

# Epidemiological association between osteoporosis and combined smoking and use of snuff among South African women

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## Abstract

**Objectives:** This study sought to explore the epidemiological association between the exclusive use and the combined use of snuff and smoking on the prevalence of osteoporosis in a national population sample of South African women who were 40 years and older.

**Materials and Methods:** This study involved a nationally representative sample of South African women who were 40 years and older and took part in the 2003/2004 South African Demographic and Health Survey ( $n = 2050$ ). Data on tobacco use patterns, dietary calcium intake and other relevant factors were obtained through an interviewer-administered questionnaire. As part of the data collection procedure, participants were asked whether a doctor, a nurse or any other health professional had ever told them they had osteoporosis. Those who answered in the affirmative and/or presented medications for osteoporosis were regarded as having osteoporosis.

**Results:** The prevalence of osteoporosis was higher among those who had ever used both snuff and smoked (17.2%) either in the past or currently than among those who had ever used snuff only (5%) or smoked only (5.1%). Even after controlling for potential confounders in a multivariable-adjusted logistic regression, the combined use of snuff and smoking remained positively associated with osteoporosis (odds ratio = 3.60, 95% confidence interval: 1.03-12.61). However, higher dietary calcium intake was negatively associated with osteoporosis.

**Conclusions:** Based on these findings, it can be concluded that the combined lifetime use of both snuff and cigarettes may increase the odds of developing osteoporosis among women who are 40 years and older.

**Key words:** Cigarette, nicotine, osteoporosis, snuff, South Africa

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## Introduction

Osteoporosis is most common among postmenopausal women. It is associated with significant morbidity and even mortality.<sup>[1]</sup> In addition to the known risk factors for osteoporosis,<sup>[2]</sup> a number of studies have associated exposure to tobacco smoke, including second-hand smoke, with low bone mineral density and thus increased risk for osteoporosis.<sup>[3,4]</sup> However, a recent review suggests that the evidence on the role of smoking on low bone mass

density remains inconclusive.<sup>[2]</sup> One study in the US has demonstrated smokeless tobacco or snuff use as a risk for osteoporosis, with a stronger effect demonstrated among former snuff users than among current snuff users.<sup>[1]</sup>

The association between tobacco use and osteoporosis has been partly attributed to the effect of nicotine.<sup>[3]</sup> Nicotine has been suggested to have an anti-estrogenic effect,

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especially in females, which could lead to early menopause and osteoporosis in smokers.<sup>[3]</sup>

Despite the fact that snuff use is more common than smoking in the majority of women in the South African population (notably among black African women)<sup>[5]</sup> and that the nicotine delivery capacity of common snuff products in South Africa has been reported to be relatively higher than that of most commercial brands elsewhere,<sup>[6]</sup> no prior study has investigated the role of snuff use as a risk to bone health in this population. Considering the recent promotion of smokeless tobacco use in both high-income and low and middle income countries (including in Nigeria and South Africa) as a safer alternative to smoking tobacco or as an aid to smoking cessation<sup>[7]</sup> and the potential for such a strategy to result in dual use of snuff and cigarettes,<sup>[8]</sup> the present study sought to explore the association between the exclusive use and combined use of smoked and smokeless tobacco products on the prevalence of osteoporosis in a national population sample of South African women who were aged 40 years and older.

## Materials and Methods

### Data source and study design

Data for this study were obtained from women who were 40 years and older ( $n = 2,050$ ) and who participated in the South African Demographic and Health Survey (SADHS 2003)<sup>[9]</sup> conducted between October 2003 and August 2004. The details of the sampling procedure used in the SADHS have been previously published.<sup>[5]</sup> Briefly, SADHS 2003 was a nationally representative, cross-sectional household survey. It used a stratified, two-staged, probability sample design. The first stage involved selecting census enumerating areas as the primary sampling units, with a probability proportional to size, based on the number of households in the enumeration areas. The second stage involved a systematic sampling of households from the selected enumeration areas. The data consist of 10 strata, one for each of the nine provinces, with 1,000 households allocated to each stratum. An additional stratum was selected in order to cover sample areas with predominantly Indian/Asian households because of the small percentage ( $\leq 3\%$ ) of this group in the South African population.

