadu, Uttar Pradesh, Bihar, West Bengal and Orissa (Reddy & Gupta, 2004).

In 2002, 40.6% of the tobacco production was used in cigarettes, 33.3% in *bidi* production and 12.4% was used for smokeless forms of chewing, snuffing and applied tobacco (Table 36; Reddy & Gupta, 2004). Between 1976 and 1994, chewing tobacco

Table 36. Tobacco production by type of tobacco in India, 2002

Type	Quantity (million kg)	%
Cigarettes	244	40.6
Bidi	200	33.3
Cigar	22	3.7
Hookah	60	10.0
Chewing tobacco	65	10.8
Snuff	10	1.6
Total	601	100

From Reddy & Gupta (2004)

production represented between 11% and 19% of total tobacco production, but production has increased substantially since 1995 (Table 37). In 2002, 65 million kg of chewing tobacco and 10 million kg of snuff tobacco were produced in India (Table 36). This increase was accompanied by a huge growth in the export of both chewing tobacco (9-fold increase between 1995 and 2005) and snuff tobacco (18-fold increase during the same period) (Table 38; Reddy & Gupta, 2004; Tobacco Board, 2006).

Table 37. Production of smokeless tobacco (in millions of kg) in India (derived estimates[a]) and percentage of total tobacco production

Years	Chewing		Snuff	
	Production	%	Production	%
1976–77	80.1	19.1	5	1.2
1977–78	70.8	14.3	6	1.6
1978–79	70	15.4	6	1.3
1979–80	72	16.4	7.6	1.7
1980–81	85.3	17.7	7.5	1.6
1981–82	77	14.8	7.6	1.5
1982–83	76.2	13.1	8.9	1.5
1983–84	78.7	16.0	9.2	1.9
1984–85	89	18.3	6.5	1.3
1985–86	75	17.0	7.9	1.8
1986–87	78	16.9	7.5	1.6
1990–91	78.8	14.2	11.8	2.1
1991–92	79.0	13.5	14.4	2.5
1992–93	71.2	11.9	13.3	2.2
1993–94	65.7	11.7	11.8	2.1
1994–95	138.3	24.4	11.7	2.1
1995–96	118.8	22.2	11.0	2.0
1996–97	156.6	26.1	10.0	1.7
1997–98[b]	108.5	18.9	11.0	1.9

[a] Calculated by the Working Group based on data from Directorate of Tobacco Development (1976–98)
[b] Provisional

Large variations in the prevalences and patterns of smokeless tobacco use occur across the country. Apart from regional preferences due to different socio-cultural norms, the preference for smokeless rather than smoked tobacco is inversely related to education and income (Gupta, 1996). Per-capita consumption of smokeless tobacco has increased among the lower socioeconomic classes between 1961 and 2000 in both rural and urban areas (data from the National Sample Survey Organization, cited in Gupta & Ray, 2003).

Table 38. Exports of tobacco from India by product (in tonnes)

Tobacco product	1995–96	1998–99	2001–2002	2004–2005
Cigarettes	884	1432	2883	7 190
Bidi	676	998	961	1062
Hookah/tobacco paste	9376	12 811	8910	10 600
Chewing tobacco/*zarda*	424	1191	2640	3778
Cut tobacco	512	2506	683	2034
Snuff	6	19	19	110
Total	11 883	18 957	16 076	24 774

From Tobacco Board (2006)

Six sets of data may allow an estimation of the prevalence of smokeless tobacco use in India: (*a*) large sub-national cross-sectional and cohort studies, (*b*) the National Family Health Survey, (*c*) the WHO sub-national study, (*d*) the National Sample survey on household consumer expenditure, (*e*) the Global Youth Tobacco Survey and (*f*) the Sample Registration system (unpublished). The last set of data is not discussed here.

(i) *Sub-national cross-sectional and cohort studies*

It has been estimated that approximately one-third of women and two-thirds of men in India use tobacco in one form or another (WHO, 1997). In prevalence surveys in 10 rural areas in eight states of India, smokeless tobacco was used by 3–53% of men and 3–49% of women (Table 39). In these areas, 2–26% of men and 0–4% of women also reported both smoking and smokeless tobacco use (Gupta & Ray, 2003). In a cross-sectional and cohort study in Mumbai, the prevalence of smokeless tobacco use in 1992–94 was 57.1% among women and 45.7% among men (Gupta, 1996). In another cross-sectional survey in a suburb of Trivandrum, Kerala, where residents were mostly of lower socioeconomic status, chewing practices were reported by 26.8% of men (n = 25 453) and 26.4% of women (n = 34 441), mainly in the form of betel quid with tobacco (Sankaranarayanan *et al.*, 2000).

(ii) *National Family Health Survey*

In the National Family Health Survey-2 conducted in 1998–99, 315 597 individuals aged 15 years or older from 91 196 households were sampled (Rani *et al.*, 2003). Among the study population, 20% (28.1% of men and 12.0% of women) reported chewing tobacco/*pan masala*; however, the prevalence may be underestimated by almost 11% for men and 1.5% for women because of the use of household informants. The prevalence of chewing tobacco/*pan masala* varied significantly (7–60%) between states (Table 40). Chewing of tobacco/*pan masala* was relatively more common (> 16%) in the central, eastern, western (except Goa) and northeastern states (except Tripura) compared with the northern and southern states. The prevalence of chewing tobacco/*pan masala* was significantly higher in rural, poorer and less educated populations compared with urban, wealthier

Table 39. Prevalence (%) of use of various types of tobacco in 10 areas in eight states of India

Area	Chewed[a] or applied	Smoked	Mixed	Total users	Reference
Men					
Bhavnagar, Gujarat	9	56	6	71	Mehta *et al.* (1969)
Darbhanga, Bihar	28	24	26	78	Mehta *et al.* (1969)
Ernakulam, Kerala	14	45	22	81	Mehta *et al.* (1969)
Goa	3	61	5	69	Bhonsle *et al.* (1976)
Mainpuri, Uttar Pradesh	21	41	20	82	Wahi (1968)
Mumbai (urban), Maharashtra	46	14	10	69	Gupta (1996)
Pune, Maharashtra	53	6	2	62	Mehta *et al.* (1972)
Singbhum, Jharkhand	17	50	14	81	Mehta *et al.* (1969)
Srikakulam, Andhra Pradesh	4	70	7	81	Mehta *et al.* (1969)
Trivandrum (urban), Kerala	27	56	NR	83	Sankaranarayanan *et al.* (2000)
Women					
Bhavnagar, Gujarat	15	–[b]	–	15	Mehta *et al.* (1969)
Darbhanga, Bihar	7	41	4	51	Mehta *et al.* (1969)
Ernakulam, Kerala	38	1	1	39	Mehta *et al.* (1969)
Goa	23	24	2	49	Bhonsle *et al.* (1976)
Mainpuri, Uttar Pradesh	9	11	1	21	Wahi (1968)
Mumbai (urban), Maharashtra	57	–	–	57.5	Gupta (1996)
Pune, Maharashtra	49	–	–	49	Mehta *et al.* (1972)
Singbhum, Jharkhand	26	5	2	33	Mehta *et al.* (1969)
Srikakulam, Andhra Pradesh	3	64	–	67	Mehta *et al.* (1969)
Trivandrum (urban), Kerala	26	2	NR	28	Sankaranarayanan *et al.* (2000)

Adapted from Gupta & Ray (2003)
NR, not reported
[a] Including betel quid with tobacco
[b] –, prevalence < 0.5%

and more educated populations in both men and women. The socioeconomic gradients (household wealth, education) had more impact for women than for men. The prevalence of chewing tobacco/*pan masala* was higher among tribal populations than among other communities (Table 41). In a multivariate analysis, the older population (≥ 25 years) had a greater likelihood of chewing tobacco compared with the younger population (15–24 years). Muslim women were more likely to chew tobacco than Hindu women, and the Sikh religion emerged as one of the strongest predictors among women for not chewing tobacco. The differentials by state of residence also persisted in the multivariate analysis. No significant association was observed between urban or rural residence and chewing of tobacco/*pan masala* among men after controlling for other characteristics. However, rural women were less likely to chew tobacco than urban women (Rani *et al.*, 2003).

Table 40. Prevalence of chewing[a] in India by state and by sex (National Family Health Survey, 1998–99)

Region/State	Men	Women
	% (95% CI)	% (95% CI)
North		
Haryana	8.1 (6.7–9.8)	0.9 (0.6–1.3)
Himachal Pradesh	7.8 (6.7–9.1)	0.5 (0.3–0.8)
Jammu & Kashmir	7.3 (5.8–9.1)	0.9 (0.6–1.3)
New Delhi	13.1 (11.5–14.9)	2.5 (1.9–3.2)
Punjab	9.3 (8.0–10.8)	0.2 (0.1–0.4)
Rajasthan	19.0 (17.7–20.4)	3.8 (2.9–4.9)
Central		
Madhya Pradesh	40.3 (38.7–42.0)	14.4 (12.7–16.2)
Uttar Pradesh	36.3 (34.6–38.0)	10.9 (10.1–11.8)
East		
Bihar	51.8 (50.1–53.5)	6.7 (6.0–7.6)
Orissa	49.0 (46.7–51.4)	34.3 (31.9–36.9)
West Bengal	23.2 (20.9–25.6)	15.1 (13.5–17.0)
Northeast		
Arunachal Pradesh	51.6 (47.9–55.3)	33.1 (29.6–36.7)
Assam	47.8 (44.7–51.0)	24.3 (22.1–26.6)
Manipur	34.1 (31.1–37.3)	19.2 (15.5–23.5)
Meghalaya	16.9 (13.8–20.5)	27.6 (23.8–31.7)
Mizoram	60.2 (56.5–63.8)	60.7 (57.2–64.0)
Nagaland	45.0 (41.3–48.8)	16.5 (13.7–19.7)
Sikkim	39.5 (36.5–42.7)	18.6 (16.2–21.2)
Tripura	10.8 (8.9–13.1)	5.2 (3.3–8.1)
West		
Goa	7.7 (6.0–9.9)	8.0 (6.3–10.2)
Gujarat	24.6 (22.8–26.4)	8.0 (7.0–9.2)
Maharashtra	34.1 (32.3–36.0)	18.0 (16.1–20.0)
South		
Andhra Pradesh	10.7 (9.4–12.0)	9.9 (8.4–11.7)
Karnataka	13.8 (12.1–15.6)	14.1 (12.7–15.7)
Kerala	9.4 (8.3–10.7)	10.1 (9.1–11.2)
Tamil Nadu	12.9 (11.5–14.5)	10.7 (9.3–12.2)

From Rani *et al.* (2003)
CI, confidence interval
[a] Tobacco or *pan masala*

Table 41. Prevalence (%) of chewing of tobacco/*pan masala* in India (National Family Health Survey, 1998–99)

Variable	Prevalence in % (95% CI)	
	Men	Women
Age (years)		
15–24	4.4 (4.2–4.6)	14.3 (13.8–14.9)
25–39	17.2 (16.8–17.6)	31.6 (30.9–32.3)
40–59	25.7 (25.2–26.2)	35.3 (34.5–36.1)
≥ 60	22.4 (21.7–23.0)	37.4 (36.3–38.5)
Residence		
Urban	20.7 (19.7–21.7)	8.6 (7.9–9.3)
Rural	31.1 (30.4–31.8)	13.3 (12.8–13.8)
Economic status		
Richest 20%	16.4 (15.6–17.2)	4.8 (4.5–5.2)
Second richest	22.8 (22.0–23.7)	9.3 (8.7–9.8)
Middle	28.1 (27.3–28.9)	12.6 (12.0–13.2)
Second poorest	34.4 (33.4–35.4)	15.6 (14.4–15.9)
Poorest 20%	41.9 (40.7–43.2)	19.6 (18.7–20.6)
Years of schooling		
≥ 11	16.9 (16.2–17.7)	1.6 (1.3–1.9)
6–10	23.7 (23.1–24.3)	4.3 (4.0–4.6)
1–5	33.0 (32.1–33.9)	11.5 (10.8–12.1)
No education	38.6 (37.6–39.6)	17.2 (16.6–17.8)
Caste		
Forward caste	24.2 (23.4–25.1)	9.5 (8.9–10.1)
Scheduled caste	30.4 (29.1–31.8)	14.6 (13.7–15.5)
Scheduled tribe	41.1 (39.1–43.1)	20.8 (19.2–22.4)
Other backward castes	28.3 (27.2 –29.4)	10.8 (10.1–11.4)
Religion		
Hindu	29.1 (28.6–29.7)	12.0 (11.5–12.5)
Muslim	25.5 (24.0–27.1)	13.0 (12.1–14.0)
Christian	9.3 (8.0–10.8)	0.1 (0.04–0.3)
Sikh	19.1 (17.0–21.4)	11.5 (10.1–13.2)
Other	31.5 (27.6–35.7)	18.4 (15.3–21.9)

From Rani *et al.* (2003)
CI, confidence interval

(iii) *WHO Sub-national Study*

In a WHO study (Chaudhry, 2001), 35 288 respondents in Karnataka and 29 931 respondents in Uttar Pradesh (aged ≥ 10 years) were surveyed. Tobacco was predominantly used in smokeless form among women of all ages and among men under 30 years of age, both in urban and rural areas. The overall prevalence of current use of smokeless tobacco was 13.9% in Karnataka (13.4% among men, 14.4% among women) (Table 42) and 17.5% in Uttar Pradesh (24.3% among men, 6.6% among women) (Table 43). In Karnataka, the

Table 42. Prevalence by rural/urban area, age and sex of current use of smokeless tobacco in Karnataka, India (WHO Sub-national Study, 2001)

Age group (years)	Urban						Rural					
	Men		Women		Total		Men		Women		Total	
	Sample (no.)	Prevalence (%)	Sample (no.)	Prevalence (%)	Sample (no.)	Prevalence (%)	Sample (no.)	Prevalence (%)	Sample (no.)	Prevalence (%)	Sample (no.)	Prevalence (%)
10–14	281	1.8	224	0.4	505	1.2	925	1.0	818	0.0	1743	0.5
15–19	419	10.3	397	1.0	816	5.8	1700	8.6	1488	0.4	3188	4.8
20–24	432	15.7	403	1.7	835	9.0	1653	16.3	1627	2.8	3280	9.6
25–29	366	18.9	414	2.4	780	10.1	1652	16.9	1634	5.8	3286	11.4
30–34	278	18.0	333	4.8	611	10.8	1394	12.3	1296	11.7	2690	12.0
35–39	313	11.8	381	7.9	694	9.7	1396	13.8	1470	14.1	2866	14.0
40–44	325	16.9	285	12.6	610	14.9	1262	12.3	1208	23.9	2470	18.0
45–49	305	13.4	216	17.1	521	15.0	1187	14.2	964	26.7	2151	19.8
50–54	233	8.2	163	19.0	396	12.6	985	16.1	927	32.8	1912	24.2
55–59	113	8.0	79	12.7	192	9.9	582	17.7	452	39.8	1034	27.4
60–64	108	9.3	146	22.6	254	16.9	792	13.9	660	39.8	1452	25.7
65–69	57	10.5	45	37.8	102	22.5	341	19.6	266	40.6	607	28.8
≥ 70	98	8.2	64	29.7	162	16.7	576	21.7	478	43.5	1054	31.6
All ages	3328	12.6	3150	8.0	6478	10.4	14 445	13.5	13 288	15.9	27 733	14.7

From Chaudhry (2001)

Table 43. Prevalence by rural/urban area, age and sex of current use of smokeless tobacco in Uttar Pradesh, India (WHO Sub-national Study, 2001)

