

Toombak Use and Cigarette Smoking in the Sudan: Estimates of Prevalence in the Nile State

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Background. Survey data on the prevalence of use of oral snuff (toombak) and cigarette consumption according to various demographic factors are needed in the Sudan.

Methods. A house to house cross-sectional survey of a random population sample of 4,535 households was performed. Of the 23,367 household members identified, 21,648 (92.6%) eligible individuals were questioned about tobacco use.

Results. Among children and adolescents (4-17 years) prevalence of tobacco use was quite low (2%, range 1-2%), but there was an abrupt increase up to 25% in late adolescence. Among the adult population aged 18 years and older the prevalences of toombak use (34%) and cigarette smoking (12%) among males were significantly higher than among females (2.5 and 0.9%, respectively). The prevalence of toombak use among the male population aged 18 years and older was significantly higher in the rural than in the urban areas (35% vs 24%), while cigarette smoking had a higher prevalence in urban areas (18% vs 12%). The highest rates of toombak use were found in rural areas among the male population ages 30 years and older (mean 46.6%, range 45-47%).

Conclusions. In view of the high prevalence of tobacco use, especially of toombak, among the population surveyed, there is an urgent need to educate the public on the health consequences of these habits.

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Key Words: cigarette smoking; epidemiology; oral snuff; tobacco; toombak.

INTRODUCTION

A causal association between use of smokeless tobacco and oral cancer has been documented by studies from Western and Asiatic countries [1,2]. Oral snuff use has also been shown to be etiologically linked with cancers of the esophagus, pancreas, kidney, and urinary bladder [1,2] and with the etiology of dental caries, tooth abrasion, periodontal disease, and gingival recession, leading to tooth loss [3-5]. Tobacco, in oral snuff form, is locally called toombak—a mixture of tobacco powder and sodium bicarbonate—and is used widely in the Sudan. Clinical and epidemiological studies have indicated an etiologic association between toombak use and oral cancer [6-9]. Chemical analyses of toombak and of saliva of toombak users have revealed unusually high levels of tobacco carcinogens, in particular the tobacco-specific *N*-nitrosamines, compared with other forms of smokeless tobacco [10-12]. Experimental studies have shown that these tobacco carcinogens cause cancer in animals [13,14]. Since its introduction 400 years ago, toombak has played an important role in the life of the Sudanese people but national figures of toombak use or of cigarette smoking are unknown. The aim of the present study was to provide a comprehensive evaluation of the prevalence of toombak use and cigarette smoking for the Nile State of the Sudan; along with the specific aim of providing data for the design of intervention programs.

Most published studies on the use of tobacco in developing countries have been either hospital based or drawn from convenience samples and are limited to small data bases. The novelty of this study is that the study population described here was drawn from a random sample of inhabitants in the Nile province of the Sudan and involves over 20,000 interviews conducted under the auspices of an international collaboration.

A preliminary report based on a smaller sample of

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by systematic random sampling with a probability proportional to their size. The method allowed equal probability of any village or town being included in the survey (Appendix). Then at the second stage, from each town or village a sample of residential wards, *ahia sakania*, were selected with a probability proportional to their total number of households.

The selection of the target households in a residential ward was completed in the field by systematic random choice of occupied households using the ration distribution lists, which were available in all towns and villages. These lists contained a comprehensive list of all households. The method allowed equal probability of any household of a randomly selected town or village being included in the survey. Substitution up to 10% was made in permanent and seminomadic villages to cater for loss due to mobility to towns. In a sampled household all occupants over the age of 4 years represented the target household sample. Toombak use or cigarette smoking was defined as self-reported daily use of these products. No attempt was made to validate usage of tobacco and self-reported use was considered to represent pattern of use. The project was approved by the Federal and the State Ministries of Health. The purpose of the study was explained to the subjects and the community representatives and assurance of participation in the study was established.