### Data collection procedure and measures

Trained fieldworkers administered the questionnaires, which were prepared in all of South Africa's 11 official languages. A self-rated general health assessment of respondents was done by asking the following question: "Would you say your health is poor, average, good or very good/excellent?" Consistent with the World Health Organization step wise approach to chronic disease risk factor surveillance,<sup>[10]</sup> the study participants were also asked whether a doctor or nurse or any other kind of health worker had ever told them they

had osteoporosis. Those who answered "yes" and/or presented their medication for osteoporosis when asked about any use of medication were categorized as having osteoporosis. The body mass index was calculated based on a duplicate measurement of the height and weight of each of the study participants.

The respondents who claimed that they currently smoked daily were asked about the number of cigarettes they smoked daily. Similarly, those who indicated that they currently used snuff daily were also asked about the frequency of their daily use of snuff. The study participants were then asked whether in the past, they had smoked daily and had used any snuff products. Those who responded in the affirmative to their current and past use of either tobacco products were classified as "ever users."

Considering the well-established relationship between osteoporosis and body calcium,<sup>[11]</sup> calcium and other micronutrient intake was assessed by means of a 30-item food frequency questionnaire as part of the nutritional index developed for South Africa.<sup>[12]</sup> Each of the participants' asset index, which was computed based on principal component analysis of the responses to questions on ownership of certain household items, was used to assess socio-economic status (Cronbach alpha = 0.73). In particular, the survey respondents were asked whether they had any of the following household items in a working condition: A radio, television, computer, refrigerator, landline telephone and/or a cell-phone. Those who answered in the affirmative were scored as "1." Otherwise, a "0" was assigned. The total scores were auto ranked into three socio-economic categories, namely those in the lowest, middle and highest tertiles. The respondents were also asked to indicate the highest level of education completed.

### Data analysis

In order to account for selection probabilities and the complex sample design used in the SADHS 2003, weight adjustments were made and the data analysis was performed in a survey mode using the "svy" command in STATA version 10 (Stata Corporation, College Station, Texas, USA). Descriptive statistics were carried out to summarize the data as prevalence rates (%). Multiple logistic regression was performed to determine the independent association between "ever tobacco use" (exclusive and combined) and osteoporosis after controlling for potential confounders such as participants' socio-economic status and calcium intake. The estimated daily dietary calcium intake was a continuous variable with a non-normal distribution; hence, it was log-transformed to approximate normality. All statistical analysis was two-tailed and the level of significance was set at  $P < 0.05$ .

## Results

Of the study respondents, 67.2% ( $n = 1269$ ) had never used any form of tobacco, 15.7% ( $n = 320$ ) had used only

snuff, 15.1% ( $n = 346$ ) had smoked cigarettes only and 2% ( $n = 35$ ) had both smoked cigarettes and used snuff in the past or were doing so at the time of the survey.

Among all the respondents who had ever used tobacco, the prevalence of osteoporosis was highest among those who had ever used snuff and smoked. The mean frequency of the daily use of smokeless tobacco was 5.1 (95% confidence interval [CI]: 4.6-5.6) while the average number of cigarettes smoked per day was 6.2 (95% CI: 5.4-7.1). The prevalence of osteoporosis was the highest among Whites, those who did not complete high school and those in the highest socio-economic class tertile [Table 1].

Compared to never tobacco users, only the ever use of both snuff and cigarette smoking in the past or currently was significantly associated with osteoporosis (odds ratio (OR) = 3.60, 95% CI: 1.03-12.61) [Table 2].

Higher daily dietary calcium intake was negatively associated with osteoporosis (OR = 0.75; 95% CI: 0.59-0.95). Furthermore, compared with the respondents who self-reported poor general health, those who self-reported that they had good or excellent health were less likely to have osteoporosis.