Age group (years)	Urban						Rural					
	Men		Women		Total		Men		Women		Total	
	Sample (no.)	Prevalence (%)	Sample (no.)	Prevalence (%)	Sample (no.)	Prevalence (%)	Sample (no.)	Prevalence (%)	Sample (no.)	Prevalence (%)	Sample (no.)	Prevalence (%)
10–14	279	3.2	118	0.8	397	2.5	1641	2.3	681	0.3	2322	1.7
15–19	381	13.9	181	0.6	562	9.6	1937	17.9	792	1.0	2729	13.0
20–24	411	23.6	247	2.4	658	15.7	1905	27.6	1332	2.3	3237	17.1
25–29	351	30.5	256	3.5	607	19.1	1812	30.0	1299	3.5	3111	18.9
30–34	282	25.2	220	6.8	502	17.1	1473	30.8	1203	4.2	2676	8.9
35–39	265	26.8	233	9.9	498	18.9	1406	27.5	1006	6.4	2412	18.7
40–44	269	28.3	187	7.5	456	19.7	1235	27.0	812	9.0	2047	19.8
45–49	231	21.6	141	11.3	372	17.7	1014	27.1	700	12.4	1714	21.1
50–54	173	25.4	89	11.2	262	20.6	885	28.0	466	13.5	1351	23.0
55–59	104	23.1	73	13.7	177	19.2	541	26.6	395	14.7	936	21.6
60–64	109	22.9	57	26.3	166	24.1	647	31.4	328	18.6	975	27.1
65–69	70	27.1	38	23.7	108	25.9	348	30.2	245	12.7	593	22.9
≥ 70	89	36.0	31	19.4	120	31.7	652	32.5	230	16.1	882	28.2
All ages	3014	22.5	1871	7.2	4885	16.6	15 496	24.6	9489	6.4	24 985	17.7

From Chaudhry (2001)

prevalence of use of smokeless tobacco was higher among women compared with men in the age groups above 40 years. In Uttar Pradesh, the proportion of men who used smokeless tobacco was higher than that of women in all age groups. In both regions, prevalence of smokeless tobacco use by women increased with age; for men, prevalence was highest in the age groups 25–29 years and above 70 years. Trends were similar in urban and rural areas. The prevalence of smokeless tobacco use was generally lower among educated women, especially in Karnataka. Clear-cut trends in reduced prevalence with increasing education were not observed in all age groups among men. Muslim men in Karnataka showed a higher overall prevalence compared with Hindus, while in Uttar Pradesh, a higher proportion of Hindu men compared with Muslims used smokeless tobacco. The reverse trend was observed among women in the two states [data for other religions were based on too few numbers to be reliable]. Variations in prevalence according to family income did not follow any specific trend, but the prevalence was comparatively lower in both states among women with higher family income (Chaudhry, 2001).

(iv) *National Sample Survey Organisation*

The National Sample Survey Organisation conducted its fifth quinquennial nationwide survey of household consumer expenditure in India during 1993–94. Interviews were conducted in 115 354 households in 6951 villages and in 4650 urban blocks. Prevalence of use of chewing tobacco was 11.2% and 6.3% among men in rural and urban areas, respectively, and 3.9% and 2.0%, respectively, for women (Table 44) (National Sample Survey Organisation, 1998). The prevalence of tobacco use was underestimated because only one household respondant answered for all inhabitants of the household.

Table 44. Prevalence (%) by rural/urban area and sex of use of tobacco in various forms in India (National Sample Survey Organisation)

Form of tobacco consumption	Use	1987–88				1993–94			
		Rural		Urban		Rural		Urban	
		Men	Women	Men	Women	Men	Women	Men	Women
Chewing tobacco[a]	Regular	11.7	5.0	6.3	2.9	11.2	3.9	6.3	2.0
	Casual	1.3	0.6	1.0	0.4	1.4	0.5	0.9	0.3
Snuff	Regular	0.7	0.8	0.4	0.5	0.5	0.6	0.3	0.3
	Casual	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0
Burnt tobacco powder/paste	Regular	2.7	3.1	1.4	1.6	2.7	2.5	1.2	1.0
	Casual	0.3	0.2	0.2	0.1	0.3	0.1	0.1	0.1
Tobacco in any form	Regular	38.7	10.3	23.9	5.3	31.9	8.1	21.6	3.7
	Casual	1.6	0.8	1.8	0.6	1.7	0.7	1.6	0.3

From National Sample Survey Organisation (1998)

[a] Including betel quid with tobacco

Comparison of the data from 1987–88 and 1993–94 (National Sample Survey Organisation, 1998; Gupta & Sankar, 2004) revealed no significant change in overall use of smokeless tobacco during this period (Table 44). Other reports suggest that there has been a shift towards use by younger people and at a very early age. For example, the prevalence of *mawa* use rose from 4.7% in 1969, mainly among older women, to 19% in 1993–94, mainly among younger generations (Gupta, 2000); in a survey conducted among rural children in three states, snuff was ever used by 38% of boys and 12% of girls aged 10–20 years (Krishnamurthy *et al.*, 1997); a comparative study of the prevalence of tobacco use in a rural area in Bihar showed that the prevalence of total tobacco use remained the same between 1967 and 2000, but that there had been a remarkable shift towards the use of smokeless tobacco (Sinha *et al.*, 2003a).

(v) *Global Youth Tobacco Survey (GYTS) and Global School Personnel Survey (GSPS)*

The Global School Personnel Survey (developed by WHO/CDC) is a cross-sectional survey that employs a cluster sample design to produce a representative sample of school personnel drawn from the same schools that were selected for GYTS. All school personnel (including non-teaching staff) in the selected schools were eligible to participate (Sinha *et al*., 2002).

In the eight northeastern states of India, daily use of smokeless tobacco among school personnel varied from 8.9 (Sikkim) to 49.4% (Mizoram) among men and from 1.6 (Manipur) to 80.3% (Mizoram) among women (Table 45) (Sinha *et al*., 2003b). In five of the eight states, the prevalence of daily use of smokeless tobacco among men and women was similar. In the eastern region, daily use of smokeless tobacco among school personnel varied from 7.8 (West Bengal) to 58.7% (Bihar) in men and from 1.0 (West Bengal) to 53.4% (Bihar) in women (Sinha *et al*., 2002, 2003b; Sinha & Gupta, 2004a; Sinha & Roychoudhury, 2004). The prevalence of use of each type of products is detailed in Table 46.

Smokeless tobacco use among students varied between states from 2.8 (Goa) to 55.6% (Bihar) (Table 47). Among boys, it varied from 2.7 (Delhi) to 57.6% (Bihar) and, among girls, from 2.1 (Goa) to 49.2% (Bihar). In 11 of 13 states, prevalences of smokeless tobacco use among boys and girls were similar; boys in Meghalaya and Uttaranchal reported significantly more smokeless tobacco use than girls (Arora *et al*., 2001; Sinha & Gupta, 2002a,b; Sinha *et al*., 2003c; Pednekar & Gupta, 2004; Sinha & Gupta, 2004b; Sinha *et al*., 2004a).

The use of tobacco products as dentrifice among students aged 13–15 years varied widely between states (Table 48). The prevalence among boys compared with that among girls was notably higher in Orissa and Uttaranchal, marginally higher in nine states and marginally lower in three states. Of the specific products, tobacco toothpaste (creamy snuff) and tooth powder (*lal dant manjan*) were common in all 14 states; the prevalence of use ranged from 2 to 32% and from 2 to 29%, respectively. *Gul* was used in eight states and the prevalence of its use ranged from 2 to 6%. Other dentifrice products containing tobacco were: *mishri* and *bajjar* in Goa and Maharashtra; *gudhaku* in Bihar, Orissa, Uttar

Table 45. Prevalence (%) by state of current use of smokeless tobacco[a] among school personnel in the northeastern and eastern regions of India (Global School Personnel Survey, 2001)

Region	Sample size	Prevalence (± 95% CI)					
		Men		Women		Total	
		Daily	Occasional	Daily	Occasional	Daily	Occasional
Northeastern region							
Arunachal Pradesh	533	28.9 (± 8.8)	19.0 (± 11.9)	25.1 (± 20.0)	23.9 (± 13.0)	28.2 (± 5.3)	19.9 (± 8.7)
Assam	782	10.1 (± 3.2)	34.3 (± 6.6)	13.5 (± 9.4)	37.0 (± 14.2)	10.7 (± 3.7)	34.7 (± 5.9)
Manipur	395	21.8 (± 9.5)	53.2 (± 14.1)	1.6 (± 2.7)	74.2 (± 9.9)	14.2 (± 5.9)	61.1 (± 9.2)
Meghalaya	447	30.8 (± 10.5)	20.5 (± 6.4)	17.4 (± 14.0)	39.2 (± 13.4)	24.9 (± 8.7)	28.8 (± 4.7)
Mizoram	307	49.4 (± 10.5)	29.8 (± 12.0)	80.3 (± 13.8)	6.9 (± 6.2)	57.8 (± 8.8)	23.7 (± 8.0)
Nagaland	426	18.5 (± 6.5)	31.3 (± 10.2)	18.1 (± 20.2)	14.4 (± 6.6)	18.3 (± 10.2)	25.4 (± 8.5)
Sikkim	342	8.9 (± 4.3)	45.3 (± 14.3)	51.9 (± 12.0)	21.7 (± 11.3)	17.6 (± 6.7)	40.6 (± 10.6)
Tripura	562	38.3 (± 11.5)	17.2 (± 6.8)	6.8 (± 2.0)	17.7 (± 10.4)	31.2 (± 9.2)	17.5 (± 5.7)
Eastern region							
Bihar	637	58.7 (± 6.3)		53.4 (± 16.1)		57.3 (± 7.5)	
Orissa	517	28.1 (± 13.3)	16.9 (± 9.0)	5.0 (± 5.2)	3.4 (± 3.6)	24.2 (± 11.3)	14.6 (± 8.1)
West Bengal	663	7.8		1.0		5.8	

From Sinha *et al.* (2002; 2003b); Sinha & Gupta (2004a); Sinha & Roychoudhury (2004)
CI, confidence interval
[a] Including betel quid with tobacco

Table 46. Prevalence (%) by type of tobacco product of smokeless tobacco use by school personnel in the north-eastern states of India (Global School Personnel Survey, 2001)

	Prevalence (± 95% CI)							
	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripur
Betel quid	70.8 (± 9.6)	69.5 (± 6.4)	54.7 (± 9.6)	55.4 (± 4.4)	20.2 (± 3.7)	69.3 (± 5.5)	15.7 (± 7.6)	54.9 (± 8.5)
Gutka	4.1 (± 1.7)	8.6 (± 2.9)	17.9 (± 12.0)	5.1 (± 1.7)	24.8 (± 3.2)	8.3 (± 3.5)	34.4 (± 4.5)	21.0 (± 6.8)
Smokeless tobacco without areca nut	24.3	15.6	27.3	39.4	54.3	20.3	49.9	22.5
Khaini	17.3 (± 8.8)	7.0 (± 1.8)	14.7 (± 2.6)	9.1 (± 2.4)	22.3 (± 2.2)	15.9 (± 5.2)	18.9 (± 5.9)	10.7 (± 2.8)
Gul	0.4 (± 0.4)	2.2 (± 2.0)	3.3 (± 2.9)	12.0 (± 6.5)	16.4 (± 3.2)	2.6 (± 1.5)	15.0 (± 3.8)	1.1 (± 1.0)
Snuff	1.9 (± 1.8)	–	–	–	9.3 (± 1.7)	–	3.0 (± 2.2)	1.2 (± 1.0)
Tuibur	4.1 (± 1.5)	6.1 (± 2.3)	8.4 (± 2.9)	13.1 (± 4.4)	5.6 (± 1.9)	0.6 (± 0.5)	12.4 (± 1.8)	1.1 (± 0.6)
Others	0.6 (± 0.6)	0.3 (± 0.3)	0.9 (± 0.7)	5.2 (± 1.9)	0.7 (± 0.7)	1.2 (± 0.9)	0.6 (± 0.5)	8.4 (± 4.0)
Multiple use	0.8 (± 0.8)	6.3 (± 6.0)	–	–	0.6 (± 0.6)	2.0 (± 2.0)	–	1.7 (± 0.9)
Total (no.)	253	327	243	219	227	180	222	211

From Sinha *et al.* (2003b)
CI, confidence interval

Table 47. Prevalence (%) by state of current use of smokeless tobacco among students in India (Global Youth Tobacco Survey)

Category	Sample size	Prevalence (± 95% CI)		
		Boys	Girls	Total
Arunachal Pradesh	2314	35.0 (± 10.4)	40.2 (± 8.0)	37.2 (± 5.9)
Assam	2177	29.3 (± 5.7)	20.4 (± 5.5)	25.3 (± 5.2)
Bihar	2636	57.6 (± 8.6)	49.2 (± 11.5)	55.6 (± 7.5)
Delhi	1731	2.7 (± 1.2)	2.5 (± 1.7)	2.8 (± 1.2)
Goa	2256	3.3 (± 1.6)	2.1 (± 1.4)	2.8 (± 1.2)
Manipur	1743	51.5 (± 11.4)	40.1 (± 14.5)	46.1 (± 10.2)
Meghalaya	2080	43.0 (± 7.0)	26.8 (± 7.2)	35.3 (± 7.4)
Mizoram	2295	45.7 (± 5.1)	40.1 (± 6.0)	42.9 (± 4.4)
Nagaland	2221	52.5 (± 7.5)	47.2 (± 6.3)	49.9 (± 4.9)
Sikkim	2236	42.5 (± 7.0)	31.8 (± 4.6)	37.7 (± 3.7)
Tripura	1866	39.7 (± 10.4)	29.4 (± 11.2)	35.1 (± 8.7)
Uttaranchal	2641	20.8 (± 11.4)	11.5 (± 6.7)	17.6 (± 9.2)
Uttar Pradesh	4542	21.6 (± 7.1)	14.5 (± 8.3)	19.7 (± 6.3)

From Arora *et al.* (2001); Pednekar & Gupta (2004); Sinha *et al.* (2003c); Sinha & Gupta (2002a,b); Sinha & Gupta (2004b); Sinha *et al.* (2004a)
CI, confidence interval

Table 48. Prevalence (%) of application of tobacco products as dentifrice in 14 states in India (Global Youth Tobacco Survey, 2000–2002)

State	Prevalence (95% CI)			
	Toothpaste	*Gul*	Tooth powder	Others
Arunachal Pradesh	23 (18–27)	2 (1–3)	4 (2–5)	–
Assam	11 (9–14)	3 (1–5)	4 (3–6)	–
Bihar	10 (7–12)	6 (4–7)	49 (43–54)	4 (3–6)
Goa	2 (1–2)	–	2 (1–2)	3 (2–4)
Maharashtra	2 (1–3)	–	2 (1–3)	9 (7–12)
Manipur	25 (22–28)	–	2 (0–3)	5 (1–9)
Meghalaya	18 (12–25)	1 (0–1)	4 (2–5)	–
Mizoram	12 (9–15)	–	9 (6–12)	4 (2–7)
Nagaland	32 (23–40)	3 (2–4)	5 (4–7)	–
Orissa	10 (8–12)	1 (1–2)	25 (23–28)	4 (2–6)
Sikkim	8 (5–11)	–	2 (1–3)	1 (1–1)
Tripura	25 (19–31)	–	3 (1–4)	1 (1–2)
Uttar Pradesh	10 (8–12)	2 (1–3)	29 (24–33)	16 (9–22)
Uttaranchal	18 (14–21)	2 (1–3)	29 (26–32)	11 (5–16)

From Sinha *et al.* (2004b)
CI, confidence interval

Pradesh and Uttaranchal; and tobacco water (*tuibur*) in Manipur, Mizoram, Sikkim and Tripura (Sinha *et al*., 2004b).

The current use of smokeless tobacco among the participants of the GSPS (Sinha *et al.*, 2003b) and GYTS (Sinha *et al.*, 2003c) surveys in eight of the states is detailed below.

