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Tobacco use and khat chewing among adolescents in Yemen: a large-scale school-based cross-sectional study

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Abstract

Objective The present study sought to assess the prevalence and determinants of tobacco use (cigarette smoking and shisha use) and khat chewing among Yemeni adolescents, and to evaluate their knowledge and attitudes toward these habits.

Methods This school-based cross-sectional study was conducted among 13 to 19-year-old students attending middle/high schools (both private and public) across five main cities in Yemen. Data were collected using self-administered questionnaires comprising questions/items related to sociodemographic data, cigarette smoking, shisha use, khat chewing, and knowledge on and attitudes toward these habits. Bivariate and multivariate analyses were used to explore the most determinant factors.

Results A total of 7505 students were recruited from 42 schools across five major cities in Yemen. The prevalence rates of khat chewing, cigarette smoking, and shisha use were 42.4%, 6.8%, and 19.3%, respectively. Compared to females, male subjects reported significantly higher prevalence of khat chewing (51.4% vs. 23.5%, $p < 0.001$), shisha use (20.3% vs. 17.2%, $p < 0.01$), and cigarette smoking (8.8% vs. 2.6%, $p < 0.001$). Male gender, older age, poor knowledge, khat chewing, parents' low education level, and parents' and peers' smoking habits were significant determinants of adolescents' cigarette smoking status. Private education, male gender, older age, poor knowledge, parents' low education level, and parents' and peers' khat chewing habits were significant determinants of adolescents' khat chewing status. The participant's knowledge of and attitudes toward tobacco use and khat chewing were inadequate.

Conclusion The prevalence of khat chewing, shisha use, and to lesser extent cigarette smoking among Yemeni adolescents is high that needs immediate intervention. The results highlight the urgent need to implement prevention strategies to tackle these habits among the youth in Yemen.

Keywords Cigarette smoking, Shisha use, Khat chewing, Adolescents, Yemen

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Introduction

The use of tobacco and other deleterious habits among the adolescents is a growing public health concern worldwide [1, 2]. Indeed, adolescents, compared to adults and children, are more likely to engage in health risk behaviors that threaten their well-being or even their mortality, including violence, drug use, and tobacco use, among others [3, 4]. Notably, the WHO estimated that 23% the world's population use tobacco (36.7% of men and 7.8% of women), and estimated that nearly 20% of 13-15-year old adolescents use some form of tobacco product [5, 6]. Tobacco, irrespective of the method of use, is very detrimental to health and is a well-recognized risk factor for a number of non-communicable diseases, such as cardiovascular disorders, respiratory diseases, cancers, and oral diseases [7, 8]. Tackling tobacco use is among a set of ten global monitoring indicators for achieving the 2030 Agenda for Sustainable Development [9].

A number of studies worldwide have investigated the prevalence of tobacco use among adolescents and reported variable results, ranging from 2.4 to 39.6% [10–17]. Numerous factors, including gender (male), low socioeconomic status, increased age/grade, low academic performance, smoking among family members and friends, and exposure to smoking in films, have been reported to be associated with a higher risk of tobacco onset in adolescents [18, 19].

In Yemen, a poor country situated in the south of the Arabian Peninsula with around 35 million inhabitants and a significant young population [20], tobacco use in its different forms is a widespread habit among the youth [8]. The ongoing 10-year civil war in Yemen has resulted in a huge destruction of the country's infrastructures and resulted in unprecedented humanitarian, psychological, social and economic consequences. This in turn contributed to the indulgence of many deleterious habits, namely cigarette smoking, shisha use and khat chewing among the population, including adolescents and school children.

Besides tobacco use, khat chewing is also a widespread socially rooted habit among the Yemeni population [21, 22]. However, despite this, there is a scarcity of data pertaining to the prevalence and associated factors of such habits among the youth in Yemen. It is estimated that over 80% of adult men and 30% of adult women chew khat daily [21, 22]. Khat or Qat is an ever-green plant with amphetamine like effects. Khat's soft leaves and twigs are chewed widely in the khat belt area (east to south Africa countries [e.g., Ethiopia, Kenya]) and the south west of Arabian Peninsula (e.g., Yemen) [21–23]. Historically, the khat chewing used to be restricted by social norms (i.e., mainly adult males chew khat for many hours per day). However, khat chewing has become a

public health concern nationally and internationally in the past two decades, and has even become widespread among school children [22, 24, 25]. Although no data to support it, it seems that the political instability and humanitarian crises have led to a sharp increase in the consumption of khat. In addition to its harmful effects on the general and oral health, khat chewing is associated with higher risk of early onset of tobacco use, and with more frequent cigarette smoking [26, 27]. Kassim et al. [26] found that khat chewing is a gateway of smoking, and that chewers tend to smoke more during chewing sessions [26]. As such, khat chewing can be considered as a determinant factor for cigarette smoking and shisha use among Yemeni adolescents.