Instruments

Using direct interviews, data were collected by trained personnel; the chosen occupied households in residential wards were visited by field personnel to carry out the interviews. A household questionnaire in Arabic language was used to list information, including geographical location of residence, age, and gender. Information on toombak use and cigarette smoking was collected from all members of the household age 4 years or older. The men, women, and children were interviewed in the presence of their co-inhabitants, spouses, and parents in a community setting. If the visit made by field personnel to a named household was unproductive (occupants were not present) after two attempts, then the household was replaced by a substitute household previously selected by the same method from the substitution list.

Statistical Methods

Data were examined through the use of frequency, cross-tabulations, and comparison of means. The χ^2 test (by the Mantel-Haenzel procedure) was used to determine if significant gender and geographic location of residence differences exist for tobacco use. The *t* test was performed to examine the differences in tobacco use in relation to age and gender.

RESULTS

The Study Population

Of the 104,416 total households in the Nile State, a sample of 5,000 households was selected; 1,310 (32%) were urban and 3,690 (68%) were rural. A preliminary report was published in 1994, but it included only a smaller sample of the study, 2,868 males [7]. In the present study, 4,535 (90.7%) households comprising 23,367 identified residents were visited. Persons below the age of 4 years (1,685) were considered not eligible for questioning about tobacco habits, thus, 21,648 individuals were interviewed: 34 subjects had missing values, and a complete data set on all parameters was available on 21,594 individuals. Of these, 11,068 (51.3%) were males, 10,526 (48.7%) were females. The Census department advised that the nomadic population should be excluded because they could not be located during the period of the survey.

Consumption of Tobacco

In 60% of all households at least one member used toombak, whereas in 30% of these households at least one member smoked cigarettes. The prevalences of toombak use and cigarette smoking in the entire population of age 4 years or older were 12.6 and 6.6%, respectively.

Age and Gender

Significant differences were found in prevalences of toombak use and of cigarette smoking by age and gender. A significantly higher proportion of males than females were toombak users (23.0% vs 1.7%; $\chi^2 = 2,218$, $P < 0.0001$). Similarly, cigarette smoking was also significantly higher among males (12.1% vs 0.7%; $\chi^2 = 1,136.4$, $P < 0.0001$) compared with females. Tobacco consumption was almost nonexistent among females and therefore in this report our analysis in detail is limited to male respondents. The age-specific prevalences for toombak use and cigarette smoking among males are summarized in Table 1. The results showed an overall significantly low prevalence for toombak use (1.7% vs 34.1%; $\chi^2 = 1,482$, $P < 0.0001$) among children and adolescents (4–17 years) compared with adults. Toombak use among the 18- to 29-year-old group was significantly lower than among the older adults (24.7% vs 40.7%; $\chi^2 = 199.6$, $P < 0.0001$). The highest rates of toombak use were reported in the oldest age group, 70 years or older (47.0%). Similarly, the prevalence of cigarette smoking was low among children and adolescents (4–17 years) compared with adults (0.7% vs 11.9%). Among the adults prevalence was lowest in the 18–29 age group (12.9%) and greatest in the 30–39 age group (25%). The prevalence declined from the age of 40 years upward.

TABLE 1

Use of Toombak and Cigarettes among Males

Age	No.	Toombak (%)	Cigarettes (%)	Both (%)
4-17	3,795	1.7	0.7	0.3
18-19	556	11.3	1.7	1.8
20-21	587	20.6	7.2	2.7
22-29	1,836	30	17.4	6.2
30-39	1,533	39.3	25.0	11.5
40-49	1,065	40.2	22.1	8.7
50-59	773	41.4	20.8	8.9
60-69	587	40.9	16.9	7.0
70-79	336	47.0	15.5	8.9
18+	7,273	34.1	11.9	8.4
All	11,068	23.0	12.1	5.5
Rural				
4-17	2,728	1.9	0.8	0.4
18-19	349	16.0	5.4	2.6
20-21	391	26.1	76.9	3.3
22-29	1,236	32.5	17	9.2
30-39	981	45.9	23.9	11.5
40-49	679	47.0	21.9	8.7
50-59	495	47.1	21.4	8.9
60-69	386	45.3	17.1	7.0
70-79	269	47.0	15.5	8.9
18+	4,786	35.4	11.9	9.0
All	7,514	23.0	12.1	5.5
Urban				
4-17	1,067	1.0	0.4	0.1
18-19	207	3.4	1.9	0.5
20-21	196	9.7	7.7	1.5
22-29	600	19.0	10.8	6.2
30-39	552	27.5	27.0	8.7
40-49	386	28.2	22.3	6.7
50-59	278	31.3	19.8	6.5
60-69	201	32.3	16.4	8.0
70-79	67	46.3	17.9	9.0
18+	2,487	23.5	17.9	6.3
All	3,554	16.7	12.6	4.4