Arunachal Pradesh

In Arunachal Pradesh, betel quid was the most popular form of smokeless tobacco among men (73.6%) and women (51.4%). *Khaini* was used exclusively by men (19.8%), while *tuibur* (32.6%) and snuff (15.2%) were used exclusively by women (Sinha *et al.*, 2003b).

Current use of smokeless tobacco was reported by 37.2% of students (35.0% of boys, 40.2% of girls), whereas smoking was reported by 22.8% (31.8% of boys, 8.3% of girls). Smokeless tobacco use exclusively in the form of chewing was reported by 55.2% and use exclusively in the form of application was reported by 28.8%. The remainder used several forms of smokeless tobacco. Among chewers, *gutka* was the most popular product (49.8%), followed by *tamol* and a tobacco mixture (31%). Among appliers, 79.7% applied tobacco toothpaste, 12.3% applied red tooth powder and 8% applied *gul* (Sinha *et al.*, 2003c).

Assam

In Assam, the most popular form of smokeless tobacco use among men was betel quid (75.5%), followed by *khaini* (7.9%) and *gutka* (7.8%). Among women, betel quid (36.3%) was commonest, followed by *tuibur* (35.7%), *gul* (13.5%) and *gutka* (13.4%). *Gul* and *tuibur* were used primarily by women (Sinha *et al*., 2003b).

Current use of smokeless tobacco was reported by 25.3% of students (29.3% of boys, 20.4% of girls). Current smoking was reported by 19.7% of students (28.6% of boys, 8.9% of girls). Smokeless tobacco use exclusively in the form of chewing was reported by 48.5% and that exclusively in the form of application by 18.8%. The remainder used several forms of smokeless tobacco. Among chewers, *gutka* was the most popular product (54.4%), followed by *tamol* and a tobacco mixture (28.9%). Among appliers, 58.5% applied tobacco toothpaste, 25% applied red tooth powder and 16.3% applied *gul* (Sinha *et al.*, 2003c).

Manipur

In Manipur, betel quid (54.7%) was the most popular form of smokeless tobacco among both men and women. The prevalence of *gutka* use among men was higher (24.1%) than that among women (2.6%), while the prevalence of *khaini* use among women was higher (29.1%) than that in men (8.9%). *Tuibur* was used predominantly by women (27.5%) (Sinha *et al.*, 2003b).

Current smokeless tobacco use was reported by 46.1% (51.5% of boys, 40.1% of girls), whereas smoking was reported by 26.8% (40.8% of boys, 10.7% of girls). Smokeless tobacco use exclusively in the form of chewing was reported by 53.2% and that exclu-

sively in the form of application by 31.9%. The remainder used several forms of smokeless tobacco. Among chewers, *gutka* (23.7%) was the most popular product (17.9% of boys, 30.2% of girls), followed by *tamol* and a tobacco mixture (18.1% overall, 28.0% of boys, 6.8% of girls). Among appliers, 18.3% of boys and 32.6% of girls applied tobacco toothpaste (Sinha *et al.*, 2003c).

Meghalaya

In Meghalaya, betel quid (55.4%) was the most popular form of smokeless tobacco, followed by *tuibur* (13.1%), *gul* (12.0%) and *khaini* (9.1%). *Gul* and *tuibur* were used primarily by women (Sinha *et al.*, 2003b).

Current smokeless tobacco use was reported by 35.3% (43.0% of boys, 26.8% of girls), whereas smoking was reported by 21.4% (32.1% of boys, 9.9% of girls). Smokeless tobacco use exclusively in the form of chewing was reported by 55.2% (62.1% of boys, 47.7% of girls) and that exclusively in the form of application by 22.9% (28% of boys, 17.6% of girls). The remainder used several forms of smokeless tobacco. Chewing was mainly in the form of *gutka* (19.4%), *tamol* with tobacco (9.2%, > 80% of boys) and *tamol* without tobacco (21%). Tobacco was applied by 18.2% as tobacco toothpaste and by 3.9% as red tooth powder (Sinha *et al.*, 2003c).

Mizoram

In Mizoram, among smokeless tobacco users, 24.8% used *gutka*, 22.3% used *khaini*, 20.2% used betel quid, 16.4% used *gul* and 9.3% used snuff. The use of *gutka* and snuff was reported slightly more frequently among women while that of betel quid and *gul* was more frequent among men (Sinha *et al.*, 2003b).

Current smokeless tobacco use was reported by 42.9% (45.7% of boys, 40.1% of girls), whereas current smoking was reported by 34.5% (40.7% of boys, 28.2% of girls). Smokeless tobacco use exclusively in the form of chewing was reported by 60.7% and that exclusively in the form of application by 25.0%. The remainder used several forms of smokeless tobacco. Among chewers, use of *gutka* (20%) was reported to be the most popular, followed by *pan* with tobacco (12.9%). Among appliers, the majority preferred tobacco toothpaste (11.8%) (Sinha *et al.*, 2003c).

Nagaland

In Nagaland, betel quid (69.3%), *khaini* (15.9%) and *gutka* (8.3%) were the most prevalent forms of smokeless tobacco used. Betel quid was more common among women, whereas *khaini* was used almost exclusively by men (Sinha *et al.*, 2003b).

Current smokeless tobacco use was reported by 49.9% (52.5% of boys, 47.2% of girls), whereas smoking was reported by 29.6% (38.7% of boys, 19.7% of girls). Smokeless tobacco use exclusively in the form of chewing was reported by 62.4% and that exclusively in the form of application by 40%. The remainder used several forms of smokeless tobacco. Among chewers, 28.1% reported chewing *gutka* and 8% reported use

of *pan* with tobacco. Among appliers, the predominant form was tobacco toothpaste (31.7%) (Sinha *et al.*, 2003c).

Sikkim

In Sikkim, *gutka* was the preferred (34.4%) form of smokeless tobacco, followed by *khaini* (18.9%), betel quid (15.7%), *gul* (15.0%) and *tuibur* (12.4%). *Gutka*, *khaini* and *tuibur* were used mainly by men while betel quid and *gul* were used primarily by women (Sinha *et al.*, 2003b).

Current smokeless tobacco use was reported by 37.7% (42.5% of boys, 31.8% of girls), whereas smoking was reported by 23.6% (32.9% of boys, 12.1% of girls). Smokeless tobacco use exclusively in the form of chewing was reported by 48.3% and that exclusively in the form of application by 11.3%. Among chewers, *tamol* and tobacco mixture were reported to be the most popular (52.3%), followed by *gutka* (33.5%). Among appliers, 69.2% applied tobacco toothpaste, 21.4% applied red tooth powder and 9.4% applied *tuibur* (Sinha *et al.*, 2003c).

Tripura

In Tripura, betel quid was the most popular (54.9%) form of smokeless tobacco, followed by *gutka* (21.0%) and *khaini* (10.7%). Betel quid was more popular among men while *khaini* was more popular among women (Sinha *et al.*, 2003b).

Current smokeless tobacco use was reported by 35.1% (39.7% of boys, 29.4% of girls), whereas smoking was reported by 21.2% (28.6% of boys, 12.4% of girls). Smokeless tobacco use exclusively in the form of chewing was reported by 57.5% and that exclusively in the form of application by 28.8%. Among chewers, *gutka* was the most popular (21.3%), followed by *tamol* with tobacco (10.5%; 17.0% of boys, 2.6% of girls) and *tamol* without tobacco (23.0%; 23.7% of boys, 22.1% of girls). Thus, boys equally used *tamol* with tobacco or without tobacco, whereas girls preferred *tamol* without tobacco. Among appliers, the majority preferred tobacco toothpaste (25%) (Sinha *et al.*, 2003c).

(vi) *Type of tobacco used by sex and region*

Bhonsle *et al.* (1992) reviewed available data from the 1970s on the prevalence of smokeless tobacco use by type of tobacco. *Khaini* use among men ranged from < 0.5% (Andhra Pradesh) to 44% (Bihar); that among women ranged from < 0.5 (Gujarat, Kerala) to 10% (Jharkhand). Chewing tobacco leaf varied among men from < 0.5 (Bihar, Goa, Gujarat, Jharkhand) to 9% (Andhra Pradesh) and among women from < 0.5 (Gujarat, Jharkhand) to 2% (Andhra Pradesh, Kerala). Applied tobacco (*bajjar* and *gudhaku*) was used by 1% of men and by 14–16% of women in Gujarat and Jharkhand (Tables 49 and 50; Bhonsle *et al.*, 1992).

Among 6271 school children in Goa (western India), 731 were tobacco users. Of these, 56% of boys and 66% of girls used *mishri* and almost half in both groups used creamy snuff (Table 51) (Vaidya *et al.*, 1992). Among 9097 adults (≥ 15 years) in a rural site in Bihar (eastern India), one third (32.7%) used smokeless tobacco, of whom 11.4%

Table 49. Prevalence of use of smokeless tobacco and other chewing products among men in selected states in India

	Gujarat		Kerala		Andhra Pradesh		Jharkhand		Bihar		Goa	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Pan with tobacco	101	2	1640	33	245	4	84	2	301	6	144	6
Pan without tobacco	242	5	15	< 0.5	134	3	–	–	–	–	48	2
Khaini	300	6	–	–	2	< 0.5	1308	27	2149	44	–	–
Tobacco leaf	30	< 0.5	104	2	484	9	9	< 0.5	6	< 0.5	12	< 0.5
Bajjar	52	1	–	–	–	–	–	–	–	–	–	–
Gudhaku	–	–	–	–	–	–	54	1	–	–	–	–
Areca nut	68	1	–	–	–	–	3	< 0.5	184	4	–	–
Multiple products	7	< 0.5	–	–	3	< 0.5	35	< 0.5	24	< 0.5	–	–
No chewing practice	4427	85	3152	64	4481	84	3307	69	2192	45	2311	92
Total	5227		4911		5349		4800		4856		2515	

From Bhonsle *et al.* (1992)

Table 50. Prevalence of use of smokeless tobacco and other chewing products among women in selected states in India

	Gujarat		Kerala		Andhra Pradesh		Jharkand		Bihar		Goa	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Pan with tobacco	1	< 0.5	1881	35	135	3	71	1	96	2	780	27
Pan without tobacco	6	< 0.5	41	< 0.5	25	< 0.5	–	–	–		131	4
Khaini	5	< 0.5	3	< 0.5	–	–	512	10	371	7	–	–
Tobacco leaf	5	< 0.5	118	2	116	2	7	< 0.5	–		18	1
Bajjar	666	14	–	–	–	–	–	–	–		–	–
Gudhaku	–	–	–	–	–	–	833	16	–		–	–
Areca nut	12	< 0.5	2	< 0.5	–	–	1	< 0.5	68	1	–	–
Multiple products	–	–	–	–	2	< 0.5	23	< 0.5	–		–	–
No chewing practice	4149	86	3331	62	4542	94	3801	72	4946	90	2005	68
Total	4844		5376		4820		5248		5481		2934	

From Bhonsle *et al.* (1992)

used *khaini* and 18.9% used tooth powder that contained tobacco (Table 52) (Sinha *et al.*, 2003a).

Table 51. Prevalence of use of different types of tobacco among schoolchildren in Goa, India

Tobacco product	Boys		Girls	
	No.	%	No.	%
Smoking	13	3	5	2
Mishri	256	56	177	66
Creamy snuff	212	46	128	47
Chewing	66	14	36	13
Single	388	84	219	81
Multiple	73	16	51	19
Total	461	100	270	100

From Vaidya *et al.* (1992)

Table 52. Prevalence of use (%) of different types of tobacco among adults (≥ 15 years) in Bihar, India

Tobacco type	Women	Men	Total
Non-user	55.0	25.9	39.6
Smoked tobacco	23.4	31.6	27.7
Bidi	84.1	82.0	82.9
Others	15.9	18.0	17.1
Smokeless tobacco	21.7	42.6	32.7
Tobacco tooth powder	41.3	8.8	18.9
Khaini	20.0	7.5	11.4
Pan masala	12.1	57.1	43.1
Others	26.6	26.6	26.6
Total (no.)	2586	2910	5496

From Sinha *et al.* (2003a)

A population-based cross-sectional survey was conducted in the city of Mumbai among 99 598 individuals aged 35 years and older during 1992–94 (Gupta, 1996). A high percentage of women used tobacco (57.5%), almost solely in the smokeless form. About one fifth (20%) of the population (26.5% of women; 10.3% of men) used *mishri* alone and 3.7% (1.1% of women; 7.5% of men) used tobacco leaf and lime (Table 53).

Table 53. Prevalence of use of smokeless tobacco and other chewing products in Mumbai, India

	Women		Men		Total	
	No.	%	No.	%	No.	%
Multiple tobacco practices	2013	3.3	2993	7.4	5006	5.0
Mishri	15 740	26.5	140	10.3	19 880	20.0
Mishri + betel quid with tobacco	10 687	18.0	4976	12.4	15 663	15.7
Betel quid with tobacco	3527	5.9	5871	14.7	9398	9.4
Khaini	640	1.1	2997	7.5	3637	3.7
Others with tobacco	1200	2.0	1144	2.9	2344	2.4
Areca nut without tobacco[a]	306	0.5	176	0.4	482	0.5
No chewing practice	25 414	42.7	17 774	44.4	43 188	43.4
Total	59 527	100	40 071	100	99 598	100

From Gupta (1996)
[a] Most frequently as betel quid without tobacco

Among 539 patients who entered hospital in Kerala and were recruited as controls for a case–control study, seven reported use of nasal snuff (Sankaranarayanan *et al*., 1989a).

(*d*) *Indonesia*

In Indonesia, smokeless tobacco is used mainly as part of a betel quid and mostly in rural areas. Betel quid with tobacco and chewing tobacco were identified as smokeless tobacco products used by a small number of respondents both in Jakarta and Sukabumi. Of 5899 tobacco users, less than 0.5% (22 persons) had used chewing tobacco (Sinha, 2004).

(*e*) *Malaysia*

A cross-sectional survey was conducted to document the use of smokeless tobacco among Kadazan women in a rural area in the state of Sabah, East Malaysia (Gan, 1995). Of the 472 women interviewed, 328 chewed; 60% of all women included tobacco as an ingredient in their chew, while 10% did not. Tobacco with lime was used by 2.3% of women and tobacco only by 1.1%. Women with a low education were more likely to be chewers. The chewing practice was usually acquired during the teenage years and was perceived mainly as a cultural norm. The majority of tobacco chewers (46.3%) used three or four fresh preparations per day. Tobacco use increased with increase in age (Table 54).

In a similar survey among the indigenous people of Sabah State, 845 Bajaus (414 men, 431 women) were interviewed (Gan, 1998). Of these, 74.4% of men smoked compared with 3.3% of women and 77% of women used smokeless tobacco compared with 4.3% of men. Tobacco was commonly used in the form of a betel quid. Among chewers,

Table 54. Prevalence of tobacco chewing by Kadazan and Bajaus women in Sabah, Malaysia

Ingredients used in chew	Kadazan (*n* = 472)		Bajaus (*n* = 431)	
	No. with chewing habit	%	No. with chewing habit	%
Smokeless tobacco	281	59.5	332	77
Tobacco, betel leaf, areca nut, lime, *gambir*	148	31.3	183	42.4
Tobacco, betel leaf, areca nut, lime	108	22.9	137	31.8
Tobacco, betel leaf, areca nut	1	0.2	1	0.2
Tobacco and lime	11	2.3	3	0.7
Tobacco and areca nut	8	1.7	2	0.5
Tobacco only	5	1.1	6	1.4
Various combinations of above ingredients without tobacco	47	10.0	14	3.2

From Gan (1995, 1998)

half (51.2%) used fewer than five quids per day. Only nine women used tobacco without areca nut (tobacco only, 1.4%; tobacco with lime, 0.7%). The prevalence of smokeless tobacco use was significantly lower among the better educated and increased with increasing age (Table 54).