**Table 1: Prevalence of osteoporosis relative to socio-demographic characteristics and tobacco use**

Characteristics	% Osteoporosis (n)	P value
Ever tobacco use		
Never used tobacco	4.90 (n=61)	0.07
Ever used only snuff	5.00 (n=22)	
Ever smoked only	5.10 (n=17)	
Ever smoked and used snuff	17.20 (n=5)	
Race		0.05
Black	5.16 (n=82)	
Colored	2.34 (n=9)	
Indian	2.16 (n=4)	
White	9.93 (n=10)	
Education level		0.24
Less than high school	5.60 (n=98)	
High school	1.90 (n=5)	
More than high school	3.39 (n=2)	
Asset index		0.06
Lowest	3.30 (n=19)	
Middle	5.14 (n=45)	
Highest	6.88 (n=38)	
General health		0.09
Not good	5.80 (n=91)	
Good/excellent	3.03 (n=11)	
Body mass index		0.97
Underweight	5.37 (n=6)	
Normal weight	5.11 (n=30)	
Overweight	4.92 (n=28)	
Obese	5.57 (n=36)	

## Discussion

This study demonstrated a strong association between ever use of both snuff and cigarette smoking and osteoporosis, but no significant association was observed between the ever exclusive use of either form of tobacco. We found that the higher the daily dietary intake of calcium, the lower the odds of reporting osteoporosis.

Similar to a previous observation of higher odds of osteoporosis among former tobacco users, as opposed to current users,<sup>[1]</sup> the intensity of the current use of either product was not associated with the prevalence of osteoporosis, even though the frequency of current snuff use tended to be associated with higher odds of osteoporosis. The reason why ever use and not intensity of current use was associated with osteoporosis might be that users try to reduce the amount of tobacco used or altogether quit the use of tobacco when osteoporosis or any other medical condition develops. Conceivably, combined use increases the cumulative levels of nicotine in the blood, given that snuff delivers a higher amount of nicotine from a single dose than cigarette smoking does.<sup>[6,13]</sup> It was therefore not surprising that increased snuff frequency as opposed to increased cigarettes smoked per day tended to be associated with higher odds of osteoporosis. This observation also

**Table 2: Multiple logistic model for factors associated with osteoporosis**

Characteristics	Odds ratio	95% confidence interval
Ever tobacco use		
Never used tobacco	1.0	
Ever used only snuff	0.52	0.22-1.23
Ever smoked only	1.49	0.60-3.69
Ever smoked and used snuff	3.60	1.03-12.61
Race		
Black	1.0	
Colored	0.36	0.12-1.03
Indian	0.29	0.09-0.93
White	3.78	1.20-11.89
Education level		
Less than high school	1.0	
High school	0.13	0.03-0.58
More than high school	0.36	0.07-1.81
Asset index		
Lowest	1.0	
Middle	2.03	1.05-3.92
Highest	3.87	1.76-8.52
Self-reported general health		
Not good	1.0	
Good/excellent	0.42	0.21-0.84
Dietary calcium intake (Log)	0.75	0.59-0.95
Daily frequency of current snuff use	1.10	1.00-1.21
Cigarettes currently smoked per day	0.88	0.77-1.01

supports a previous observation that osteoporosis was associated mainly with heavy smoking, but had no significant association with either moderate or light smoking,<sup>[3]</sup> as is commonly the case in the studied population.

Although snuff use is most common among black Africans, uneducated and rural South African women,<sup>[14]</sup> it was among the White and the most educated women that a higher proportion of smokers was found that tend to smoke more intensively and that had the highest prevalence of osteoporosis. This observation suggests that that raised blood nicotine may not be the only factor explaining higher prevalence of osteoporosis in tobacco users. Other factors may include genetic predisposition<sup>[15]</sup> and other factors not controlled for in the current study.

### Study limitations

This is a cross-sectional study and does not establish causality, as there was no record of the temporal order of events. Furthermore, the current study relied on self-reported tobacco use and osteoporosis and thus it was subject to reporting bias. For instance, it is possible that current smokers with osteoporosis may find it socially desirable to under-report the intensity of their smoking. However, considering that other potential under-reporting would probably occur randomly (that is, would not be related to tobacco use status), this self-reporting is not likely to influence the results of our analysis on the association between tobacco use and osteoporosis significantly. Another limitation of this study is that the dataset used is dated. The SADHS 2003 is the most recent demographic and health survey made publicly available and also since osteoporosis is a biological process, the results are not likely to be affected.

Despite these limitations, this study provides information on the factors associated with osteoporosis using a large nationally representative population sample from a developing country.

### Conclusion

This study's findings suggest that combined users of both snuff and cigarette in South Africa may carry a higher risk of osteoporosis. The findings from this study highlight the need for tobacco use prevention and for health-care professionals to advise their patients on the importance of cessation of all forms of tobacco use in the prevention of osteoporosis. This is an important message, especially because snuff users in South Africa are predominantly women.

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