Among females the prevalence rates of toombak use and cigarette smoking were low compared with males (Table 2). The rates of toombak use by age groups were 4-17 years (0.2%), 18-29 years (0.9%), 30-39 years (1.7%), 40-49 years (4.0%), 50-59 years (5.0%), 60-69 years (7.7%), 70 or older (14.0%), while the rates for cigarette smoking by age group were 4-17 years (0.2%),

TABLE 3

Risk of Adopting Tobacco Habit by Age among Males and Females

Age	Gender	Toombak odds ratio	Cigarettes odds ratio
4-17	M	1.04 (2.02-0.54)	0.95 (2.92-0.31)
	F	2.28 (13.65-0.38)	0.00
18-29	M	1.30 (1.62-1.04)	1.49 (1.49-0.85)
	F	0.58 (1.8-0.19)	1.45 (4.78-0.44)
30-39	M	1.22 (1.55-0.97)	0.88 (1.15-0.67)
	F	0.34 (1.02-0.12)	0.25 (1.12-0.06)
40-49	M	1.35 (1.75-1.04)	0.85 (1.17-0.62)
	F	0.83 (1.64-0.42)	1.69 (5.27-0.54)
50-59	M	1.07 (1.45-0.79)	0.98 (1.41-0.68)
	F	0.39 (1.04-0.79)	1.70 (5.13-0.56)
60-69	M	1.06 (1.5-0.75)	1.53 (2.40-0.97)
	F	1.94 (4.75-0.75)	0.00
70+	M	0.87 (1.37-0.56)	0.81 (1.53-0.43)
	F	1.84 (4.57-0.74)	0.00

18-29 years (0.6%), 30-39 years (1.0%), 40-49 years (1.3%), 50-59 years (2.2%), 60-69 years (1.5%), 70 or older (3.5%).

In our sample, adult males are significantly older than adult females (mean 27.9 vs 25.6, $P < 0.0001$), whereas the mean age for prevalence of toombak use among males compared with females (39.6 vs 45.3 years) was significantly lower ($t = 4.59$, $P < 0.0001$, 95% CI 3.3-8.2). Like among males, prevalence of toombak use among females increased as age increased, while the prevalence of cigarette smoking among females was not so closely related to age. The highest odds ratio for toombak use among males was seen in the 30-49 age groups (Table 3).

Urban vs Rural

The prevalence of toombak use among the male population aged 18 years and older was significantly higher in the rural than in the urban areas (35% vs 24%), while cigarette smoking had a higher prevalence in urban areas (18% vs 12%). The highest rates of toombak use were found in rural areas among the male population aged 30 years and older (mean 46.6%; range 45-47%).

TABLE 2

Use of Toombak and Cigarettes by Sex for Urban and Rural Populations

	Urban		Rural		All	
	Male ($n = 3,554$) (%)	Female ($n = 3,294$) (%)	Male ($n = 7,514$) (%)	Female ($n = 7,232$) (%)	Male ($n = 11,068$) (%)	Female ($n = 10,526$) (%)
Toombak	16.7	2.3	23.0	1.0	23.0	1.7
Cigarettes	12.6	0.8	12.1	0.3	12.1	0.7
Both	4.4	0.3	5.5	0.3	5.5	0.3

Mantel-Haenzel analyses were conducted to determine the age-adjusted risk of being a toombak user in urban vs rural areas of residence. Among children and adolescents (4–17 years), the risk of adopting the habit of toombak use was more prevalent in the rural areas than in the urban areas (1.9% vs 1.0%). In both rural and urban populations, toombak use continued to rise with increasing age. The peak of the prevalence of toombak use in the male rural population (47%) came around 40 years of age with a significantly lower level (28%) in the urban population at this age.