Understanding the prevalence of tobacco use (i.e., cigarette smoking and shisha use) and khat chewing among the youth is very crucial for developing effective public health policies for future control and prevention measures. The available information will enable researchers and policy makers alike to tailor well-planned schemes and campaigns for tackling these habits among the youth in particular and the whole society at large. In light of paucity of data on the tobacco use and khat chewing among the adolescents in Yemen, the present large-scale, school-based study aimed to: (1) determine the prevalence and determinants of tobacco use (smoking and shisha use) and khat chewing among Yemeni school-attending adolescents residing in different regions of Yemen, and (2) assess their knowledge and attitudes toward these habits.

Methods

Study population, setting and ethical approval

This school-based cross-sectional study was conducted among Yemeni adolescents attending intermediate and high schools in five different Yemeni governorates: Sana'a, Dhamar, Ibb, Taiz and Hadhramaut. Out of the Yemeni 21 governorates, five cities from five governorates were selected for the study. These cities are the most populous cities in Yemen, and hence they may provide a relatively good representation of the population from all different regions of the country. The study was conducted between November 2021 and December 2022.

Formal education system in Yemen is divided into three main levels: primary, grade 1–6; lower secondary (intermediate), grade 7–9; and upper secondary (high schools), grade 10–12. To be eligible, participants needed to be enrolled in a public or private school in one of the designated cities, aged between 13 and 19, and consent to participate.

The present study was approved by the ethical committee, College of Dental Medicine, Ibb University, Yemen (Ref #: B2021-078 H). All participants were informed

about the purpose of the study, and an informed consent was obtained from all participants. For participation of those who were younger than 16 years old, we received formal consents from the relevant school authorities, as well as consents from their parents or guardians.

Sampling and sample size

The present study adopted a convenience sampling from five densely populated Yemeni cities located in different parts of Yemen. In fact, the intention was to have a probability representative sample of all targeted population from different regions of Yemen. However, due to the current unstable political status in the country along with the difficulties to access the local educational authorities for establishing the number and the regional distribution of the schools, we were unable to pursue this plan and thus resorted to convenience sampling strategy. Where possible, different schools located in different localities were selected in order to obtain a good representation of the population within each city. Additionally, within each selected school, one class from each grade was randomly selected to be included in the study. In Yemen, most of schools are sex-segregated, and so this matter was considered during the sampling process in order to obtain a good representation of both genders.

The sample size was calculated based on the estimated smoking prevalence of 15.17% among adolescents in Saudi Arabia [11] with 3% absolute precision and 95% confidence interval. The estimated sample size was 545 (from each geographic area); we added 10% to account for non-response, thus the minimum estimated sample size from each city/region was 600 (3000 from all cities). In order to increase precision and reduce the effect of any missing data, the sample size was doubled, yielding a total estimated sample size of 6000 (1200 from each region).

Data collection and tool used

A self-administered questionnaire was used for data collection. The questions were adapted from previously validated questionnaires conducted elsewhere [10, 11]. The questionnaire was pretested on 30 schoolchildren (13–19 years) to ensure clarity and understanding of the questions, and modifications were made accordingly.

The questionnaire included 25 items divided into four sections. The first section covered the socioeconomic status; the second section included questions on practices and frequencies of tobacco use (cigarette smoking, and shisha use) and khat chewing; the third section included four questions on the potential factors associated with these habits; and the fourth section included questions on the knowledge (six items) and attitudes (five items) of the subjects pertaining smoking and khat chewing. Students were asked to complete the questionnaire in the

classroom in the presence of one member of the research team.

Exploratory and outcomes factors

Independent factors (exploratory factors) were gender (male/female), age (in years), parents' education level (three categories), peers' habits history (Yes/No) and parents' habits history (Yes/No).

The primary outcomes of interest were the following binary variables: cigarette smoking status (Yes/No), shisha use (Yes/No), khat chewing (Yes/No). The participant was defined as a smoker if reported smoking within the past 30 days [6, 11]. The same applies to shisha use and khat chewing. The secondary outcomes were knowledge and attitudes toward these habits.

