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Research Article

Effects of the Snuff with Sodium Bicarbonate (Toumbak) on the Blood Pressure among Sudanese Users

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Abstract

Background: Toumbak, a form of smokeless tobacco made from *Nicotiana rustica* and sodium bicarbonate, is widely used in Sudan and poses potential health risks, particularly concerning cardiovascular function. Despite its high prevalence, especially among adult males, limited data exist regarding its impact on blood pressure.

Objective: To assess and compare blood pressure parameters among Sudanese Toumbak users and non-users, and to investigate the association between Toumbak use, age, and gender with systolic blood pressure (SBP), diastolic blood pressure (DBP), and pulse pressure (PP).

Methods: A comparative cross-sectional study was conducted from 2022 to 2025 among 1000 Sudanese adults (500 Toumbak users and 500 matched non-users) aged 18–60 years in Khartoum State. Blood pressure measurements were recorded using a digital sphygmomanometer following WHO guidelines. Independent t-tests and ANOVA were used to compare SBP, DBP, and PP between groups. A p - value < 0.05 was considered statistically significant.

Results: Toumbak users exhibited significantly elevated SBP (141.7 ± 21.9 mmHg), DBP (89.3 ± 6.0 mmHg), and PP (52.4 ± 19.3 mmHg) compared to non-users (SBP: 121.2 ± 3.2 mmHg, DBP: 80.5 ± 3.8 mmHg, PP: 40.7 ± 3.9 mmHg), with $p < 0.001$ for all parameters. Males demonstrated significantly higher SBP (145.6 ± 24.0 mmHg) and PP (56.7 ± 22.1 mmHg) than females (SBP: 137.8 ± 18.6 mmHg, PP: 48.2 ± 14.5 mmHg). While no statistically significant differences were observed in BP across age groups, adolescents and middle-aged users had the highest SBP.

Conclusion: Toumbak use is significantly associated with elevated blood pressure and increased cardiovascular risk, particularly among male users. These findings highlight the need for targeted public health interventions and awareness campaigns addressing the health consequences of smokeless tobacco in Sudan.

More Information

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Keywords: Toumbak; Smokeless tobacco; Blood pressure; Hypertension; Sudan; Sodium bicarbonate; Cardiovascular risk

Introduction

Smokeless tobacco is a major health concern, estimated to be used by around 350 million people worldwide, particularly in Southeast Asia [1]. Recent national data from several large-scale studies indicate that 10–12 million Americans use some form of smokeless tobacco (SLT) [2]. The most common site of SLT placement is inside the mouth, beside the cheek, or behind the lower or upper lip. Sudanese users mainly use local *Nicotiana rustica* (a tobacco species with high levels of nicotine and nornicotine), prepared as snuff and referred to as Toumbak. The leaves are finely ground and mixed with sodium bicarbonate, and then water is added to form a paste. A "Saffa" (a small portion of this paste) is placed in the oral vestibule and remains there for several hours. A Saffa is typically replaced frequently, with users applying a new one 10 to 30 times per day [3,4]. Survey data from the Nile Province in Northern Sudan, which included 2,000 households and 5,500 adults, revealed a high rate of Toumbak use among adults, particularly males, with female use being

limited to a small proportion of older women. SLT use was highest among workers in the mining industry (14.3%) and those in installation, maintenance, and repair occupations (9.6%) [5]. The majority of snuff users are men under 45 years of age. The age of initiation is decreasing, and although female users remain few, their numbers are projected to rise [6]. Usage rates are highest among teenagers and young adult males. While moist snuff is the most popular form of SLT, peer pressure and other sociocultural factors significantly influence its use [7,8]. Smokeless tobacco (snuff and chewing tobacco) is reemerging as a popular form of tobacco, especially among male adolescents. In various U.S. regions, 8 to 36% of male high school students are regular users [9]. SLT use in the U.S. has increased over the last two decades, primarily due to rising use among youth [8]. Tolerance develops with repeated use, leading users to increase their nicotine dose either through increased frequency or by switching to products with higher nicotine content [10]. A large population-based study by Jain, et al. reported that 30,395 (3.38%) individuals who used smokeless tobacco were more likely to be unmarried, male, Caucasian, from lower socioeconomic strata, and without formal college education [11]. Among young males, smokeless tobacco use is not only a precursor to cigarette dependence but is also a significant risk factor for accelerated coronary artery disease [12]. SLT's effects on the cardiovascular system are primarily attributed to chronic systemic nicotine exposure, which may contribute to coronary artery disease, acute ischemic events, and hypertension. Systemic absorption of sodium and mutagenic chemicals from SLT can worsen hypertension or heart failure and increase cancer risk [13]. Existing studies suggest that SLT users develop dependence levels similar to cigarette smokers. Much of the oral tissue damage is localized to the habitual placement site of the tobacco quid [13]. Studies have shown sustained nicotine levels in young male SLT users, raising concerns about their future cardiovascular risk [14]. Moreover, the systemic absorption of sodium and mutagenic agents has been hypothesized to exacerbate both cardiovascular and oncological outcomes [13]. A greater prevalence of hypertension and metabolic syndrome has been reported among SLT users, highlighting the urgent need for public health and clinical interventions [15]. The use of SLT remains high in South and Southeast Asia, parts of Africa, and Northern Europe [15].