(*f*) *Myanmar*

Zarda is manufactured in Myanmar and is also imported from India (Sinha, 2004).

The WHO Sentinel Prevalence Survey of Tobacco Use in Myanmar (WHO SEARO, 2001) covered a sample of 6600 individuals (2903 men, 3697 women) in the Hinthada district from the Delta region and the Pakkuku township from the Dry zone region. Among current tobacco users, two-thirds reported smoking and one-third reported chewing. Among chewers, most chewed tobacco with areca nut (31%) and only 2% chewed raw tobacco. Among the respondents, 21.2% (33.8% of men, 11.2% of women) reported ever use of smokeless tobacco and 14.9% reported current use. Current smokeless tobacco use was nearly three times more prevalent among men than among women both in rural and urban areas. Use of smokeless tobacco was not reported by any respondent aged 10–14 years.

In the GYTS conducted in 2004, smokeless tobacco use was reported by 10.8% of students aged 13–15 years. Boys reported significantly more smokeless tobacco use than girls (18.1% versus 3.6%) (Kyaing, 2005).

(*g*) *Nepal*

Several smokeless tobacco products — *khaini*, *gutka* and *zarda* — are consumed in Nepal. Although they are fairly new to the hill population, they are becoming increasingly

popular in all parts of the country. Between 1996 and 1999, imports of *khaini* and *zarda* into Nepal, mostly from India, increased 72-fold (Karki *et al.*, 2003).

Studies on the economics of tobacco use in Nepal revealed that there are no national or sub-national data from Nepal. A prevalence of 9.4% for *khaini* use and of 31.6% for smoking has been reported from a survey of 6000 people aged 10 years or over (Karki *et al.*, 2003).

A cross-sectional survey was conducted in Dharan municipality (eastern Nepal) in 2001–2002 (Niraula, 2004). A representative sample of 2340 women aged 15 years and above was selected. Of these, 12.9% were cigarette smokers and 14.1% were smokeless tobacco users. The prevalence of tobacco chewing increased from 6.0% in the 15–24-year age group to peak at 25.3% in the 35–44-year age group, after which it decreased gradually. Tobacco chewing was more common among women who were involved in business (30.5%) than among others. Muslims were more likely and Christians were less likely to use tobacco than Buddhists (Table 55).

Nearly one student in 10 (9.3%) aged 13–15 years from the GYTS survey in Nepal reported current smokeless tobacco use. The prevalence of use among boys was significantly higher than that among girls (11.8% versus 5.6%) (Pandey & Pathak, 2001).

Among secondary school students of the sub-metropolitan city of Pokhara, ever use of *gutka* and *khaini* was reported by 41.2% and 3.0%, respectively. Smokeless tobacco use was more frequent among boys than girls (56.4% versus 31.2%). Non-governmental school students were more likely to use smokeless tobacco than governmental school students (Table 56; Paudel, 2003).

(*h*) *Pakistan*

Tobacco chewing alone, tobacco chewing with *pan* and tobacco chewing with smoking was reported by 2.2, 14.8 and 0.5% respondents, respectively, in a population sample of 10 749 people in Karachi (Mahmood *et al*., 1974) (Table 57). In a survey conducted in 1980 among 990 residents in Karachi, about 60% of men and 38% of women used tobacco; of these, about 11% of men and 31% of women chewed tobacco either on its own (1–2%), with *pan* (6.4–27%) or in association with smoking (2.2–2.5%) (Mahmood, 1982).

(*i*) *People's Republic of China*

China is the largest producer of tobacco in Asia (Shafey *et al.*, 2003). No additional information on China was available to the Working Group.

(*j*) *Sri Lanka*

In the WHO Sentinel Prevalence Survey of Tobacco Use in Sri Lanka (cited in Sinha, 2004), a total sample population of 5886 people (49.3% men, 50.7% women) was investigated. Current use of smokeless tobacco products was mainly a rural phenomenon (seven times more prevalent among men and six times more prevalent among women; Table 58), and prevalence among men was almost twice that among women. The trend

indicated a decrease in the current use of smokeless tobacco with education and economic level and an increase with increasing age.

Table 55. Prevalence by sociodemographic characteristics of tobacco chewing among women (≥ 15 years) in Dharan, Nepal, 2002

Characteristic	No. of women	Prevalence (%)
All	2340	14.1
Age group (years)		
15–24	933	6.0
25–34	582	21.1
35–44	250	25.2
45–54	279	23.3
55–64	190	9.5
≥ 65	106	7.9
Marital status		
Unmarried	725	1.4
Married	1376	21.1
Separated	35	22.9
Divorced	8	12.5
Widowed	196	10.7
Occupation		
Housewife	1312	18.3
Business	187	30.5
Service	137	10.2
Labourer	78	21.8
Student	605	0.5
Unemployed	21	0.0
Ethnicity		
Hill native castes	1219	15.1
Major Hill castes	759	12.9
Hill occupational castes	156	14.1
Terai castes	206	13.1
Religion		
Hindu	1659	14.4
Christian	157	3.8
Kirat	300	16.0
Buddhist	216	16.7
Muslim	8	25.0

From Niraula (2004)

Table 56. Prevalence (%) of ever use of tobacco by type of product among 2032 secondary school students in Nepal

Category		Prevalence (± 95% CI)	
		Surti, khaini	*Pan masala, gutka*
Sex	Boys	5.0 (± 1.4)	51.4 (± 3.1)
	Girls	0.9 (± 0.7)	30.3 (± 3.0)
School	Government	2.4 (± 0.9)	31.3 (± 2.7)
	Non-government	4.0 (± 1.4)	56.3 (± 3.5)
Caste	Brahmin/Chhetri	2.6 (± 1.1)	38.6 (± 3.2)
	Gurung/Magar	3.5 (± 1.4)	45.6 (± 3.7)
	Newar	2.4 (± 3.2)	40.5 (± 8.9)
	Others	3.3 (± 2.6)	37.9 (± 6.3)
Total		3.0 (± 0.8)	41.2 (± 2.2)

From Paudel (2003)

Table 57. Prevalence (%) of use of different tobacco products in Karachi, Pakistan, 1967–72

Habit	Men	Women	Total
Sample size (n)	5802	4947	10 749
No tobacco use	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
Pan + tobacco chewing + smoking	8.7	0.9	5.1
Unknown	1.6	1.2	1.4

From Mahmood *et al.* (1974)

(*k*) *Uzbekistan*

In a survey conducted in Samarkand Oblast, all men aged 55–69 years who were residents in one local authority district were invited to participate. Of 1569 men, 636 (41%) reported *naswar* use and 259 (17%) were cigarette smokers (Zaridze *et al.*, 1985).

Table 58. Prevalence by selected sociodemographic characteristics of current use of smokeless tobacco in Sri Lanka, 2001

Characteristic	Prevalence (%)
Sample size (n)	5886
Urban	
Men	3.7
Women	1.7
Rural	
Men	26.4
Women	12.0
Education	
No schooling	41.6
Primary	33.9
Secondary	8.9
Higher secondary	1.9
University	2.3
Monthly income (Rs)	
< 3000	17.0
3001–6000	12.7
6001–9000	10.4
9001–12 000	7.7
≥ 12 001	2.4

Adapted from Sinha (2004)

1.4.4 *Africa*

The two major tobacco producing countries in Africa are Malawi and Zimbabwe (Shafey *et al.*, 2003). The most widely grown type of tobacco in Zimbabwe is flue-cured Virginia, while Malawi is the largest producer of Burley tobacco in Africa. (Burley tobacco accounts for just under 15% of global tobacco production.) Worldwide, approximately 11–12 million farmers cultivate tobacco, about 18 000 of whom are in Zimbabwe and 375 000 in Malawi (Jaffee, 2003). Exports of tobacco leaf increased continuously in both countries between 1980–82 and 1997–99, by 130% in Malawi and by 69% in Zimbabwe (Jaffee, 2003). According to different sources, Zimbabwe produced 210 000–230 000 tonnes of tobacco leaves and Malawi 99 000–125 000 tonnes in 2000 (Jaffee, 2003; Shafey *et al.*, 2003). Tobacco accounts for over 30% of the export revenue of Zimbabwe and 75% of that of Malawi (Shafey *et al*., 2003).

Data from countries that participated in the GYTS are presented in Table 59 (Global Youth Tobacco Survey Collaborating Group, 2003).

Table 59. Prevalence (%) of use[a] of non-cigarette tobacco among students aged 13–15 years in African countries, 1999–2002 (Global Youth Tobacco Survey)

Country	Year of survey	Prevalence (± 95% CI)	
		Boys	Girls
Africa		11.0	9.2
Botswana	2002	10.1 (± 3.1)	9.2 (± 2.4)
Burkina Faso			
Ouagadougou	2001	7.9 (± 3.3)	6.3 (± 2.5)
Bobo Dioulasso	2001	5.9 (± 2.6)	5.5 (± 2.7)
Egypt	2001	18.3 (± 4.4)	12.0 (± 3.9)
Ghana	2000	13.6 (± 4.0)	15.5 (± 4.3)
Kenya	2001	9.0 (± 3.1)	8.9 (± 2.8)
Lesotho	2002	12.3 (± 2.9)	14.8 (± 2.3)
Malawi			
Blantyre	2001	14.4 (± 4.4)	15.2 (± 3.8)
Lilongwe	2001	12.8 (± 3.4)	12.7 (± 2.7)
Mali			
Bamako	2001	13.1 (± 3.8)	4.8 (± 2.5)
Mauritania	2001	15.8 (± 2.7)	13.4 (± 3.1)
Morocco	2001	10.4 (± 1.4)	7.6 (± 1.8)
Mozambique			
Maputo	2002	5.4 (± 1.7)	6.0 (± 1.7)
Gaza Inhambe	2002	5.7 (± 2.4)	7.8 (± 2.0)
Niger	2001	6.7 (± 2.4)	7.5 (± 3.4)
Nigeria			
Cross River State	2001	18.6 (± 4.6)	9.4 (± 3.3)
Senegal	2002	7.3 (± 2.1)	2.9 (± 1.0)
Seychelles	2002	13.0 (± 3.8)	5.5 (± 2.3)
South Africa	2002	14.8 (± 2.4)	11.9 (± 1.9)
Sudan	2001	17.2 (± 3.4)	10.4 (± 2.6)
Swaziland	2001	8.9 (± 2.2)	5.2 (± 0.2)
Togo	2002	9.5 (± 2.5)	7.1 (± 2.1)
Tunisia	2001	11.3 (± 2.2)	3.1 (± 0.8)
Uganda			
Arua	2002	23.8 (± 7.3)	20.0 (± 6.5)
Kampala	2002	9.7 (± 1.2)	9.8 (± 3.1)
Mpigi	2002	10.9 (± 3.4)	9.3 (± 1.8)
Zimbabwe			
Harare	1999	11.0 (± 4.1)	8.4 (± 4.4)
Manicaland	1999	11.6 (± 5.7)	13.9 (± 4.4)
Zambia	2002	17.0 (± 3.4)	17.4 (± 4.0)

From Global Youth Tobacco Survey Collaborative Group (2003)
CI, confidence interval
[a] Use is defined as used at least once in the 30 days preceding the survey.

(*a*) *Kenya*

A small study conducted among five ethnic groups in Kenya assessed differences in smokeless tobacco use related to gender and generation. In four of the five groups, little or no difference was observed in the prevalence of smokeless tobacco use between generations (except for the Gikuyu) or between sexes (except for the Luo) (Kaplan *et al.*, 1990).

(*b*) *South Africa*

In South Africa, smokeless tobacco is more commonly used through the nose and less commonly orally (Ayo-Yusuf *et al.*, 2004). Between 1992 and 1995, the consumption of snuff in South Africa increased by about 30% from 1.1 million kg to 1.5 million kg (Tobacco Board, 1992, 1994/95, cited in Ayo-Yusuf *et al.*, 2004).

A national household survey provided cross-sectional data on a representative sample of the population of South Africa (Table 60). Of 13 826 participants (5753 men, 8073 women), 6.7% (0.9% of men, 10.2% of women) used snuff or chewed tobacco. Smokeless tobacco was used predominantly by African and coloured women and the prevalence increased with age to peak at 28.9% and 9.7%, respectively, in women older than 64 years. The age-standardized prevalence of use of smokeless tobacco in South Africa was higher for Africans (8.4%) than for other ethnic groups (coloureds, 1.9%; whites, 0.8%; Asians, 0.2%) (Steyn *et al.*, 2002).

A telephone survey of 300 tobacco users each in Seshego (black area) and Pietersburg (white area) revealed that 3% of the white tobacco users used snuff while almost half (46.7%) of the blacks used snuff (Peltzer, 1999). The typical form of using snuff in this survey was sniffing (86.7%); placing snuff in the mouth was practiced by men only (13.3%).

In a sample of 330 grade-10 and 382 grade-12 students from a rural population (age range, 13–23 years), 4.0% of boys and 8.4% of girls were current snuff users (Peltzer, 2003). Twenty-four (3.4%) of the participants were current snuff users only, 31 (4.3%) were current smokers only and 17 (2.4%) currently used both snuff and cigarettes (Table 61). The preferable mode of taking snuff was by sniffing, followed by mouth only and both sniffing and by mouth. The prevalence of smokeless tobacco use was not significantly different between grade-10 and grade-12 students (Peltzer, 2003).

A structured questionnaire was administered by means of face-to-face interviews to 30 randomly selected households in a rural population (125 adults over the age of 30 years). Of the respondents, 20.8% were active oral snuff dippers (Table 62). No significant difference was observed in the prevalence between sexes ($p > 0.05$). None of the snuff dippers chewed or smoked tobacco. Among the snuff dippers, the vast majority (85%) placed the snuff in the lower labial sulcus; the remainder placed it in the lower buccal sulcus. About half of them prepared the snuff themselves and the other half acquired it commercially. The mean age of snuff dippers was 62.7 years (range, 36–95 years) and mean duration of use was 21.5 years; dipping lasted for about 2 h per day with an average of 35 min per dip (Ayo-Yusuf *et al.*, 2000).

Table 60. Prevalence of use of smokeless tobacco[a] in South Africa, 1998

Age group (years)	Men										Women									
	African		Coloured		White		Asian		Total		African		Coloured		White		Asian		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
15–24	1493	0.2	207	0.8	93	2.3	46	0	1844	0.4	1709	3.2	224	2.4	97	0	70	0	2102	2.8
25–34	809	0	158	0	87	1.2	32	0	1091	0.1	1256	8.6	227	0.6	97	2.4	56	0	1634	7.0
35–44	737	0.5	154	0	85	0	39	0	1016	0.4	1022	12.7	197	2.3	94	0.2	61	0	1396	9.8
45–54	480	2.5	103	0	99	2.5	31	0	715	2.1	773	18.8	161	1.3	110	0	41	0	1088	13.5
55–64	359	2.1	80	0	70	0	19	–[b]	529	1.6	712	21.6	102	6.5	113	0	35	0	938	16.3
≥ 65	405	4.3	70	1.9	66	0	16	–	558	3.2	701	28.9	97	9.7	89	0	16	–	915	22.9
All ages	4283	1.0	772	0.4	500	1.2	183	0	5753	0.9	6173	12.6	1008	2.9	603	0.4	279	0	8073	10.2

From Steyn *et al.* (2002)

[a] Smokeless tobacco is defined as snuff or chewing tobacco.

[b] Subgroups with fewer than 30 people

Table 61. Status of snuff use and age at start by sex among students in South Africa

Tobacco use status	Boys No. (%)	Girls No. (%)
Sample size	328	384
Ever use	42 (12.8)	77 (20.1)
Current use	13 (4.0)	32 (8.4)
Mean age at start (years)	13.3 (4.9)	11.9 (5.7)

From Peltzer (2003)
[The Working Group noted some discrepancies between the text and table in the prevalence of current snuff users and current smokers.]