Adult rural populations 18 years and older had twice the risk of being toombak users compared with urban populations, and the difference was statistically significant (prevalence ratio 2.14; 95% CI 1.93–2.39). The risk of being a cigarette smoker was slightly higher in urban compared with rural populations but the difference was not statistically significant (prevalence ratio 1.02; 95% CI 0.90–1.16).

The tendency of being a user of toombak was well established in early adulthood (Table 1) and increased with increasing age and was significantly ($\chi^2 = 107.7$; $P < 0.0001$) higher in rural than in urban populations (prevalence, 20.5% vs 12.3%) (prevalence ratio 1.8, 95% CI 1.63–2.05). The tendency of being an exclusive cigarette smoker or regular user of both products was lower than that for exclusive toombak use. In both the urban and the rural populations cigarette smoking was less prevalent than toombak use (Table 2).

DISCUSSION

This study presents the findings of the full-scale survey of the prevalence of tobacco usage in the Nile State. It was the first endeavor to provide the most reliable and valid information for the whole of the Nile State on the prevalence of tobacco use. The study is part of an ongoing health program in the Sudan aiming to establish the prevalence of tobacco use on a state-by-state basis for the country.

The study clearly documented that the prevalence of toombak use was as high as 12.6% in the entire population of the Nile State (age 4+ years). This prevalence was sevenfold higher than the estimates suggested previously [6] and was at least twofold higher than any reported rates of oral snuff use from high-prevalence areas in North America, Sweden, Norway, Nigeria, and South Africa [17–24]. Nasal snuff as practiced in the United States, Europe, and some areas in Africa [1,2] and the practice of chewing tobacco as found in Asia [1] and the United States were not seen in the study area. In Nigeria, a prevalence study has shown that use of oral snuff was only 1/4 of the prevalence recorded in our study [24].

The prevalence of cigarette smoking in the entire population of the Nile State was far lower than toombak

use. History and cultural heritage indicate that toombak was introduced to the Sudan 400 years ago, while cigarette smoking was rare before 1940 and consequently is not a deep-rooted characteristic of the people of the Sudan. Cigarette smoking was, however, more popular in the 1950s and 1960s. In the 1970s through 1990s, along with the rise in cigarette prices, the use of toombak increased and toombak manufacturers began to advertise and promote this product by opening shops specializing in sales of particular brands of toombak. This has resulted in the lower rates of cigarette consumption and the high rates of toombak use found in the present study.

Toombak use and cigarette smoking were confined almost exclusively to males. Little is known about factors that contribute to this gender difference. Some of the differences found might reflect underreporting by females, since it is generally accepted by the people of the Sudan that females tend to deny these habits while use of these products by males is perceived as more socially acceptable. However, a male dominance of oral use of tobacco has also been reported from the United States and Sweden [1,2]. In Southern parts of the United States, however, elderly women indulge extensively in the habit of oral snuff use [25].

Among males toombak use showed an evident positive age gradient, with low prevalence before the age of 17 years. This pattern of use is similar to the evolution of use of smokeless tobacco in the United States. At the turn of the century smokeless tobacco use in the United States was particularly high among persons over the age of 50 years [17]. This positive age gradient of use smokeless tobacco in the United States was replaced in recent years by an inverse gradient as in other countries [18–24]. The age profile of the prevalence of toombak use in the Sudan provides a good opportunity for preventive action.

The higher prevalence of toombak use in the rural than in the urban areas probably reflects lower socioeconomic status, as well as a reduced influence of western culture on smoking habits and the strength of the traditional cultural practices of the rural population. The continued toombak use until old age, the high nicotine content, and the use of natron (sodium bicarbonate) in its processing all suggest that toombak is a highly addictive substance [10]. The relatively low prices of toombak together with a high availability of the product make preventive measures very important.