Statistical analysis

Data were initially entered into an Excel Spreadsheet file, double-checked, coded, and then imported into a statistical software program (SPSS V25, IBM Corp., USA) for data analysis. The results were presented as frequencies and corresponding proportions for categorical variables and means and standard deviations (SD) for continuous variables. The crude associations between the outcome (cigarette smoking, shisha use, and khat chewing) and explanatory variables (demographic variables) were tested using the Chi-squared test. The logistic regression analysis was utilized to explore the adjusted odds ratios of the habits among participants in relation to the explanatory factors. The results were presented as odds ratio (OR) and 95% confidence intervals (CI). Responses pertaining to knowledge/attitudes were converted into numerical variables based on the correct answers in the knowledge section or positive responses in the attitude section. Then, the total score for each section was calculated. A *p*-value less than 0.05 was considered statistically significant.

Results

Out of the distributed 8000 questionnaires, 7812 questionnaires were returned with a response rate of 97.6%; of these, 307 were excluded due to significant missing data (more than 6 unanswered items), and thus only 7505 were analyzed.

A detailed description of the general characteristics of the sample is presented in Table 1. Overall, a total of 7505 adolescent school students from 42 schools across five different cities (Sanaa, *n* = 2588; Taiz, *n* = 1780; Dhamar, *n* = 1469; Ibb, *n* = 1129; and Hadhramaut, *n* = 539) participated in the present study. Around two thirds of the sample (67.8%) were males. The age ranged between 13 and 19 years, with 16.7% were in 13 to 14-year-old age group, 41.7% in 15 to 16-year-old age

Table 1 General characteristics of the sample

Variable	Total 7505 (100.0)	Sana'a 2588 (34.5)	Dhamar 1469 (19.6)	Ibb 1129 (15.0)	Taiz 1780 (23.7)	Hadhramaut 539 (7.2)
School (n=7505)						
Public	4927 (65.6)	1053 (40.7)	1289 (87.7)	1129 (100.0)	1428 (80.2)	28 (5.2)
Private	2578 (34.4)	1535 (59.3)	180 (12.3)	0 (0.0)	352 (19.8)	511 (94.8)
Gender (7500)						
Male	5084 (67.8)	1902 (73.6)	965 (65.7)	792 (70.3)	1066 (59.9)	359 (66.6)
Female	2416 (32.2)	683 (26.4)	504 (34.3)	335 (29.7)	714 (40.1)	180 (33.4)
Age group (n=7440)						
13–14 yrs	1239 (16.7)	445 (17.2)	193 (13.1)	48 (4.3)	411 (23.9)	142 (26.3)
15–16 yrs	3105 (41.7)	1031 (39.9)	687 (46.8)	463 (41.0)	663 (38.6)	261 (48.4)
≥ 17 yrs	3096 (41.6)	1110 (42.9)	589 (40.1)	617 (54.7)	644 (37.5)	136 (25.2)
Father's education (n=7426)						
Illiterate	704 (9.5)	223 (8.6)	157 (10.7)	176 (15.6)	138 (8.0)	10 (1.9)
Elementary/Secondary	3297 (44.4)	1015 (39.2)	675 (45.9)	606 (53.7)	763 (44.2)	238 (46.2)
College/University	3425 (46.1)	1350 (52.2)	637 (43.4)	347 (30.7)	824 (47.8)	267 (51.8)
Mother's education (n=7428)						
Illiterate	2286 (30.8)	703 (27.2)	510 (34.7)	543 (48.1)	481 (27.8)	49 (9.6)
Elementary/Secondary	3821 (51.4)	1320 (51.0)	757 (51.5)	509 (45.1)	887 (51.3)	348 (68.0)
College/University	1321 (17.8)	565 (21.8)	202 (13.8)	77 (6.8)	362 (20.9)	115 (22.5)

group, and 41.6% were ≥ 17-year-old. Majority of the participants were from public schools (65.6%) (Table 1).

The prevalence of khat chewing, cigarette smoking, and shisha use were 42.4%, 6.8%, and 19.3%, respectively, with some geographical differences (Supplementary Fig. 1). Around 4.6% of the participants reported indulging in both cigarettes smoking and shisha (dual habit). The prevalence of cigarette smoking and shisha use were highest in Sanaa (8.9%, 28%, respectively) and lowest in Hadhramaut (4.3%, 3.3%, respectively). On the other hand, khat chewing was highest among participants from Ibb and Dhamar (56.4%, 55.1%, respectively), and lowest in Hadhramaut (5%) (Supplementary Fig. 2). With respect to the frequency of the habits, around one third of khat chewers as well as cigarette smokers indulge in the habits on daily basis, whereas most of shisha users indulged in it very rarely (Supplementary Fig. 3).