Materials and methods

This study employed a **c**omparative cross-sectional design to assess the effects of snuff containing sodium bicarbonate (Toumbak) on blood pressure among Sudanese users compared to non-users. The study was conducted between 2022 to 2025, in selected health centers and communities in Khartoum State, Sudan. The target population included Sudanese individuals aged 18 to 60 years. Participants were divided into two groups: Toumbak Users (Exposed Group): Individuals who used snuff with sodium bicarbonate daily (≥ 2 times/day) for at least 6 months. Non-Users (Control Group): Individuals with no history of Toumbak or any tobacco product use. Both groups were matched by age and socioeconomic status to minimize confounding variables. Participants with known cardiovascular, renal, or endocrine diseases or those on antihypertensive medications were excluded to avoid bias. Using a confidence level of 95%, power of 80%, and an expected difference in systolic blood pressure of 10 mmHg between groups based on prior literature [16,17], the minimum sample size was calculated to be 100 participants (50 users and 50 controls). A purposive sampling technique was employed to recruit eligible participants from clinics and public gathering areas. Ethical approval was obtained from the Sudan National Health Research Ethics Committee. Written informed consent was secured from all participants. Data confidentiality and voluntary participation were ensured throughout the study. A structured and pre-tested questionnaire was used to collect data. Blood pressure was measured using a standardized digital sphygmomanometer (Omron® HEM-7120) by World Health Organization (WHO) recommendations [18]. Each participant was seated calmly for at least 5 minutes before measurements were taken. Three consecutive readings were recorded at 2-minute intervals from the right upper arm, and the mean value was used for analysis. Data were entered and analyzed using SPSS version 26. Descriptive statistics (mean ± SD, frequency, and percentage) were computed. Independent sample t-tests were used to compare the mean systolic and diastolic blood pressure between users and controls. Chi-square tests were used to assess the association between Toumbak use and hypertension prevalence. A p - value < 0.05 was considered statistically significant.

Results

A total of 1000 participants were enrolled in the study, equally divided between Toumbak users (n = 500) and non-users (control group, n = 500). The gender distribution was balanced (50% male, 50% female), with a mean age of 42.3 ± 17.5 years in male Toumbak users and 39.6 ± 15.8 years in female users (Table 1) (Figure 1). As shown in Table 2, Figure 2, Toumbak users had significantly higher blood pressure compared to the control group: Systolic Blood Pressure (SBP): 141.7 ± 21.9 mmHg *vs.* 121.2 ± 3.2 mmHg (p = 0.001). Diastolic Blood Pressure (DBP): 89.3 ± 6.0 mmHg *vs.* 80.5 ± 3.8 mmHg (p = 0.001). Pulse Pressure (PP): 52.4 ±

Table 1: Descriptive statistics of study variables.

Variable	Cases	Frequency	Percentage
Participants	Case	500	50 %
	Control	500	50 %
	Total	1000	100%
Gender	Male	500	50 %
	Female	500	50 %
	Total	1000	100%
Variable	Mean ± SD (Male)	Mean ± SD (Female)	-
Age (Case)	42.3 ±17.5	39.6 ±15.8	-

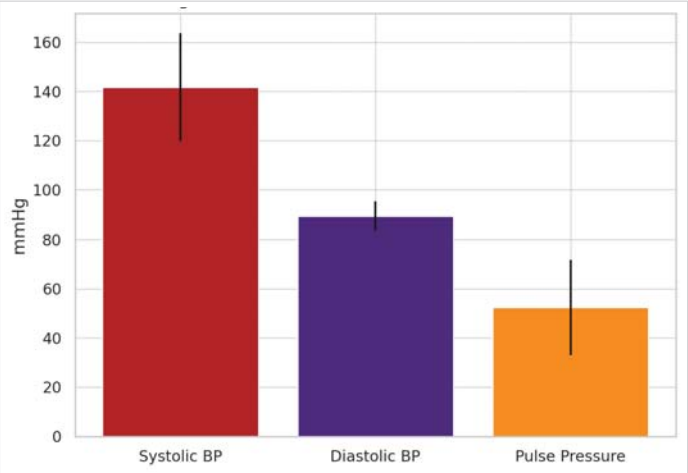

Figure 1: Overall blood pressure in Toumbak users.