In addition to the high prevalence of toombak use, a substantial number of people used toombak as well as smoked cigarettes throughout their adulthood. The health implications of this exposure can be tremendous. Lack of relevant data, however, has made it difficult to correlate toombak use and cigarette smoking patterns

with related morbidity and mortality in the Sudan. Nevertheless, the highest rates of buccal cancers in a non-Asiatic country have been reported from the Sudan [8] and an etiological association with toombak use has been documented [9]. In previous retrospective studies [4] and in biopsies taken from subjects from this study [26] squamous cell carcinoma and keratotic mucosal lesions were found mainly at the sites of toombak placement. Ongoing projects in our group are examining further this relationship between toombak use and the development of oral precancer and cancer. We have shown that toombak contains extraordinarily high levels of carcinogens, in particular the tobacco-specific nitrosamines, compared with other forms of snuff used in western countries [10, 11]. The levels of these carcinogens are much higher in toombak than in any previously reported type of snuff [10]. We have also demonstrated unusually high levels of TSNA in saliva of toombak users [11]. High risk for neoplastic changes in the oral mucosa is therefore a possible consequence of the prolonged use in the study areas. The high prevalence of toombak use among the Sudanese and high levels of carcinogenic TSNA in toombak emphasize the major health risk associated with toombak use in the Sudan. Public awareness should be increased, and health education and other active measures to curb the habit especially among children should be encouraged.

APPENDIX

Toombak Use and Cigarette Smoking in the Nile State of the Sudan: Population Studied

Total households	104,416	
Urban households	27,108	(26.0%)
Rural households	77,308	(74.0%)
Total households selected	5,000	(4.8%)
Urban households selected	1,310	(4.8%)
Rural households selected	3,690	(4.8%)
Households visited	4,535	(90.7%)
Subjects in households visited	23,367	
Subjects interviewed	21,648	(92.6%)
Informative cases	21,594	(92.4%)
Males interviewed	11,068	(51.3%)
Females interviewed	10,526	(48.7%)
Household use of tobacco ³		
Toombak	2,721	(60%)
Cigarettes	1,360	(30%)
Toombak use reported		
Males	2,545	(23.0%)
Females	181	(1.7%)
Smoking reported		
Males	1,339	(12.1%)
Females	77	(0.7%)

ACKNOWLEDGMENTS

We thank Mr. I. Abbas and Mr. E. Suliaman of the Census Office, Department of Statistics, Ministry of Economic and National Planning, Sudan for their help in the sampling procedures. We gratefully

acknowledge the University of Khartoum, NUFU, Ministry of Foreign Affairs, and the University of Bergen, Norway, for financial support (Grant NUFU Pro 51/91).