Bivariate analysis of determinant factors related to different habits are presented in Table 2. The results showed that being male, at older age, with parent's low education level, and having cigarette smoker/khat chewer parents and smoker peers were significantly associated with current tobacco use and/or khat chewing among the participants. Compared to females, male subjects reported significantly higher prevalence of khat chewing (51.4% vs. 23.5%), shisha use (20.3% vs. 17.2%), and cigarette smoking (8.8% vs. 2.6%).

Expectedly, all habits were positively associated with age, being highest among subjects ≥ 17years.

Multiple logistic regression showed that school (being private), gender (being male), age (older than 14 years), poor knowledge, khat chewing (being chewer), fathers' education level (being low), mother's education level (being high), parents' smoking habits (at least one is smoker), and peers' smoking habits (being smoker) were all positive determinants for cigarette smoking among the participants. With respect to shisha use, the results revealed that school (being private), gender (being male), age (≥ 17years), poor knowledge, khat chewing (being chewer), mothers' education level (being high), parents' smoking habits (at least one is smoker), peers' smoking habits (being smoker) were all positive determinants for shisha use among the participants. The results also showed that school (being private), gender (being male), age (older than 14 years), poor knowledge, mothers'/fathers' education level (being low), parent' khat chewing habits (at least one is chewer), peers chewing habits (being chewer) were all positive determinants for khat chewing (Table 3).

Knowledge and attitudes of the participants are presented in Table 4. Overall, participants revealed relatively fair knowledge on the harmful effects of cigarette smoking and khat chewing with correct answers ranging from 79.3 to 93.3%. Interestingly, participants had better knowledge on the harmful effects of smoking (82 -93.3%) than on khat chewing (79.3-81.8%); and better knowledge

Table 2 Proportion of tobacco users and khat chewers by different factors N (%)

Variables	Smoking		Shisha use		Khat	
	No	Yes	No	Yes	No	Yes
School	P=0.007		<i>P</i> <0.001		<i>P</i> <0.001	
Public	4618 (93.7)	309 (6.3)	4056 (82.3)	871 (17.7)	2679 (54.4)	2248 (45.6)
Private	2373 (92.0)	205 (8.0)	1997 (77.5)	581 (22.5)	1642 (63.7)	936 (36.3)
Gender	<i>P</i> <0.001		P=0.001		<i>P</i> <0.001	
Male	4635 (91.2)	449 (8.8)	4050 (79.7)	1034 (20.3)	2471 (48.6)	2613 (51.4)
Female	2352 (97.4)	64 (2.6)	2001 (82.8)	415 (17.2)	1848 (76.5)	568 (23.5)
Age group	<i>P</i> <0.001		<i>P</i> <0.001		<i>P</i> <0.001	
13–14 yrs	1219 (98.4)	20 (1.6)	1105 (89.2)	134 (10.8)	924 (74.6)	315 (25.4)
15–16 yrs	2918 (94.0)	187 (6.0)	2564 (82.6)	541 (17.4)	1860 (59.9)	1245 (40.1)
≥ 17 yrs	2793 (90.2)	303 (9.8)	2330 (75.3)	766 (24.7)	1497 (48.4)	1599 (51.6)
Father's education	<i>P</i> <0.001		<0.001		<i>P</i> <0.001	
No education	621 (88.2)	83 (11.8)	561 (79.7)	143 (20.3)	326 (46.3)	378 (53.7)
Elementary/Secondary	3092 (93.8)	205 (6.2)	2663 (80.8)	634 (19.2)	1849 (56.1)	1448 (43.9)
College/University	3204 (93.5)	221 (6.5)	2757 (80.5)	668 (19.5)	2089 (61.0)	1336 (39.0)
Mother's education	0.048		P=0.867		<i>P</i> <0.001	
No education	2119 (92.7)	167 (7.3)	1845 (80.7)	441 (19.3)	1144 (50.0)	1142 (50.0)
Elementary/Secondary	3584 (93.8)	237 (6.2)	3080 (80.6)	741 (19.4)	2257 (59.1)	1564 (40.9)
College/University	1215 (92.0)	106 (8.0)	1057 (80.0)	264 (20.0)	860 (65.1)	461 (34.9)
Parents smoking habit	<i>P</i> <0.001		<i>P</i> <0.001		<i>P</i> <0.001	
No	4527 (94.9)	241 (5.1)	4105 (86.1)	663 (13.9)	2908 (61.0)	1860 (39.0)
Yes	2452 (90.0)	271 (10.0)	1938 (71.2)	785 (28.8)	1403 (51.5)	1320 (48.5)
Friends smoking habit	<i>P</i> <0.001		<i>P</i> <0.001		<i>P</i> <0.001	
No	3343 (98.1)	66 (1.9)	3191 (93.6)	218 (6.4)	2409 (70.7)	1000 (29.3)
Yes	3625 (89.0)	448 (11.0)	2840 (69.7)	1233 (30.3)	1894 (46.5)	2179 (53.5)
Parents khat habit	<i>P</i> <0.001		<i>P</i> <0.001		<i>P</i> <0.001	
No	1509 (96.9)	48 (3.1)	1424 (91.5)	133 (8.5)	1276 (82.0)	281 (18.0)
Yes	5433 (92.2)	462 (7.8)	4584 (77.8)	1311 (22.2)	3004 (51.0)	2891 (49.0)
Friends khat habit	<i>P</i> <0.001		<i>P</i> <0.001		<i>P</i> <0.001	
No	1844 (97.9)	40 (2.1)	1743 (92.5)	141 (7.5)	1639 (87.0)	245 (13.0)
Yes	5097 (91.5)	471 (8.5)	4263 (76.6)	1305 (23.4)	2644 (47.5)	2924 (52.5)