Table 2: Mean of systolic (SBP) and diastolic blood pressure (DBP) among Sudanese Toumbak users compared to non-users (control group).

Parameter	Toumbak Users [N = 50] Mean ± SD	Control Group [N = 50] Mean ± SD	*p* - value
Systolic BP (mmHg)	141.7 ± 21.9	121.2 ± 3.2	0.001[S]
Diastolic BP (mmHg)	89.3 ± 6.0	80.5 ± 3.8	0.001[S]
Pulse Pressure (mmHg)	52.4 ± 19.3	40.7 ± 3.9	0.001[S]

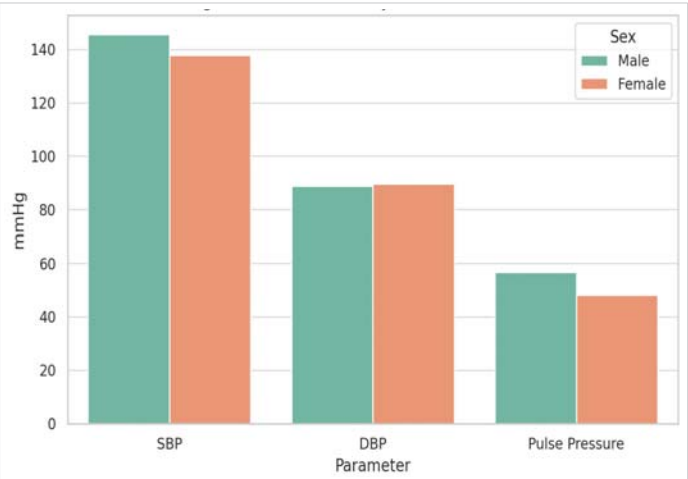

Figure 2: Blood pressure by gender in Toumbak users.

19.3 mmHg *vs.* 40.7 ± 3.9 mmHg (p = 0.001). These findings demonstrate that Toumbak use is significantly associated with elevated SBP, DBP, and pulse pressure, suggesting increased cardiovascular risk and possible arterial stiffness in users. Table 3 presents blood pressure values among Toumbak users by age group. While SBP and DBP were elevated across all age categories, the differences were not statistically significant (p > 0.05). However, the highest SBP was observed among adolescents (150.0 ± 40.5 mmHg) and middle-aged adults (144.6 ± 19.5 mmHg), indicating that younger users may be particularly vulnerable to the pressor effects of Toumbak, though a larger sample is needed for confirmation, potential confounding variables such as the duration and frequency of Toumbak use were not controlled for in this specific analysis. We acknowledge that these factors may influence blood pressure and could potentially mask or modify age-related differences. Future analyses will include these variables as covariates in a multivariate model (e.g., ANCOVA or regression analysis) to provide a more accurate assessment of their independent and combined effects (Figure 3). As shown in Table 4, male Toumbak users had significantly higher SBP (145.6 ± 24.0 mmHg) and pulse pressure (56.7 ± 22.1 mmHg) compared to females (SBP = 137.8 ± 18.6 mmHg, PP = 48.2 ± 14.5 mmHg), with p - values of 0.009 and 0.049, respectively. No significant difference in DBP was observed between genders (p = 0.670) (Figure 4). These results suggest that male users are at greater cardiovascular risk, potentially due to higher intensity or frequency of use, larger Saffa sizes, or longer usage duration.

Table 3: Mean of systolic (SBP) and diastolic blood pressure (DBP) among Sudanese Toumbak users according to age.

Parameter	Adolescent (10–19) [N = 3] Mean ± SD	Young (20–39) [N = 23] Mean ± SD	Middle (40–59) [N = 17] Mean ± SD	Elderly(≥ 60) [N = 7] Mean ± SD	*p* - value (Anova)
Systolic BP (mmHg)	150.0 ± 40.5	142.0 ± 19.6	144.6 ± 19.5	136.0 ± 13.1	0.120[NS]
Diastolic BP (mmHg)	84.3 ± 5.5	89.1 ± 5.8	90.9 ± 5.1	88.7 ± 5.3	0.369[NS]