REFERENCES

1. International Agency for Research on Cancer. In: IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: tobacco habits other than smoking: betel quid and areca nut chewing and some related nitrosamines. Lyon: IARC, 1985;37:37-136.
2. U.S. Department of Health and Human Services. The health consequences of using smokeless tobacco: A report of the advisory committee to the Surgeon General. Washington: U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, National Cancer Institute, 1986. [DHHS Publication No. (NIH) 86-2874]
3. Hirsch JM, Livian G, Edward S, Noren JG. Tobacco habits among teenagers in the city of Goteborg, Sweden, and possible association with dental caries. *Swed Dent J* 1991;15:117-23.
4. Jette AM, Feldman HA, Tennstedt SI. Tobacco use: a modifiable risk factor for dental disease among the elderly. *Am J Public Health* 1993;83:1272-6.
5. Ekfeldt A, Hugoson A, Bergendal T, Helkimo MI. An individual tooth wear index and an analysis of factors correlated to incisal and occlusal wear in an adult Swedish population. *Acta Odontol Scand* 1990;48:343-9.
6. El-Beshir EI, Abeen HA, Idris AM, Abbas K. Snuff dipping and oral cancer in the Sudan: a retrospective study. *Br J Oral Maxillofac Surg* 1989;27:243-8.
7. Idris AM, Prokopszyk B, Hoffmann D. Toombak: a major risk for cancer of the oral cavity in the Sudan. *Prev Med* 1994;23:832-9.
8. Idris AM, Ahmed HM, Mukhtar BI, Gadir AF, El-Besheir EL. Descriptive epidemiology of oral neoplasms in the Sudan, 1970-1985, and the role of toombak. *Int J Cancer* 1995;61:155-8.
9. Idris AM, Ahmed HM, Malik MOA. Toombak dipping and cancer of the oral cavity in the Sudan: a case control study. *Int J Cancer* 1995;63:481-5.
10. Idris AM, Nair J, Oshima H, Friesen M, Bronet I, Faustman EM, Bartsch H. Unusually high levels of carcinogenic tobacco-specific nitrosamines in the Sudan snuff (toombak). *Carcinogenesis* 1995;12:1115-8.
11. Idris AM, Nair J, Oshima H, Friesen M, Bronet I, Faustman EM, Bartsch H. Carcinogenic tobacco-specific nitrosamines are present in unusually high levels in the saliva of oral snuff users in the Sudan. *Carcinogenesis* 1992;13:1001-5.
12. Prokopszyk B, Wu M, Amin S, Desai D, Idris AM, Hoffmann D. Improved methodology for the quantitative assessment of tobacco-specific nitrosamines by supercritical fluid extraction. *J Agric Food Chem* 1995;43:916-22.
13. Hoffmann D, Castonguay A, Rivenson A, Hecht SS. Comparative carcinogenicity and metabolism of 4-(methyl nitrosamino)-1-(3-pyridyl)-1-butanone in hamsters. *Cancer Res* 1981;1:2386-91.
14. Hecht SS, Rivenson A, Braley J, Dibello J, Adms JD, Hoffmann D. Induction of oral cavity tumours in F344 rats by tobacco-specific nitrosamines and snuff. *Cancer Res* 1986;46:4162-6.
15. Sudan Institute for Resources Development. Sudan demographic health survey. Maryland: Macro International, 1991:5-7.
16. Cockran WG. Sampling techniques. New York: Wiley, 1991: Chaps. 10 and 11.
17. Marcus AC, Crane LA, Shopland DR, Lynn WR. Use of smokeless tobacco in the United States: recent estimates from the population survey. *Natl Cancer Inst Monogr* 1989;8:17-23.

³ At least one person used tobacco products.

18. Morstad H, Axell T, Sundstrom B. Clinical picture of snuff dipper's lesions in Sweden. *Community Dent Oral Epidemiol* 1989; 17:97-101.
19. Peterson JS, Barreto LA, Brunnemann KD. Smokeless tobacco: a product for the new generation of tobacco users. Dipping and chewing in the Northwest Territories, Canada, and its global relevance. *Arctic Med Res* 1990;49:32-8.
20. Hoover J, Mcdermott R, Hartsfield T. The prevalence of smokeless tobacco use in native children in northern Saskatchewan, Canada. *Can J Public Health* 1990;81:350-2.
21. Millar WJ. Smokeless tobacco use by youth in the Canadian Arctic. *Arctic Med Res* 1990;49:39-47.
22. Schei E, Fonnebo V, Aaro LE. Use of smokeless tobacco among conscripts: a cross-sectional study of Norwegian army conscripts. *Prev Med* 1990;19:667-74.
23. Schei E. Tobacco habits, lifestyle, and reactions to smoking restrictions among Norwegian military officers. *Mil Med* 1992; 157:636-40.
24. Obot IS. The tobacco use products among Nigerian adults: a general population survey. *Drug Alcohol Depend* 1990;26:203-8.
25. Winn DM, Blot WJ, Shy CM, Pickle LW, Toledo A, Fraumeni JF Jr. Snuff dipping and oral cancer among women in the southern United States. *N Engl J Med* 1981;304:745-9.
26. Idris AM, Warnakulsuriya KAAS, Ibrahim YE, Nilsen R, Cooper D, Johnson NW. Toombak associated oral mucosal lesions in Sudanese show a low prevalence of oral dysplasia. *J Oral Pathol Med* 1996;25:239-44.