Chi-square test

on the potential association of smoking with lung cancer than with oral cancer (91.3% vs. 82%). In terms of attitudes, the findings revealed mixed results. Females showed significantly better knowledge and more positive attitudes than males did (Table 4).

The results of the bivariate analysis of factors influencing the knowledge and attitudes of the participants are presented in supplementary Table 1. Females, young age, and those whose parents have a high education level showed significantly better knowledge scores. Additionally, being in private schools, females, young age (13–14 years), and parents with high education status were significantly associated with better attitudes (supplementary Table 1).

Discussion

The present large-scale cross-sectional study investigated the prevalence of tobacco use (cigarette smoking and shisha use) and khat chewing among Yemeni adolescents. The results of the current study are alarming: up to 42%, 19%, and 6.8% of the adolescents reported khat chewing, shisha use and cigarette smoking, respectively. The adolescents in public school, males, older, with poor knowledge on tobacco/khat, whose fathers/mothers, and/or friends already practicing these habits were more likely to be indulged in these habits. Another surprising and disappointing result was the relatively fair knowledge on, and attitude about the harmful effects of smoking and tobacco use.

Table 3 Multivariate analysis of factors associated with oral habits practice (logistic regression)

	Cigarette Smoking		Shisha use		Khat	
	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value
School (Public)	Reference					
School (Private)	1.4 (1.2, 1.8)	<0.001	1.7 (1.5, 2.0)	<0.001	0.7 (0.7, 0.8)	<0.001
Gender (Female)	Reference					
Gender (Male)	1.9 (1.4, 2.5)	<0.001	0.6 (0.5, 0.7)	<0.001	2.7 (2.4, 3.0)	<0.001
Age group (13–14 yrs)	Reference					
Age group (15–16 yrs)	2.7 (1.7, 4.4)	<0.001	1.2 (1.0, 1.6)	0.056	1.7 (1.5, 2.0)	<0.001
Age group (≥ 17 yrs)	3.5 (2.2, 5.6)	<0.001	1.5 (1.2, 1.9)	<0.001	2.3 (2.0, 2.8)	<0.001
Father's education (Illiterate)	Reference					
Father's education (Elementary/Secondary)	0.5 (0.3, 0.7)	<0.001	1.0 (0.7, 1.2)	0.697	0.8 (0.6, 0.9)	0.006
Father's education (College/University)	0.5 (0.3, 0.7)	<0.001	1.0 (0.8, 1.3)	0.937	0.7 (0.6, 0.9)	0.002
Mother's education (Illiterate)	Reference					
Mother's education (Elementary/Secondary)	1.1 (0.9, 1.5)	0.290	1.1 (0.9, 1.3)	0.228	0.9 (0.8, 1.0)	0.215
Mother's education (College/University)	1.6 (1.1, 2.2)	0.005	1.2 (1.0, 1.5)	0.051	0.7 (0.6, 0.9)	<0.001
Khat chewer No	Reference				-----	----
Khat chewer (Yes)	5.1 (3.9, 6.5)	<0.001	5.2 (4.5, 6.0)	<0.001	-----	----
Parents smoking habit (No)	Reference				-----	----
Parents smoking habit (Yes)	1.7 (1.4, 2.1)	<0.001	2.0 (1.7, 2.2)	<0.001	-----	----
Friends smoking habit (No)	Reference				-----	----
Friends smoking habit (Yes)	3.7 (2.8, 4.9)	<0.001	4.5 (3.8, 5.3)	<0.001	-----	----
Parents Khat habit (No)	-----	----	-----	----	Reference	
Parents Khat habit (Yes)	-----	----	-----	----	3.4 (2.9, 3.9)	<0.001
Friends Khat habit (No)	-----	----	-----	----	Reference	
Friends Khat habit (Yes)	-----	----	-----	----	4.1 (3.5, 4.8)	<0.001
Knowledge level (good)	Reference					
Knowledge level (poor)	2.4 (1.9, 3.1)	<0.001	2.0 (1.6, 2.4)	<0.001	2.5 (2.1, 3.0)	<0.001