Table 62. Prevalence and pattern of snuff dipping in a rural population in South Africa

	Men	Women	Total
Respondents	62	63	125
Snuff dipper			
No.	11	15	26
Prevalence (%)	[17.7	23.8	20.8]

From Ayo-Yusuf *et al.* (2000)

(*c*) *Sudan*

Idris *et al.* (1994) conducted a cross-sectional survey on the use of *toombak* in a random population sample in the Nile State in northern Sudan. In a preliminary report on 2000 households with 5500 adults, about 40% of the men dipped *toombak*, and 9% were both cigarette smokers and *toombak* dippers. *Toombak* was particularly prevalent (> 45%) among men aged 40 years or older. Among women, *toombak* use was popular only in the older age groups; up to 10% of women aged 60 years and over used *toombak* (Idris *et al*., 1994).

A later report included results from 4535 households with 21 594 individuals aged 4 years and over (Table 63). In 60% of all households at least one member used *toombak*. The prevalence of *toombak* use in the entire population aged 4 years or older was 12.6%. The prevalence of *toombak* use was low (1.7%) among children and adolescents (4–17 years) and was highest in the oldest age group (70 years and older). Among the adult population aged 18 years and older, the prevalence of *toombak* use was significantly higher among men (34.1%) than among women (2.5 %), and was significantly higher in rural than in urban areas (35.4% versus 23.5% in men). The highest rates of *toombak* use

were found in the rural areas among men aged 30 years and older (mean, 46.6%; range, 45.3–47.1%) (Idris *et al*., 1998b).

Table 63. Prevalence (%) by age and area of residence of current use of *toombak* among men and women in Sudan, 1992

Age	Men		Women	
	Sample size	Prevalence	Sample size	Prevalence
Rural				
4–17	2728	1.9		
18–19	349	16.0		
20–21	391	26.1		
22–29	1236	32.5		
30–39	981	45.9		
40–49	679	47.0		
50–59	495	47.1		
60–69	386	45.3		
70–79	269	47.0		
≥ 18	4786	35.4		
All ages	7514	23.0	7232	1.0
Urban				
4–17	1067	1.0		
18–19	207	3.4		
20–21	196	9.7		
22–29	600	19.0		
30–39	552	27.5		
40–49	386	28.2		
50–59	278	31.3		
60–69	201	32.3		
70–79	67	46.3		
≥ 18	2487	23.5		
All ages	3554	16.7	3294	2.3
Combined				
4–17	3795	1.7		
18–19	556	11.3		
20–21	587	20.6		
22–29	1836	30.0		
30–39	1533	39.3		
40–49	1065	40.2		
50–59	773	41.4		
60–69	587	40.9		
70–79	336	47.0		
≥ 18	7273	34.1	[6731]	[2.5]
All ages	11 068	23.0	10 526	1.7

From Idris *et al*. (1998b)

(*d*) *Tunisia*

A cross-sectional study of a representative national sample of 5696 subjects aged 25 years and over was conducted in 1996, in which data were collected by means of a questionnaire. Tobacco use was reported by 30.4% of the respondents; 5.8% consumed 'traditional' tobacco, which was defined as tobacco in the form of snuff (*neffa*), chewing tobacco and/or a waterpipe. In this geographical area, *neffa* is the predominant form of snuff used. Use of 'traditional' tobacco was influenced by age, sex, level of education and rural or urban environment (Table 64). The proportion of men who only consumed 'traditional' tobacco increased from 2.4% in the 25–34-year age group to 20.4% in the ≥ 55-year age group; the corresponding values for women were 0.1% and 14.3%, respectively. The consumption of 'traditional' tobacco was more widespread in rural than in urban areas and was relatively high among poorly educated men from economically deprived backgrounds (Fakhfakh *et al*., 2002).

Table 64. Prevalence (%) by socioeconomic characteristics and age of use of 'traditional' tobacco[a] in 5696 subjects in Tunisia, 1996

	Men	Women
Overall prevalence	7.9	3.7
Location		
Rural	14.3	6.0
Urban	3.4	[2.1][b]
Education		
Illiterate	18.0	6.5
Primary	4.8	0.7
Secondary	2.6	
Tertiary	3.6	
Occupation		
Unemployed	13.9	3.8
Manual worker, service personnel	7.0	3.9
Employee, middle management	2.5	1.0
Employee, senior management	6.9	2.6
Age (years)		
25–34	2.4	0.1
35–44	4.7	0.4
45–54	5.7	2.5
≥ 55	20.4	14.3

From Fakhfakh *et al.* (2002)

[a] 'Traditional' tobacco is defined as snuff, chewing tobacco and waterpipe.

[b] Value given as 22.1% in the original source. The Working Group believed that the correct value is one order of magnitude lower.

(*e*) *Other countries*

In Algeria, an estimated 90% of tobacco production is used for the manufacture of snuff, and 24% of all tobacco consumed is in the form of snuff (WHO, 1997).

In Libya, apporoximately 140 tonnes of chewing tobacco are consumed every year (WHO, 1997).

Shammah is a traditional form of chewing tobacco that is used very commonly in southern Saudi Arabia and in Yemen (Hannan *et al*., 1986; Ibrahim *et al*., 1986).

In Lesotho, according to a 1992 survey in rural areas, prevalence of smokeless tobacco use was 2.7% for nasal snuff and 0.3% for oral snuff in those aged 15–29 years, 19.6% for nasal snuff and 2.1% for oral snuff in those aged 30–44 years and 28.5% for nasal snuff and 8.7% for oral snuff in those aged 45 years and over (WHO, 1997).

In Swaziland, Zambia and Zimbabwe, snuff taking is common in rural areas, particularly among older persons (WHO, 1997).

1.4.5 *Association between smokeless tobacco use and cigarette smoking*

Because the use of smokeless tobacco or cigarettes are both associated with nicotine delivery and addiction, interrelationships between smokeless tobacco use and smoking may help to explain long-term historical patterns and trends in the use of these products by populations of various cultures. Some observations suggest that certain smokeless tobacco products may serve as an effective method to quit smoking (Kozlowski *et al.*, 2003). Others have attributed the decline in smoking that has occurred in Sweden since the early 1980s to the expansion of moist snuff use in that country (Bates *et al*., 2003). However, some researchers have suggested that smokeless tobacco may actually serve as starter product for nicotine addiction among young people in the USA, which could lead to subsequent smoking (Tomar, 2003b), and is rarely used as a smoking cessation strategy (Tomar & Loree, 2004); others have questioned whether snuff played any significant role in reducing smoking in Sweden (Tomar *et al.*, 2003; Lambe, 2004). The interrelationship between smokeless tobacco use and smoking, together with recommendations by tobacco manufacturers or those who advocate that tobacco users switch from one product type to another, may have significant implications for exposure to carcinogens among individuals and populations. Sweden and the USA provide the only two examples of nations in which commercial moist snuff products are widely promoted, available and used, and from which there are available epidemiological data to examine the interrelationship between the use of moist snuff and cigarette smoking.

(*a*) *Data from Sweden*

A number of reports indicate that dual use of moist snuff and cigarettes is fairly prevalent in Sweden. In 1985–87, 47% of all male snuff dippers were also smokers compared with 36% of non-snuff users who were smokers (Nordgren & Ramström, 1990). More recent, official national data on the prevalence of dual use could not be located, although a Swedish survey of current and former smokers commissioned by the Swedish Cancer

Society and Pharmacia AB in 2000 found that 19.8% of male current smokers also used moist snuff (Gilljam & Galanti, 2003). A census of ninth grade students (aged 15–16 years) in the County of Stockholm found that 14.3% of boys were exclusively smokers, 5.7% were exclusively snuff dippers and 13.8% used both cigarettes and snuff (Galanti *et al*., 2001a), that is, 71% of boys who used snuff also smoked and 49% of boys who smoked also used snuff.

Some data indicate that snuff use may be a precursor to smoking among young men in Sweden. In a cohort study conducted in the County of Stockholm that began in 1997, 2883 students in the fifth grade were recruited and followed-up 1 year later (Galanti *et al*., 2001b). At baseline, 22% of boys and 15% of girls had ever smoked and 8 and 3%, respectively, had ever used oral moist snuff. One year later, the overall prevalence of smoking had increased markedly, as had the transition to more advanced stages of smoking, especially among girls. The authors concluded that, in most cases, experimentation with oral snuff among boys marked the transition to cigarette smoking.

The extent to which snuff use may account for the decline in smoking in Sweden during the past few decades is unclear. Ramström (2000) reported that, in national surveys of the Swedish population in 1987 and 1988, respondents who had ever used tobacco were asked whether their primary tobacco use was smoking or snuff dipping. Among men aged 18–34 years, 43% were ever daily smokers; of these, 21.5% were former smokers and 21.5% were current daily smokers. Fifty-one per cent of women of the same age were ever daily smokers: 18.5% were former smokers and 32.5% were current daily smokers. From this observation, the author concluded that "Since the one major difference between men and women in Sweden is the widespread use of snuff among men and virtually no snuff use among women, it seems probable that male snuff use has kept down onset of smoking and increased smoking cessation" (Ramström, 2000). Similarly, the review by Foulds *et al*. (2003) cited ecological data on trends of sales of snuff and cigarettes, unadjusted data on prevalence of smoking and male snuff use and sequential cross-sectional surveys from a study in northern Sweden [the Working Group noted that this study was funded by the smokeless tobacco industry] (Rodu *et al*., 2002) as being "strongly suggestive of *snus* having a direct effect on the changes in male smoking and health". [Most conclusions that suggest that snuff played a significant role in reducing cigarette smoking are based largely on ecological or cross-sectional studies.]

Several studies in Sweden examined the possible contribution of snuff to quitting smoking. In a 1-year cohort study of 12 507 persons aged 47–68 years at baseline in 1992–94, Lindström *et al.* (2002a) examined predictors of smoking cessation or change to intermittent (non-daily) smoking among 3550 daily smokers. At baseline, 7.0% of all men and 0.4% of all women were snuff users. At the 1-year follow-up, 7.2% of daily smokers had quit and 6.5% had become intermittent smokers. In a multiple logistic regression analysis that controlled for sex and other demographic characteristics, daily smokers who remained so were less likely than the total population to be snuff users at baseline (odds ratio, 0.67; 95% confidence interval [CI], 0.51–0.87); daily smokers who became intermittent smokers were more likely than the general population to be snuff dippers at baseline

(odds ratio, 1.94; 95% CI, 1.07–3.51); and daily smokers who quit smoking did not differ from the total population in their use of snuff at baseline (odds ratio, 1.1; 95% CI, 0.54–2.26). The study did not report changes in snuff use during the period of follow-up. The authors concluded that sex differences in snuff consumption could provide "… a substantial, although not major, fraction of the explanation for why there has been an increase in smoking cessation in recent years among men but not among women, although we believe that other social and work-related factors may be even more important". Another analysis of the same cohort focused on intermittent smokers at baseline (Lindström *et al.*, 2002b), who accounted for 4.8% of the cohort of 699 people. At the 1-year follow-up, 59.9% of intermittent smokers were still intermittent smokers (intermittent/intermittent), 15.9% had become daily smokers (intermittent/daily) and 19.2% had stopped smoking (intermittent/stopped). Among intermittent/intermittent, 11.5% were snuff users at baseline, as were 9.5% of intermittent/daily, 9.0% of intermittent/stopped and 3.0% of the total cohort which included daily smokers, former smokers and never smokers. In multivariate logistic regression modelling, snuff use was a moderately strong correlate of intermittent smoking compared with the reference group regardless of smoking status at follow-up: odds ratios were 3.40 (95% CI, 1.70–6.81) for intermittent/daily, 4.22 (95% CI, 3.00–5.94) for intermittent/intermittent and 3.20 (95% CI, 1.79–5.71) for intermittent/stopped. The investigators did not report changes in snuff use during the follow-up and did not explicitly compare changes in smoking status as a function of snuff use at baseline. From these two studies, it may be concluded that: (*a*) snuff use may have been more common among intermittent smokers aged 45–69 years than among the rest of the adult population of that age group, but did not seem to be associated with subsequent cessation or prevent transition to daily smoking; and (*b*) snuff use was less common among daily smokers who remained daily smokers than among the general population, but was associated only with their transition to intermittent smoking and not with smoking cessation at the 1-year follow-up.

In a similar study, 5104 persons aged 16–84 years were interviewed in 1980–81 and then followed up in 1988–89 (Tillgren *et al.*, 1996). The cohort included 1546 daily smokers, 418 men who were daily snuff users and 129 men who used both snuff and cigarettes. At follow-up, 5% of male smokers had switched to snuff and 2% had started using snuff in addition to cigarettes, and 5% of non-tobacco users had started using snuff. Among male exclusive snuff users, 26% had quit all tobacco use and 10% had taken up cigarettes in addition to (5%) or instead of (5%) snuff. Among male dual product users, 56% either had continued dual product use or exclusively smoked, 31% exclusively used snuff and 13% had quit all tobacco use.

Rodu *et al*. (2003) reported findings from the MONICA cohort study: persons aged 25–64 years at study entry and who joined the cohort in 1986, 1990 and 1994 were followed up until 1999. Among all 308 men who smoked at entry to the study, 19% exclusively used snuff and 24% used no tobacco product at follow-up. Among 195 male smokers who had never used snuff at entry [63% of all male smokers], 57% were still exclusively smokers at follow-up, 8% had switched to snuff, 6% used both cigarettes and

snuff and 29% used no tobacco product. Among 423 women who smoked at entry to the study, 3% exclusively used snuff and 27% used no tobacco products at follow-up.

The most recent evidence that snuff may be a factor in the decline in smoking in Sweden over the past 20 years derives from cross-sectional studies. Gilljam and Galanti (2003) reported results from a survey in 2000 of 1000 former and 985 current daily smokers aged 25–55 years. Among men, more former smokers than current smokers had ever used snuff (54.7% versus 44.8%; $p = 0.003$) or currently used snuff (28.9% versus 19.8%; $p = 0.002$). Among men, snuff had been used at the most recent attempt to quit smoking by 28.7% of former smokers and 23.0% of current smokers ($p = 0.072$). The study found that having used snuff at the most recent attempt to quit was associated with an increased likelihood of abstinence among men (odds ratio, 1.54; 95% CI, 1.09–2.20). [The authors did not report an association between snuff use and cigarette smoking separately for women, but it could be calculated from the data reported in the tables. Snuff use was much less common among women than among men and did not differ between current and former smokers: 13.1% of women reported ever using snuff, including 14.1% of current smokers and 12.1% of former smokers, and 2.9% of women were current snuff users, including 2.5% of current smokers and 3.3% of former smokers. Use of snuff at the most recent attempt to quit smoking was reported by 4.8% of female current smokers who had attempted to quit and 4.5% of female former smokers.] These findings suggest that snuff use may be associated with smoking cessation among Swedish men but not women.

(*b*) *Data from the USA*

Many cross-sectional studies in the USA have reported moderate-to-strong degrees of association between concurrent smoking and use of smokeless tobacco in the adolescent population (Lichtenstein *et al*., 1984; Ary *et al*., 1987; Jones & Moberg, 1988; Murray *et al*., 1988; Olds, 1988; Ary *et al*., 1989; Colborn *et al*., 1989; Glover *et al*., 1989; Peterson *et al*., 1989; Riley *et al*., 1989; Sussman *et al*., 1989; Severson, 1990; Lee *et al*., 1994; Hatsukami *et al*., 1999; Coogan *et al*., 2000; Ringel *et al*., 2000). These studies, however, used a wide range of definitions of tobacco use and were often unable to establish a temporal relationship with the initiation of use of each tobacco product. Relatively few reports of longitudinal investigations into the relationship between smoking and smokeless tobacco have been published.