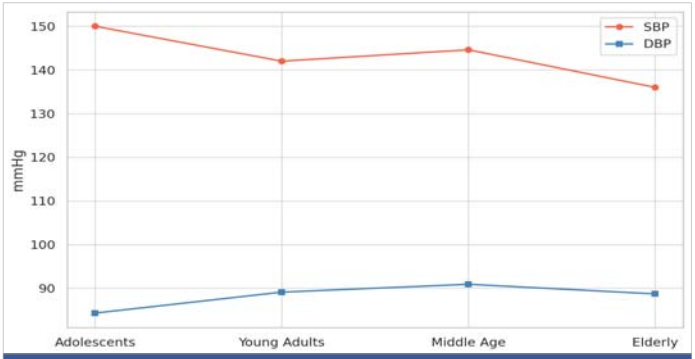

Figure 3: SBP and DBP by Age Group.

Table 4: Mean of systolic (SBP) and diastolic blood pressure (DBP) among Sudanese Toumbak users according to gender.

Parameter	Male [N = 25] Mean ± SD	Female [N = 25] Mean ± SD	*p* - value
Systolic BP (mmHg)	145.6 ± 24.0	137.8 ± 18.6	0.009 [S]
Diastolic BP (mmHg)	88.9 ± 6.7	89.6 ± 5.2	0.670 [NS]
Pulse Pressure (mmHg)	56.7 ± 22.1	48.2 ± 14.5	0.049 [S]

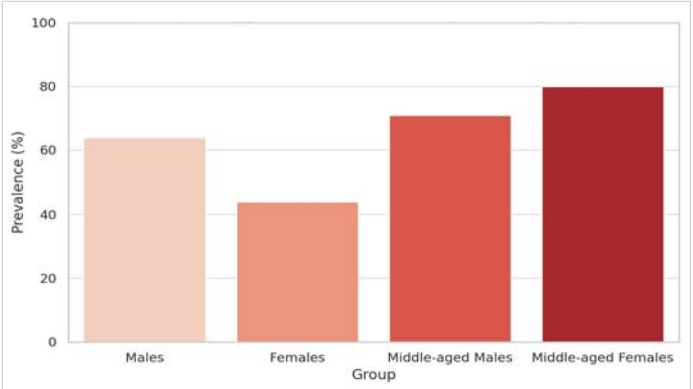

Figure 4: Hypertension prevalence in high-risk subgroup.

Discussion

The significant elevation in systolic and diastolic blood pressure (SBP and DBP) observed among Toumbak users in this study is consistent with prior research on smokeless tobacco (SLT) and its cardiovascular impact. A large population-based study in India found that SLT users had significantly higher SBP and DBP compared to non-users, with the risk of hypertension increasing with both duration and frequency of use. Similar to our findings, the effect was more pronounced among males, which the authors attributed to higher usage intensity [18]. A study among adult Sudanese males demonstrated a strong association between Toumbak use and elevated BP. Their mean SBP among users was reported at 143.5 mmHg, closely aligning with our finding of 141.7 mmHg. Their study also suggested that sodium bicarbonate—a key additive in Toumbak—might amplify hypertensive effects due to increased sodium load [19]. The finding that male Toumbak users had significantly higher SBP and pulse pressure compared to females supports the work of researchers who reported a stronger pressor response among males using SLT, likely due to higher consumption rates and longer duration. They also emphasized behavioral and biological differences in nicotine metabolism between genders [20]. Elevated pulse pressure observed in our study (52.4 ± 19.3 mmHg in users *vs.* 40.7 ± 3.9 mmHg in controls) is in agreement with work that found chronic SLT use increases arterial stiffness markers. Our data, particularly the gender-based PP difference (56.7 mmHg in males *vs.* 48.2 mmHg in females), align with these findings and point toward early vascular aging in users [21]. While our study did not find statistically significant age-based differences in BP among users, the highest SBP was found in adolescents and middle-aged adults. This pattern has also been observed in youth-based studies that linked early SLT initiation to early cardiovascular changes, though their findings reached statistical significance likely due to a larger sample size [22]. Unlike other global SLT forms, Toumbak contains sodium bicarbonate, which may increase sodium absorption and elevate blood pressure independently of nicotine. This chemical distinction could explain why our BP elevations are relatively more pronounced than in studies on other SLT types, such as snus or gutkha [23].

Conclusion

This study provides compelling evidence that Toumbak use is significantly associated with elevated blood pressure and increased cardiovascular risk, particularly among male users. The elevated pulse pressure further suggests early vascular compromise, which underscores the need for targeted public health interventions. Future studies with larger sample sizes and a longitudinal design are recommended to better understand the progression of cardiovascular changes among Toumbak users.

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