The prevalence of khat chewing in our study (42%) is far higher than that among Ethiopian adolescents (27%), where khat is culturally accepted and legally allowed [28], and among Saudi adolescents (20.5%) in Jazan region, where khat is illegal [29]. A much lower global prevalence of khat chewing (14.16%) among university students has been reported [23]. Unexpectedly, out of these 42% of khat chewers in our sample, up to 32% reported doing so at least once a week; 14% reported daily khat chewing. In one study before the civil war in Yemen, the prevalence of khat chewing among adolescents was far lower (11%) [25] than the current study. It should be noted that although khat chewing is a deep-rooted habit in Yemen, the habit was exclusive among adults who are working and have their own incomes; it was entirely shameful for young dependent, non-productive persons to practice this habit. In fact, the spread of this habit began to decline many years before the war, and even a substantial fraction of Yemeni people became convinced of its disadvantages. Even more than that, it was not acceptable for school and university students to practice this habit, and their parents would always discourage them from

doing so. Regrettably, since the civil war (which started in 2014), all the positive aspects of life in Yemen, including the improvement of people's view toward the habit of khat chewing have been ruined. Worse than that, the habit increased more intensively even among people who never practiced it before as a way to escape from their catastrophic circumstances. Parents prefer that their offspring chew khat in their presence than joining any war parties. Indeed, adolescents are attracted easily to this (joining the war militias) because there is no horizon of hope or signs of a solution in Yemen in the near term. Interestingly, the results stressed on the role of the local communities and their beliefs toward these habits: The prevalence of these habits were lowest in Hadhramaut governorate, where the society always fights these habits owing to their positive attitude against them and their belief of their deteriorative effects at all levels: the individual, health, economic, family, and society.

Cigarette Smoking was found to be the least prevalent (6.8%) among the assessed habits in our study. This is exactly the same as what WHO estimated in its "GLOBAL YOUTH TOBACCO SURVEY" in 2014, where

Table 4 Knowledge and attitudes of participants about tobacco use and khat chewing (%)