Some longitudinal studies found that the use of smokeless tobacco was predictive of the onset of or increase in cigarette smoking (Ary *et al*., 1987; Dent *et al*., 1987; Ary *et al*., 1989; Haddock *et al*., 2001), while others reported that smoking was predictive of initiation of experimentation with or regular use of smokeless tobacco (Ary *et al*., 1987; Dent *et al*., 1987; Ary, 1989; Sussman *et al*., 1989; Tomar & Giovino, 1998).

Two recent cohort studies suggest that use of smokeless tobacco may be a predictor of subsequent smoking among young men in the USA. In a cohort study of 7865 Air Force recruits with a mean age of 19 years at baseline, Haddock *et al*. (2001) considered regular smokeless tobacco use to be use of these products at least once per day; the 1-year measure of smoking outcome was defined as any smoking within the preceding 7 days.

Among current smokeless tobacco users, 27% initiated smoking, compared with 26.3% of former smokeless tobacco users and 12.9% of never users. After adjustment for demographic characteristics among recruits who had never been daily smokers, current users (odds ratio, 2.33; 95% CI, 1.84–2.94) and former users (odds ratio, 2.27; 95% CI, 1.64–3.15) of smokeless tobacco products were significantly more likely than never users to initiate smoking. Current or former smokeless tobacco use was a much stronger predictor of initiation of smoking than a range of other behaviours, including rebelliousness, use of a seat belt, alcoholic beverage consumption, binge drinking, level of physical activity and fruit and vegetable intake.

A recent nationally representative cohort study of adolescent boys and young adult men in the USA examined the longitudinal relationship between use of smokeless tobacco and initiation of smoking (Tomar, 2003b). Data were from the 1989 Teenage Attitudes and Practices Survey and its 1993 follow-up that comprised 7960 people aged 11–19 years at baseline. Analyses were limited to 3996 boys and men with complete data on smoking and smokeless tobacco use at both interviews. Young men who were not smokers in 1989 but regularly used smokeless tobacco were more than three times more likely than never users to be current smokers 4 years later (23.9% versus 7.6%; adjusted odds ratio, 3.45; 95% CI, 1.84–6.47). In contrast, 2.4% of current smokers and 1.5% of never smokers at baseline had become current regular smokeless tobacco users by follow-up. More than 80% of baseline current smokers were still smokers 4 years later and less than 1% had switched to smokeless tobacco; in contrast, 40% of baseline current regular smokeless tobacco users became smokers either in addition to or in place of smokeless tobacco use. The results suggest that smokeless tobacco may be a starter product for subsequent smoking among young men and boys in the USA, but may have little effect on quitting smoking in that age group.

Another analysis (O'Connor *et al*., 2003) of the same cohort as that analysed by Tomar (2003b) suggested that smokeless tobacco was no longer a statistically significant predictor of initiation of smoking when psychosocial risk factors were included in multiple logistic regression modelling. In modelling of predictors of current smoking among men and boys who had never experimented with cigarettes at baseline, an adjusted odds ratio of 1.97 (95% CI, 0.69–5.65) was found for those who reported regular use of smokeless tobacco. The study also suggested an association between smokeless tobacco use and established risk factors for initiation of smoking, such as having a smoker in the household (odds ratio, 1.52; 95% CI, 1.10–2.11). Another analysis also suggested a positive association between regular smokeless tobacco use and initiation of smoking in a model that included experimentation with cigarettes, school performance, depressive symptoms, having a smoker in the household and several markers of risk-taking behaviour (odds ratio, 1.68; 95% CI, 0.83–3.41).

A repeat of the analytic approach of O'Connor *et al*. (2003) that limited the analysis to boys under 16 years of age at baseline found that boys who had used smokeless tobacco were significantly more likely than non-users to be current smokers at follow-up (odds ratio, 1.67; 95% CI, 1.03–2.70) in multivariable modelling that included race or ethnicity,

geographical region of residence, experimentation with cigarettes, school performance, having a smoker in the house, depressive symptoms and two markers for risk-taking behaviour (Tomar, 2003c).

This series of analyses showed that smokeless tobacco use was an independent predictor of cigarette smoking among adolescent boys with a strength of association that was comparable with that of other established risk factors. However, regular use of smokeless tobacco was relatively uncommon at baseline in this cohort study and therefore the parameter estimates were fairly imprecise.

In an analysis of cross-sectional data from the 1987 National Health Interview Survey (NHIS), Kozlowski *et al*. (2003) found a significant association between ever use of smokeless tobacco and current smoking (odds ratio, 1.35; 95% CI, 1.05–1.74), but no association when men who had used cigarettes before smokeless tobacco were excluded from the analysis (odds ratio, 0.79; 95% CI, 0.56–1.11). On this basis, the authors concluded that the order of product use must be considered and that use of smokeless tobacco was unlikely to predict smoking. [The Working Group noted that the analysis did not exclude the many persons at any given age who had already become smokers; the large majority of men in the USA who initiate smoking do so without ever using smokeless tobacco, but that does not rule out the use of smokeless tobacco as a risk factor for nicotine addiction and initiation of smoking. The analytic approach of Kozlowski *et al*. (2003) was analogous to conducting a case–control study in which a very large proportion of the control group actually had the disease; such misclassification generally biases results toward the null (Rothman & Greenland, 1998).]

Tomar and Loree (2004) subsequently modelled smokeless tobacco use as a possible predictor of smoking by excluding from the analysis those who were already smokers at a particular age, and then examined whether smokeless tobacco use predicted subsequent smoking. In contrast to the conclusion of Kozlowski *et al*. (2003), Tomar and Loree (2004) found that white boys who used smokeless tobacco at age 15 years but had never smoked were significantly more likely than non-users of smokeless tobacco to become smokers subsequently, after controlling for age, geographical region and educational attainment (odds ratio, 1.80; 95% CI, 1.15–2.82). Similar results were found when the analysis was repeated for age 16 years (odds ratio, 1.53; 95% CI, 1.03–2.30) or age 17 years (odds ratio, 1.87; 95% CI, 1.17–2.98).

Only one study in the USA has explicitly examined the effectiveness of snuff use as a method for smoking cessation (Tilashalski *et al*., 1998). This pilot study found that 16 of the 63 subjects (25%) in the study had quit smoking at the 1-year follow-up by using snuff and six subjects (10%) had quit smoking by using some other method. [The study did not include a control group.] In a 7-year follow-up of 62 of the original 63 subjects, 28 (45%) had quit smoking, although fewer than half of subjects (n = 12) had reportedly done so by using snuff (Tilashalski *et al*., 2003).

Fiore *et al*. (1990) reported findings from the 1986 Adult Use of Tobacco Survey on the methods that smokers used to quit. In the mid-1980s, 6.8% of former smokers who had successfully quit smoking for at least 1 year had substituted cigarettes with other

tobacco products (including snuff, chewing tobacco, pipes or cigars) during any attempt to quit and 4.0% during their last attempt to quit. However, the proportions were very similar among those who relapsed: 6.8% of smokers who had made a serious attempt to quit in the past year but were not successful had tried substituting other tobacco products at any attempt and 2.1% had tried that strategy at their last attempt to quit.

The most recent direct measurement of the extent of smokeless tobacco use in the USA as a method for quitting smoking derives from the 2000 NHIS. Tomar and Loree (2004) examined changes in tobacco use within the male birth cohorts that were included in the cross-sectional analysis of Kozlowski *et al*. (2003) of data from the 1987 NHIS. A comparison of the prevalence of tobacco use among men aged 23–34 years in 1987 with that of 36–47-year-olds in 2000 revealed a very small decline in the prevalence of current smoking among this birth cohort, from 34.1% (95% CI, 31.9–36.3%) in 1987 to 31.0% (95% CI, 29.1–32.9%) in 2000; the prevalence of current snuff use declined during the same period from 5.8% (95% CI, 4.6–7.0%) to 2.5% (95% CI, 1.9–3.1%). Former smokers in the 2000 NHIS were asked what method they had used to quit smoking completely. Only 1.2% (95% CI, 0.1–2.3%) of male former smokers aged 36–47 years in 2000 reported switching to snuff or chewing tobacco to quit smoking. Of male current smokers in that age group who had unsuccessfully tried to quit, 0.3% (95% CI, 0.0–0.7%) reported switching to smokeless tobacco on their last attempt to quit. In a birth cohort in which 15.5% of men, who included 19.0% of ever smokers, had used smokeless tobacco by the age of 34 years, this practice accounted for a very small proportion of smoking cessation. The authors calculated that the number of men in this birth cohort who used smokeless tobacco, apparently for reasons other than smoking cessation, was up to 68 times greater than the number who used it to quit smoking. The number of men in this birth cohort for whom smokeless tobacco was a probable starter product for smoking was estimated to be about 17 times that of men who reported quitting smoking by using smokeless tobacco.

A recent cross-sectional study examined the associations between snuff use and smoking in a representative sample of men in the USA (Tomar, 2002). The 13 865 subjects were men aged 18 years and older in the 1998 NHIS. Multiple logistic regression modelling was used to examine the association between the use of snuff and cessation of smoking. The study reported that, in 1998, 26.4% of men in the USA smoked, 3.6% used snuff and 1.1% used both products. After adjusting for age and race or ethnicity, the prevalence of current smoking was higher among former snuff users (39.4%) and occasional users (38.9%) than among daily users (19.2%) or never users (25.4%). Daily snuff users were significantly more likely than never users to have quit smoking in the preceding 12 months (odds ratio, 4.2; 95% CI, 2.2–8.3). Occasional snuff users were more likely than never users to have tried to quit smoking in the preceding year (odds ratio, 1.7; 95% CI, 1.0–2.8) but tended to be less likely to succeed (odds ratio, 0.5; 95% CI, 0.2–1.3). After adjustment for age and race or ethnicity, smokers who used snuff daily smoked significantly fewer cigarettes per day on average than those who never used snuff (11.4 versus 18.4 cigarettes; $p = 0.0001$). Men were nearly three times more likely to be former snuff users who currently smoked (2.5%) than to be former smokers who currently used snuff

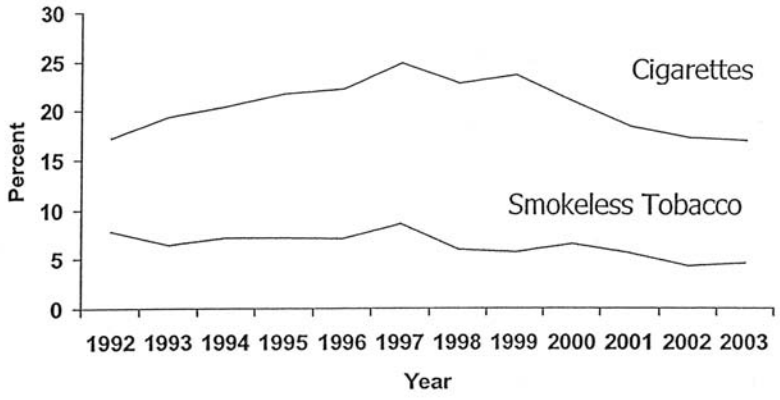
(0.9%). The author concluded that although some men may use snuff to quit smoking, men in the USA more commonly switched from snuff use to smoking.

Wetter *et al*. (2002) examined the characteristics, tobacco use patterns over time and predictors of tobacco cessation among 220 male concomitant users of cigarettes and smokeless tobacco in a large, randomized, worksite-based, matched-pair cancer prevention trial (n = 4886). High levels of dual use were found: 20% of smokeless tobacco users were also smokers (4% of the total study population). Compared with exclusively smokeless tobacco users, dual users were significantly more likely to be unmarried, to drink more alcoholic beverages, to live with a smoker and to use less smokeless tobacco per day, but had higher estimated exposure to nicotine. Dual users appeared to be less ready to change their use of smokeless tobacco than exclusively smokeless tobacco users. At the 4-year follow-up, exclusively smokeless tobacco users were the most likely (20.1%) and dual users were the least likely (11.3%) to have quit all tobacco use; 15.7% of exclusively smokers had quit. Among men who were dual users at baseline, 44.3% were still dual users at the 4-year follow-up, 27.0% were exclusively smokers and 17.4% were exclusively smokeless tobacco users. Men who were exclusively smokers or smokeless tobacco users at baseline showed little inclination to switch products completely, and comparable proportions added use of the other product: 4.6% of baseline smokers began using smokeless tobacco exclusively or in combination with cigarettes and 3.4% of baseline smokeless tobacco users began to smoke either exclusively or in combination with smokeless tobacco. Traditional measures of nicotine dependence (e.g. number of cigarettes or smokeless tobacco uses per day) that predicted cessation among exclusive smokers or smokeless tobacco users were not related to smoking cessation among dual users. Whether due to subject characteristics or the nature of dual product use, dual users in this study had the lowest tobacco cessation rates and tended to shift product use in both directions.

Dual tobacco use has been found to be fairly prevalent in specific subpopulations in the USA, such as in certain Native American populations, among whom 18% of current smokers also used smokeless tobacco and 26% of smokeless tobacco users also smoked (Spangler *et al*., 2001a).

At the population level, a possible effect of the substitution of smokeless tobacco for cigarettes could be manifested by a trend of increasing prevalence of smokeless tobacco use and declining prevalence of smoking. The possibility of such a pattern was explored by examining survey data collected among senior high school pupils as part of the Monitoring the Future Project, which has been conducted since 1975 by the University of Michigan under contract with the National Institute on Drug Abuse (Johnston *et al*., 2003). Data on cigarette smoking have been collected since the inception of the study and those on smokeless tobacco use since 1986. Trends in daily tobacco use among male senior high school pupils in the USA do not support a substitution effect of one product for another (Figure 4). The prevalence of daily smokeless tobacco use remained relatively constant from 1992 to 1996, and was 6–7% for young men. Following a slight increase in 1997 to 8.6%, the prevalence has declined gradually and was 4.3% in 2002. The prevalence of daily cigarette smoking increased from 17.2% in 1992 to 24.8% in 1997, after

Figure 4. Trends in prevalence of daily use of cigarettes or smokeless tobacco among male high school seniors. Monitoring the Future Project, 1992–2003

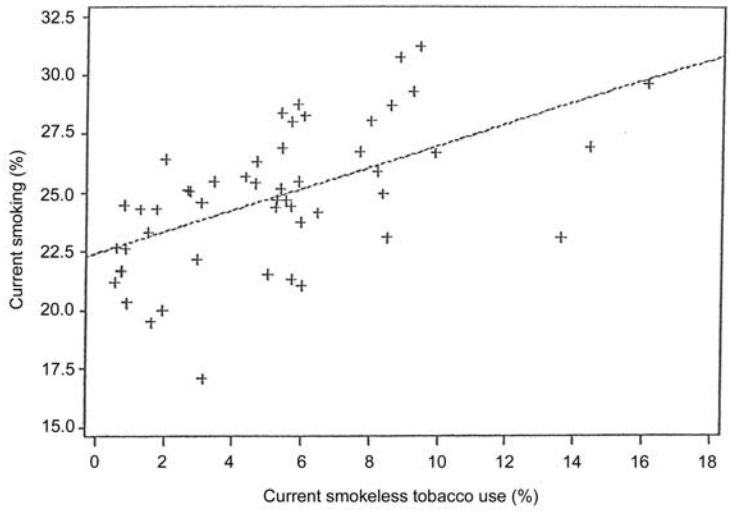


From Johnston *et al.* (2003)

which it began to decline and returned to 17.2% in 2002. At the population level, therefore, it appears that daily use of either cigarettes or snuff has been declining since 1997.

Another approach to the association between smokeless tobacco use and cigarette smoking in populations is to examine their prevalence by state. This was investigated by using data from the September 1998 and January and May 2000 Tobacco Use Supplements to the Current Population Survey. The Current Population Survey was conducted for the Bureau of Labor Statistics by the US Census Bureau and the Tobacco Use Supplements were developed and sponsored by the National Cancer Institute. Linear regression analysis revealed a statistically significantly positive association ($\beta = 0.456$; $p < 0.0001$; $R^2 = 0.2984$) between state-level prevalence of smokeless tobacco use and cigarette smoking among men aged 18 years and older (Figure 5). Similarly, there was a significantly positive association ($\beta = 1.291$; $p < 0.0001$; $R^2 = 0.2841$) between the prevalence of daily use of snuff and the prevalence of daily cigarette smoking among men in the states. The association between state prevalence of smokeless tobacco use and cigarette smoking was nearly identical when analyses were limited to white men. Although cultural and economic factors may affect the use of either tobacco product within states, the ecological patterns of use do not support the existence of widespread product substitution or a 'preventive' effect, in which higher prevalence of smokeless tobacco use is associated with lower prevalence of cigarette smoking (Tomar & Loree, 2004; Tomar, 2007).

Figure 5. Linear regression model of prevalence[a] of current[b] smokeless tobacco use on prevalence of current cigarette smoking among men aged 18 years and older in 50 states, USA, 1998 and 2000



From unpublished data from the September 1998 and January and May 2000 Current Population Survey Tobacco Use Supplements (combined), US Census Bureau and National Cancer Institute

[a] Age-adjusted (five categories) to 2000 US standard population

[b] Used smokeless tobacco (chewing tobacco or snuff) or cigarettes every day or on some days at the time of the interview

Model current smoking = 22.424 + 0.4567 * Smokeless tobacco use

Model $R^2 = 0.2984$

(*c*) *Summary*

In many ways, the recent histories of snuff use in Sweden and the USA are very similar. In both countries, the products were heading towards extinction in the late 1960s, when the development of new products, new images and aggressive marketing led to a new surge in sales. In both countries, these products were adopted largely by young men.

The primary difference between the countries is that the prevalence of daily use of snuff grew to a much larger extent in Sweden, perhaps due to a long history of snuff use and greater cultural acceptance of snuff dipping. The difference may also be attributable to the dominance of a single domestic tobacco company, Swedish Match, in both the cigarette and snuff markets. Swedish Match may have been willing to expand one market (moist snuff) by fostering a transfer of customers from the cigarette market; the company even sold its cigarette business to an Austrian tobacco company in 2000 (Henningfield & Fagerström, 2001). The exact role that snuff has played in reducing the prevalence of smoking in Sweden is unclear, but it has probably been overstated (Tomar *et al*., 2003).

The decline in smoking in Sweden during the past two decades occurred in an environment of increased taxation on cigarettes, increased availability of treatment, expansion of clean indoor air policies and increased communication about the dangers of smoking in Sweden (Henningfield & Fagerström, 2001). Evidence from ecological studies that the increasing prevalence of moist snuff use in Sweden has led to a decline in smoking is inconclusive because of the methodological limitations of ecological studies, which do not directly measure changes in behaviours by individuals. Data from the few available Swedish cohort studies do not support a conclusion that moist snuff was a major factor in the decline in smoking, and in even in areas of Sweden that have a relatively high use of moist snuff, adult smokers who have no previous history of snuff use rarely adopted these products. In the USA, cohort studies of young men suggest that a high proportion of young smokeless tobacco users subsequently initiate smoking, but very few smokers switch to using smokeless tobacco. Consistent with cohort studies, cross-sectional studies in the USA suggest that smokeless tobacco use is rarely used to quit smoking, even among birth cohorts with a substantial history of using those products. It is less clear what the effects might be if moist snuff is aggressively marketed in societies that have little previous experience with these products. Recent history suggests that snuff use will probably gain much more popularity among young men who have never used tobacco or are in the early stages of initiation of tobacco use than among middle-aged smokers who are looking for a cessation strategy.

1.4.6 *Occupational exposure to unburnt tobacco*

The manufacture of *bidis* is one of the largest cottage industries in India and provides employment to more than 3 million people (Govekar & Bhisey, 1992). On average, a *bidi* roller makes 500–1000 *bidis* per day and handles 225–450 g of tobacco flakes, and is thus exposed by dermal contact. In addition, the workers also receive airborne exposure to tobacco dust and volatile components.

(*a*) *Exposure to tobacco dust*

Several studies conducted in various countries suggest that tobacco workers are exposed to tobacco dust and particulate matter (Mengesha & Bekele, 1998; Uitti *et al*., 1998; Mustajbegovic *et al*., 2003; Yanev & Kostianev, 2004; Zuskin *et al*., 2004) (Table 65). In a study that assessed the extent of exposure to tobacco dust among workers in *bidi* tobacco processing plants (Bhisey *et al*., 1999a), the mean concentration of inspirable dust particles was 150 times higher than that in the control environment.

Yanev and Kostianev (2004) determined that the majority of tobacco dust particles had a size of 0.3 μm (range, 0.05–16 μm), and some anisometric forms ranged in size from 0.1 to 2.0 μm.

Table 65. Dust levels in tobacco factories

Country	Job task	No. of samples	Measurement	Mean concentration ($mg/m^3 \pm SD$)	Reference
Ethiopia	Blending	5	Respirable dust area samples	1.83 ± 1.69	Mengesha & Bekele (1998)
	Making	4		0.48 ± 0.31	
	Packing	3		0.29 ± 0.11	
				Total	
Croatia	Sorting	4	Total and respirable dust area samples	14.4	Mustajbegovic *et al*. (2003); Zuskin *et al*. (2004)
	Placing on belts	4		8.5	
	Grinding/shredding	4		4.4	
	Overall	12		9.1	
				Respirable	
				2.4	
				2.1	
				1.1	
				1.9	

SD, standard deviation

(*b*) *Biomonitoring of* bidi *industry workers*

Exposure to tobacco-specific compounds and to electrophilic moities through the occupational use of tobacco can be determined among *bidi* rollers by measuring urinary cotinine and thioethers, respectively. A series of studies have measured occupational exposure of *bidi* workers to nicotine and carcinogens through biomonitoring.

Ghosh *et al.* (1985) conducted a study of tobacco processing workers in India. Among non-tobacco users, none of the control subjects had detectable levels of urinary nicotine or cotinine; levels in exposed workers were 3.13 μg/mL and 3.4 μg/mL, respectively. The mean urinary nicotine and cotinine levels were higher among workers than among controls.

Urinary cotinine and thioethers were determined in samples from two groups of *bidi* rollers and controls from the same community (Bhisey & Govekar, 1991). None of the subjects used tobacco in any form. One group of *bidi* rollers lived in the most densely populated part of Mumbai and worked in a poorly ventilated room, while the other lived in an area with open spaces and worked singly in open courtyards. Urinary cotinine was not detected in control samples while it was present in most samples from *bidi* rollers. In both groups of *bidi* rollers, workers who rolled up to 1000 *bidis* per day showed higher urinary thioether excretion than those who made up to 500 *bidis* per day.

The same authors conducted a larger study that included a greater number of subjects (Govekar & Bhisey, 1992). Among those who had no personal use of tobacco, cotinine was not detected in the urine samples of workers who did not roll *bidis* but was present in samples of workers who did. Among tobacco users, the levels of urinary cotinine were similar in *bidi* rollers and non-*bidi* rollers. Mean urinary thioether levels were signifi-

cantly elevated among *bidi* rollers with or without personal use of tobacco compared with samples from the respective workers who did not roll *bidis*.

In another study (Bagwe & Bhisey, 1993), occupational exposure to tobacco was evident from the higher mean salivary cotinine levels that were observed in samples from *bidi* rollers and tobacco processing plant workers who did not report any personal tobacco use compared with their respective non-occupationally exposed counterparts.

A more recent study confirmed the findings for cotinine in saliva and urine and for thioethers (Bhisey *et al*., 1999a).

Nicotine and cotinine levels were measured in blood and urine samples from 10 healthy nonsmoking tobacco harvesters and five healthy nonsmoking controls at six time-points during a regular working shift (D'Alessandro *et al*., 2001). Maximum values of plasma and urinary nicotine were 3.45 ± 0.84 and 158.3 ± 42.5 ng/mL, respectively. The maximum values for cotinine were 20.54 ± 9.55 and 108.84 ± 47.02 ng/mL, respectively. The levels of plasma and urinary nicotine and those of urinary cotinine were significantly higher in samples from tobacco harvesters than in those from unexposed controls.

1.5 Regulations

1.5.1 *Framework Convention on Tobacco Control*

The first international tobacco control treaty, the Framework Convention on Tobacco Control (FCTC), was adopted unanimously by the 192 Member States of the World Health Organization in May 2003 and was opened for signature for a 1-year period. At closure, on 29 June 2004, 168 countries had signed the treaty. The Convention entered into force on 27 February 2005, 90 days after it had been acceded to, ratified, accepted and approved by 40 States. The FCTC provides a comprehensive regulatory structure for all forms of tobacco use, including smokeless tobacco (Part 1, Article 1F). Throughout the FCTC, the term 'tobacco products' is used to include specifically smokeless tobacco together with combusted tobacco products. The treaty will lay the legal framework in each country that ratifies the Convention for regulation to restrict or eliminate the use of any form of tobacco and to promote healthy tobacco-free lifestyles (WHO, 2003a).

1.5.2 *Australia and New Zealand*

In 1986, the South Australian Government became the first government in the world to ban smokeless tobacco. The ban subsequently became national in 1991 (Chapman & Wakefield, 2001).

New Zealand has also banned smokeless tobacco (WHO, 1997).

1.5.3 *Europe*

(*a*) *European Union*

Since 2001, smokeless tobacco has been regulated in the European Union under Directive 2001/37/EC, which supercedes Council Directive 89/622/EEC of 13 November 1989 and Directive 92/41/EEC of 15 May 1992 (European Parliament and Council, 2001). Article 2.4 of the 2001 directive defines 'tobacco for oral use' as "… all products for oral use, except those intended to be smoked or chewed, made wholly or partly of tobacco, in powder or in particulate form or in any combination of those forms, particularly those presented in sachet portions or porous sachets, or in a form resembling a food product." Article 8 of Directive 2001/37/EC requires that Member States prohibit the marketing of tobacco for oral use (as defined above), but explicitly exempts Sweden and the EFTA (European Free Trade Association) country Norway. Previously, all snuff packages had to carry the health warning "causes cancer" (Directive 92/41/EEC). This was changed in the 2001 Directive, which requires that smokeless tobacco products carry the following warning: "This tobacco product can damage your health and is addictive". The warning must cover at least 30% of the package.

Manufacturers and importers of tobacco products are required to submit to the Member States, on a yearly basis, a list of all ingredients and quantities thereof used in the manufacture of tobacco products, together with toxicological data on their effects on health and any addictive effects. This list must be accompanied by a statement that sets out the reasons for their inclusion. It must also be made public and be submitted to the Commission on a yearly basis (Article 6).

Texts, names, trade marks and figurative or other signs that suggest that a particular tobacco product is less harmful than others is prohibited on the packaging of tobacco products (Article 7).

(*b*) *Sweden*

Most regulations that govern the marketing and contents of smokeless tobacco in Sweden stem from provisions of the Swedish Tobacco Act. English language text of the provisions of the Swedish Tobacco Act is available through the website of the WHO Regional Office for Europe (WHO EURO, 2004). The Swedish Tobacco Act bans the advertisement of all tobacco products on national television, cable and radio, in local magazines and newspapers and in cinemas. Advertising on billboards, outdoor walls and at the point of sale are not permitted to "be invasive, enticing or encourage use of tobacco". Businesses may not market such products as shoes and clothing if they include a tobacco trademark (brand stretching).

The Swedish Tobacco Act also regulates the contents and packaging of all tobacco products: it requires the manufacturers to list the general ingredients on each package and, in accordance with EU Directive 2001/37/EC, requires a health warning label stating "This tobacco product can damage your health and is addictive". Sales of all tobacco products are restricted to persons aged 18 years and older and merchants are required to request

purchasers to provide proof of age. Guideline No. 7 of the National Board for Consumer Policies prohibits sponsorship of events by tobacco brands.

(*c*) *Norway*

The Norwegian Tobacco Act and regulation on the prohibition of tobacco advertising contains provisions on the marketing of smokeless tobacco. A translation of this legislation is available through the website of the WHO Regional Office for Europe (WHO EURO, 2004). The Norwegian Tobacco Act and above-mentioned regulation bans all forms of advertisement of tobacco products. Tobacco products must not be included in the advertising of other goods and services, and all free distribution of tobacco products is prohibited. Indirect advertising of tobacco products was also forbidden as of 1 January 1996. It is prohibited to produce in or import into Norway new types of product that contain tobacco or nicotine.

The Norwegian Tobacco Act also regulates the contents and packaging of all tobacco products. The provisions require the manufacturer to provide information of the general ingredients on each package. A health warning is also required on smokeless tobacco: "This tobacco product can damage your health and is addictive".

Tobacco products cannot to be sold to persons under 18 years of age.

1.5.4 *North America*

(*a*) *Canada*

The most recent regulations in Canada on information on tobacco products were enacted in June 2000 (Health Canada, 2000, 2001).

These regulations require that every manufacturer of chewing tobacco or oral snuff include one of the following bilingual warnings on every package: (*a*) "THIS PRODUCT IS HIGHLY ADDICTIVE" and "CE PRODUIT CRÉE UNE FORTE DÉPENDANCE"; (*b*) "THIS PRODUCT CAUSES MOUTH DISEASE" and "CE PRODUIT CAUSE DES MALADIES DE LA BOUCHE"; (*c*) "THIS PRODUCT IS NOT A SAFE ALTERNATIVE TO CIGARETTES" and "CE PRODUIT N'EST PAS UN SUBSTITUT SÉCURITAIRE À LA CIGARETTE"; or (*d*) "USE OF THIS PRODUCT CAN CAUSE CANCER" and "L'USAGE DE CE PRODUIT PEUT CAUSER LE CANCER".

Every manufacturer of nasal snuff is required to display one of the following bilingual health warnings on every package: (*a*) "THIS PRODUCT IS NOT A SAFE ALTERNATIVE TO CIGARETTES" and "CE PRODUIT N'EST PAS UN SUBSTITUT SÉCURITAIRE À LA CIGARETTE"; (*b*) "THIS PRODUCT CONTAINS CANCER CAUSING AGENTS" and "CE PRODUIT CONTIENT DES AGENTS CANCÉRIGÈNES"; (*c*) "THIS PRODUCT MAY BE ADDICTIVE" and "CE PRODUIT PEUT CRÉER UNE DÉPENDANCE"; or (*d*) "THIS PRODUCT MAY BE HARMFUL" and "CE PRODUIT PEUT ÊTRE NOCIF".

Every manufacturer of chewing tobacco or snuff is also required to display on every package of chewing tobacco or snuff that they manufacture the mean amount of toxic

constituents (nitrosamines, lead and nicotine) contained in the product, expressed in milligrams, micrograms or nanograms per gram of chewing tobacco or snuff and determined in accordance with the official method set out for that toxic constituent.

(*b*) *USA*

Most of the current federal regulations on the marketing of smokeless tobacco products were adopted as part of the Federal Comprehensive Smokeless Tobacco Health Education Act of 1986 (Public Law 99-252), which was signed into law in February 1986 (DHHS, 1989). The Act requires that one of three warnings be displayed on all packages and advertisements (except billboards) of smokeless tobacco. The three package warnings are: "WARNING: This product may cause mouth cancer; WARNING: This product may cause gum disease and tooth loss; and WARNING: This product is not a safe alternative to cigarettes." It requires that the three package warnings "be randomly displayed…in each 12-month period in as equal a number of times as is possible on each brand of the product and be randomly distributed in all parts of the USA in which such product is marketed." On advertisements, the law requires rotation of each warning every 4 months for each brand. The warnings on advertisements are required to appear in a circle-and-arrow format recommended earlier by the Federal Trade Commission for cigarette warnings. The Act prohibits Federal agencies or State or local jurisdictions from requiring any other health warnings on packages and advertisements (except billboards) of smokeless tobacco. No other Federal, State or local actions were pre-empted by the Act. The Federal Trade Commission issued regulations implementing the law on 4 November 1986.