Knowledge questions		Total N (%)	Gender		P
			Male	Female	
Do you know that smoking is harmful to health?	No	476 (6.3)	366 (7.2)	110 (4.6)	<0.001
	Yes	7003 (93.3)	4706 (92.8)	2292 (95.4)	
Do you know that smoking is harmful to oral health?	No	676 (9.0)	523 (10.3)	153 (6.3)	<0.001
	Yes	6813 (90.8)	4549 (89.7)	2259 (93.7)	
Do you know that smoking is a risk factor for lung cancer?	No	632 (8.4)	475 (9.4)	157 (6.5)	<0.001
	Yes	6852 (91.3)	4596 (90.6)	2251 (93.5)	
Do you know that smoking is a risk factor for oral cancer?	No	1335 (17.8)	921 (18.2)	413 (17.2)	0.301
	Yes	6151 (82.0)	4152 (81.8)	1995 (82.8)	
Do you know that khat is harmful to health?	No	1538 (20.5)	1292 (25.4)	243 (10.1)	<0.001
	Yes	5955 (79.3)	3785 (74.6)	2168 (89.9)	
Do you know that khat is harmful to oral health?	No	1350 (18.0)	1125 (22.2)	224 (9.3)	<0.001
	Yes	6137 (81.8)	3946 (77.8)	2187 (90.7)	
Attitudes questions:					
Do you support banning smoking in public places?	No	1517 (20.3)	1097 (21.7)	419 (17.4)	<0.001
	Yes	5962 (79.7)	3967 (78.3)	1991 (82.6)	
Do you support banning khat in public places?	No	2282 (30.6)	1631 (32.3)	649 (27.0)	<0.001
	Yes	5179 (69.4)	3424 (67.7)	1752 (73.0)	
Do you support conducting educational campaigns on the harmful effects of khat and tobacco in schools?	No	1733 (23.2)	1309 (25.9)	424 (17.6)	<0.001
	Yes	5744 (76.8)	3753 (74.1)	1986 (82.4)	
Do you have the intention to quit Khat chewing?	No	1402 (19.4)	1197 (24.6)	203 (8.7)	<0.001
	Yes	1492 (20.7)	1203 (24.7)	288 (12.3)	
	Non-chewer	4321 (59.9)	2471 (50.7)	1848 (79.0)	
Do you have the intention to quit smoking?	No	162 (2.2)	136 (2.7)	26 (1.1)	<0.001
	Yes	279 (3.8)	249 (5.0)	29 (1.2)	
	Never smoke	6991 (94.1)	4635 (92.3)	2352 (97.7)	

6.8% of 13-15-year-old Yemeni adolescents were found to be current smokers, and even the gender-wise prevalence being very close to ours [30]. Accordingly, the observed steadiness in the prevalence of cigarette smoking might be at the expense of the increased indulging in the other two habits, particularly the habit of shisha use as an alternative to cigarette smoking (see the paragraphs above and below). The prevalence of cigarette smoking habit in our study was somewhat similar or close to that reported among Swiss and Italian middle school students where 4% and 5% of the sample were classified as light and heavy smokers, respectively [31], and among adolescents in Peru (5.7%) [14]. The prevalence of this habit in our study was lower than that reported among adolescents in South Eastern Asian countries (13.1%) [32], Lebanon (24.5%) [33], Saudi Arabia (15.17%) [11], Turkey (11.3%) [34], Qatar (9.8%) [10], and Ethiopia (21.1%) [35]. Contrastingly, this figure is higher than that reported among adolescents in China (2.3%) [36], and South Korea (2.3%) [17].

It seems that shisha use is a trend. Surprisingly, up to 18% of females reported shisha use versus only 2.6% of females who reported cigarette smoking. Even further, the percentage of female shisha users (18%) approaches that of males (20%). This is higher than that reported in the 2014 WHO report (14.1%), but, unlike our results, the prevalence was far higher among males (17.1%) compared to females (7.3%) [30]. According to the above argument, it seems that there is a significant increase in shisha use among Yemeni adolescents, started immediately after the civil war. The above-mentioned figures in our study are higher than the global prevalence of current waterpipe (shisha) use, which was estimated at 6.9%, being highest in the European and Eastern Mediterranean regions (10.9% and 10.7%, respectively), but lowest in the Western Pacific region (1.9%) [19]. Indeed, such a high prevalence of shisha use in our study is worrying. In a study in Syria, a war-torn country like Yemen, a higher prevalence (men 35% and 27.6% women) of shisha use was found [37]. It seems that people in war-torn countries adopt such habits trying to cope with various

stressors and to escape their difficult circumstances. Compared to our study, the shisha use among adolescents is lower in Sudan (13.4%) [38], but slightly higher among Iranian adolescent females (20.4%) [13], and much higher among Lebanese adolescents (33.9%) [33]. Between 2013 and 2018, 4.8% of adolescents in the USA were reported to initiate waterpipe smoking, and 10.6% were reported to continue the habit [39].