The Comprehensive Smokeless Tobacco Health Education Act of 1986 also required that the manufacturers, packagers and importers of smokeless tobacco products provide annually a list of additives used in the manufacture of these products to the Secretary of Health and Human Services. The Secretary is required to treat the lists as "trade secret or confidential information", but may report to Congress on research activities concerning the health risks of these additives. However, the Secretary is granted no specific authority to regulate any of the additives. It also required that manufacturers provide to the Secretary of Health and Human Services a specification of the nicotine content of smokeless tobacco products, but it does not require that nicotine content be listed on packages or in advertisements. The list is an amalgamation of all additives used by any manufacturer in any type of smokeless tobacco product and is not brand-specific. It also contains no information on quantity or concentration of these 500 'ingredients' in any product. More recently, manufacturers of smokeless tobacco were required to use a standardized protocol to determine the nicotine concentration, pH and moisture content in all of their smokeless tobacco products and to provide that information annually to the CDC (1999b). Similarly to the information on product additives, however, CDC is prohibited from releasing that information to the public.

The Comprehensive Smokeless Tobacco Health Education Act of 1986 also prohibited the advertisement of smokeless tobacco products on television or radio.

The legal age at which persons can purchase smokeless tobacco in the USA is currently set at the state level. As of 1998, all states and the District of Columbia prohibit the sale of smokeless tobacco products to persons under the age of 18 years (Fishman *et al.*, 1999). In 1992, Congress passed a provision of the 1992 Alcohol, Drug Abuse, and Mental Health Administration Reorganization Act (the 'Synar Amendment') that addressed the access of minors to tobacco products. The final Synar regulation, issued in 1996, requires states to conduct annually random, unannounced inspections on a representative sample of retail tobacco outlets to assess the extent of sales to minors, and to show they have significantly reduced them to specified target levels (Fishman *et al*., 1999). On 23 August 1996, the US Food and Drug Administration issued a regulation to restrict the sale and promotion of cigarettes and smokeless tobacco products to children and adolescents (Kessler *et al*., 1996). The first two provisions of the regulation made it illegal for retailers to sell cigarettes or smokeless tobacco to anyone under the age of 18 years and required that they check the photographic identification of anyone under the age of 27 years. These two provisions went into effect on 28 February 1997 and remained in effect until 21 March 2000, when the US Supreme Court ruled that the Food and Drug Administration lacked the statutory authority to regulate cigarettes and smokeless tobacco (Natanblut *et al*., 2001). While the provision was in effect, compliance checks conducted in 110 000 establishments in 36 states and the District of Columbia found that the rate of sales to minors was higher for smokeless tobacco (38%) than for cigarettes (24%) (Clark *et al*., 2000).

In November 1998, the US Smokeless Tobacco Company, the largest manufacturer of smokeless tobacco products in the USA, reached a legal settlement with attorneys general for 46 states, the District of Columbia and several US territories (National Association of Attorneys General, 1998). This settlement, known as the Smokeless Tobacco Master Settlement Agreement, included a number of provisions that were intended to reduce the promotion and accessibility of smokeless tobacco products to minors. These provisions include: (*a*) the prohibition of the targeting of youths by advertising and promotion; (*b*) a ban on the use of cartoon characters in tobacco advertisements or packaging; (*c*) limitations on tobacco brand name sponsorships, including prohibition of the sponsorship of certain athletic events and concerts; (*d*) the elimination of outdoor advertising and transit advertisements; (*e*) the prohibition of payments related to tobacco products and media, including product placement in motion pictures and television; (*f*) a ban on tobacco brand name merchandise, including clothing; (*g*) a ban on the access of youths to free samples of smokeless tobacco; (*h*) a ban on gifts to under age persons based on proofs of purchase, including coupons; (*i*) limitations of third-party use of smokeless tobacco brand names; (*j*) a ban on the use of nationally recognized or established non-tobacco brand names as the brand name for a tobacco product; (*k*) the prohibition of the provision of tobacco products to sports teams; (*l*) the promulgation or reaffirmation of corporate cultural commitments related to access and consumption of youths, including the identification of an executive level manager to be responsible for identifying methods to reduce the use of tobacco by youths; (*m*) limitations on lobbying, including a prohibition of opposition by the US Smokeless Tobacco company to the passage of state or local legislative proposals

or administrative rules that are intended to reduce access to and use of tobacco products by youths; (*n*) the regulation and oversight of new tobacco-related trade associations; (*o*) the prohibition of agreements to suppress research; and (*p*) the prohibition of material misrepresentations of fact regarding the health consequences of using any tobacco product.

1.5.5 *Asia*

(*a*) *Overview of regulations on tobacco in Asia*

The status of regulations on tobacco products in Asia in 2003 is given in Table 66 (Shafey *et al.*, 2003). Some countries have regulations that are related to tobacco advertisement. In 11 countries, the contents or designs of tobacco advertisements are restricted. While six countries have banned the sponsorship of events by tobacco trans-nationals, no restrictions exist in eight. Sales of tobacco to minors are not regulated in nearly one-third of the countries, and verification of age at the point of sale is not enforced in any Asian country. Other provisions that are not regulated in some countries in the region include sale by minors in 11 countries, free products in 14 countries, misleading information on packaging in 15 countries and brand-stretching in 16 countries. [Brand-stretching is defined as the use of tobacco brand names on non-tobacco merchandise or services.]

Table 66. Status of regulations on tobacco products in Asia, 2003

	Banned	Restricted	Not Regulated	Unknown
Advertisements				
in certain media	18	21	6	5
to certain audiences	16	5	8	21
in certain locations	10	15	13	12
content or design	–	11	7	32
Sponsorship for certain audiences	11	2	16	21
Sponsorship advertising of events	6	2	8	34
Brand-stretching	7	2	16	25
Sales to minors	23	–	16	11
Sales by minors	1	–	11	38
Place of sales	–	10	12	28
Free products	14	3	14	19
Misleading information on packaging	1	–	15	31

Adapted from Shafey *et al.* (2003)
Countries include: Afghanistan, Armenia, Azerbaijan, Bahrain, Bangladesh, Bhutan, Brunei, Cambodia, China, Hong Kong, India, Indonesia, Iran, Iraq, Israel, Japan, Jordan, Kazakhstan, Korea (Democratic People's Republic of and Republic of), Kuwait, Kyrgyzstan, Laos, Lebanon, Malaysia, Maldives, Mongolia, Myanmar, Nepal, Oman, Pakistan, the Philippines, Qatar, Saudi Arabia, Singapore, Sri Lanka, Syria, Taiwan (China), Tajikistan, Thailand, Turkey, Turkmenistan, United Arab Emirates, Uzbekistan, Viet Nam, West Bank and Yemen

Few countries in Asia have comprehensive anti-tobacco laws that are strengthened by key principles such as taxation, advertising bans, smoking restrictions and effective cessation and education programmes. Egypt, Pakistan and Qatar in the WHO Eastern Mediterranean Region (EMRO) adopted tobacco control laws in 2002. In the WHO South-East Asian Region (SEARO) in 2003, only Thailand had a comprehensive tobacco control policy that included smokeless tobacco products (Shafey *et al.*, 2003); India, Myanmar and Sri Lanka have since followed (WHO Tobacco Free Initiative SEARO website). The Bangladesh Act does not cover smokeless tobacco products.

A number of countries in Asia have taken initiatives specifically to control the use of smokeless tobacco (Table 67). The manufacture of all types of smokeless tobacco product is prohibited in Israel, Taiwan (China) and Thailand, while the manufacture of nasal snuff is allowed in Hong Kong (Special Administrative Region) and Singapore. The promotion of smokeless tobacco products is not permitted in Hong Kong, Singapore, Taiwan (China) or Thailand. In addition to these four states, the sale of smokeless tobacco is not allowed in Bahrain, Bhutan, Israel or Turkey. The import of smokeless tobacco products is prohibited in Hong Kong, Iran, Israel, Japan, Kuwait, Saudi Arabia, Singapore, Taiwan (China), Thailand and the United Arab Emirates. Regulations in India, Thailand and Turkey are detailed below.

Table 67. Available information on legislative action to control the use of smokeless tobacco in Asian countries

Country	Year	Manufacture	Promotion	Sale	Import
Bahrain				+	
Bhutan				+	
Hong Kong, SAR	1987	+*	+	+	+
India[a]		+	+		
Iran					+
Israel	1986	+	+	+	+
Japan					+
Kuwait					+
Saudi Arabia	1990				+
Singapore	1987	+*	+	+	+
Taiwan (China)	1990	+	+	+	+
Thailand	1992	+	+	+	+
Turkey				+	
UAE					+

From WHO (1988); Masironi (1992); WHO (1997); World Bank (2000); Ugen (2003)
+, prohibited; *, except for nasal snuff
SAR, Special Administrative Region; UAE, United Arab Emirates
[a] See also Table 68

Bans on spitting are one of the measures that may influence the prevalence of smokeless tobacco use. In Singapore and in Goa, Tamil Nadu and West Bengal in India, spitting is prohibited in public places and in Maharashtra, India, in police stations only (Table 68). However, implementation is poor in India.

(*b*) *India*

Legislation in India began with the promulgation of the Cigarette Act, 1975 (Regulation of Production, Supply and Distribution Act). Following the example of the state of Maharashtra in 1987, some other states (Goa, Delhi) took initiatives to prevent smoking and spitting on government premises and have conducted educational campaigns against tobacco use. In June 1999, Indian railways, which operated 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. Tobacco chewing is prohibited in schools that are run by the Union Government of India.

The Cigarettes and Other Tobacco Products Act, 2003 (Government of India, 2003) prohibits direct advertising in all media and sports sponsorship by tobacco companies. It also prohibits smoking in public places. It disallows the sale of tobacco in any form to persons under 18 years of age and within 100 yards of educational institutions. It also disallows the sale of tobacco in any form by persons under 18 years of age. Clear health warnings in local languages and in English are mandatory on all packages.

Recently, beginning with Tamil Nadu in 2001, banning orders have been issued in several states against the sale, manufacture and storage of *gutka* and, in some states, other forms of chewing tobacco and *pan masala* for a certain period of time (Gupta, 2001; Gupta & Ray, 2002). The production, sale, storage, distribution and use of smokeless tobacco products have been banned in Bihar, Andhra Pradesh, Goa, West Bengal, Tamil Nadu, Kerala, Maharashtra and Rajasthan (Table 68), but opposition by industry through the courts has forced these states to modify the ban or postpone its implementation until the Supreme Court reaches a decision.

Unmanufactured tobacco that does not bear any brand name and is used mainly for chewing is exempt from excise duty. Chewing tobacco and snuff that have a brand name are subject to 50% ad-valorem excise duty. Until 1994–95, chewing tobacco with a brand name was taxed (basic and additional excise duty tax) at 40% (Government of India, 2001; Reddy & Gupta, 2004).

(*c*) *Thailand*

Thailand has been a leader in formulating comprehensive control of tobacco, including smokeless tobacco. In 1992, the Tobacco Products Control Act B.E. 2535 was enacted with provisions to: prohibit the sale of tobacco products to persons under 18 years of age; prohibit sale promotions, e.g. exchanges, additions, offers to attend games or shows free of charge, or services to buyers or persons returning tobacco products for exchange or redemption; prohibit free samples; prohibit advertisement in all media except live broadcasts from abroad and foreign publications; prohibit the manufacture, import and advertise-

Table 68. Regulation of smokeless tobacco products in selected states in India

State	Year	Period in years	Products[a]	Production	Sale	Storage	Distribution	Use	Spitting	Advertising	Reference
India	2003		3	+	+[b]		+			+	Government of India (2003)
Andhra Pradesh	2002		3	+	+	+	+	+			Government of Andhra Pradesh (2002)
Bihar	2003	5	1	+	+	+	+				Government of Bihar (2003)
Goa	2003			+	+	+	+	–	+		Government of Goa (2003)
Kerala	1999			+	+	+					Government of Kerala (1999)
Maharashtra	2002	5	1	+	+	+			+[c]		Goverment of Maharashtra (2002)
Rajasthan	1950		2	–	+[d]	–		–	–	–	Government of Rajasthan (1950)
Tamil Nadu	2001	5	3	+	+[b]	+			+		Government of Tamil Nadu (2003)
West Bengal	2001		3	–	+[b]	+	+		+	+	Government of West Bengal (2001)

+, banned; –, unrestricted

[a] 1, *gutka*, *pan masala* with and without tobacco; 2, any smokeless tobacco product; 3, chewing tobacco

[b] Minors < 18 years of age

[c] In police stations only

[d] Minors < 16 years of age

ment of goods that imitate tobacco products and their packages. In Section 11, the composition of tobacco products must be in accordance with Ministerial Rules; and in Section 12, the packages of tobacco products must exhibit labels in accordance with the Ministerial Announcement. The Ministerial Rule pursuant to Section 11 was passed and became effective on 1 February 1997. This rule mandates manufacturers to disclose the ingredients of every brand of their products to the Ministry of Public Health. The Ministerial Announcements persuant to Section 12 were passed and became effective on 25 September 1993, and another announcement became effective on 16 October 1997 (WHO SEARO, 2004).

(*d*) *Turkey*

A strong anti-tobacco law (No. 4207) was enacted in Turkey in 1996. Sales of smokeless tobacco are banned, as is the advertisement of tobacco on radio and television and in government buildings. However, advertising is permitted in print media. Indirect advertising (using tobacco or tobacco products and their brand names) and any tobacco campaign that will promote and motivate the use of tobacco or tobacco products are banned. Restrictions on the access of minors to tobacco products were strengthened by increasing the minimum age at which tobacco or tobacco products may be bought to 18 years. Turkish radio and television and private television channels have to broadcast on the harmful effects of the use of tobacco and its products for at least 90 min per month (World Bank, 2000).

1.5.6 *Africa*

(*a*) *Comprehensive anti-tobacco laws*

Botswana, Mali, Mauritius and South Africa have comprehensive anti-tobacco laws that are based on key principles such as taxation, advertising bans, smoking restrictions, and effective cessation and education programmes (Shafey *et al*., 2003).

(*b*) *Tobacco advertisements in certain media*

Only a few countries, namely Algeria, Cape Verde, Libya, Morocco, Mozambique, Niger, South Africa, Sudan and Tunisia, have banned tobacco advertising in certain media. This represents 16.6% of the 54 African countries (Shafey *et al.*, 2003). In Algeria, advertising of tobacco has been banned since 1985. In Egypt, a complete ban on television and radio advertisements for tobacco has been in force since 1977 (WHO, 1997).

In 27 (58.7%) of the 46 countries in the WHO African Region, the contents or designs of tobacco advertisements are not regulated. While three countries (6.5%) have banned the sponsorship of events by tobacco trans-nationals, no restrictions have been imposed in 29 (63%) (Shafey *et al.*, 2003).

(*c*) *Other provisions*

Other provisions that are not regulated in a majority of countries in Africa include sale by minors in 32 countries (70%), sales of tobacco to minors in 29 countries (63%) (verification of age at the point of sale is not enforced in any African country), free products in 31 countries (67.3%), brand-stretching in 27 countries (58.7%), misleading information on packaging in 32 countries (70%), place of sale in 31 countries (67%), health warnings and messages in 25 countries (54.3%) and the indication of the amount of contents or constituents other than tar and nicotine on packaging in 32 countries (69%) (Shafey *et al.*, 2003).

In Uganda, excise tax on tobacco use was increased by 45% in 1993 (WHO, 1997).

None of the African countries is known to have constituted a National Tobacco Control Committee, none requires constituent disclosures for public or confidential use and none has provisions to enable litigation or measures to reduce the smuggling of tobacco.