Based on the above, it seems that the prevalence of khat chewing and shisha use among Yemeni adolescents has increased while the smoking habit remained steady. Smoking and shisha use are highly linked to khat chewing among adolescents and young adults in countries where khat is legal [40, 41]. In our logistic regression model, the shisha use and cigarette smoking are more prevalent among khat chewers (OR = 5.2 and 5.1, respectively). Shisha users argue that shisha is less harmful than smoking [42]. Moreover, in difficult circumstances like the civil war in Yemen and Syria, where there appears to be no prospects for hope and peace, no job opportunities, and where the education and health systems and all services have deteriorated, the risky health concerns or behaviors increase among local population or refugees, especially adolescents [37, 43]. In addition, people, particularly adolescents and females, now consider shisha use as a prestigious and fashionable practice [44]. With regards to khat chewing, many factors explain the trend of its increased prevalence after the civil war. One of the major factors is that khat cultivation and marketing have now become the central backbone of economy, pushing so many people to work in its cultivation and marketing.

The determining factors of the assessed habits seem to be global. Our study was not an exception although retains its peculiarities. Indeed, in our study, individuals are more likely to be indulged in one or all of these habits in case they are adolescents in public school, males, older, have low knowledge on tobacco/khat, low parental education levels and have friends or parents who practice these habits. Presence of individuals practicing any or all of these habits from the close circle (parents, close friends, teachers, ...etc) plays a pivotal role in this context [1, 16, 45]. As mentioned earlier, it is a global trend that more males practice these habits than females [1, 2, 46]. In Yemen, there are cultural considerations that restrict females to indulge in these habits. Age, particularly during adolescence, is considered a significant predictor of tobacco use [1, 47]. The positive effect of parents' education in fighting the bad habits like tobacco and drugs use is well-documented [48, 49]. Indeed, the lower parents' education level might be associated with modeling of parental behaviors of these habits, inadequate parental monitoring, lower access to information about health

risks and to preventive health services owing to the lower knowledge [49].

Of utmost importance, the knowledge on, and attitude toward the addressed habits were fair. It was surprising that up to one fifth of the subjects did not know that khat chewing is harmful to one's general or oral health. The knowledge on smoking was better, with only 9.3% and 9.1% reported that tobacco is not deteriorative to general and oral health, respectively. There was discrepancy between the above knowledge with the reported attitude: 21% and 31% reported they don't support banning smoking and khat chewing, respectively, in public places. The reported knowledge on, and attitude toward these habits were highly variable by different factors. In support of our study, such knowledge and attitude were found worse among those who indulged in any of the habits [12, 50]. The results emphasize the importance of periodic educational programs on the harmful effects of tobacco/khat habits among school going children and adolescents.

This study has its strengths and limitations. Among its strengths are the following: it comprised a very large sample size, covered different and main cities in Yemen, included public and private schools, and addressed multiple dimensions of khat chewing, shisha use and cigarette smoking namely prevalence, predictors, knowledge and attitude. However, the present study has many limitations that should be highlighted. The main limitation is the lack of proper probability sampling, which is the backbone of school-based cross-sectional studies. Additionally, a lack of proper cluster analysis is another important limitation of the presents study. Furthermore, while the study included a large sample size from different main cities in Yemen, schools located in rural areas were not included. Considering the above-mentioned limitations, the generalizability of the results might be questionable and thus might not be extrapolated to all adolescents in Yemen.

To sum up, the prevalence of khat chewing, shisha use, and to less extent cigarette smoking, are high among Yemeni adolescents. The substantial determinant factors include male gender, older age, low knowledge on the harmful effects of tobacco/khat, parents' low education levels, and parents' and peers' smoking/chewing habits. The study also revealed fair knowledge on, and attitude toward these habits among the Yemeni adolescents. The results emphasize the importance of combating these widespread habits in our society and considering them public health priorities. Therefore, proper and well-tailored guidance and educational programs and campaigns must be initiated and directed to everyone, and to this age group in particular.

Supplementary Information

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Supplementary Material 1

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Authors' contributions

Sadeq A. Al-Maweri: Study conceptualization, data analysis, drafting the manuscript, final editing, overall supervising the study. Mohammed Nasser Alhaji, Asma Saleh Almeslet: Data collection, data analysis, drafting the manuscript. Esam Halboub, Saba Kassim, Walid Al-Soneidar, Abdulaziz Asiri: manuscript drafting, critical revising the manuscript; Anas Shamala, Baleegh Abdulraoof Alkadasi, Abdullah Ghalib Amran, Faisal Abulohom, Hesham Mohammed Al-Sharani, Mohammed Abdullah Basalamah, Zakarya Al-Muaalem, Saleem Abdulrab: data curation, critical revising the manuscript. All authors read and approved the final version.

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Availability of data and materials

All data generated or analyzed during this study are available from the corresponding author at a reasonable request.

Declarations

Ethics approval and consent to participate

The study was approved by the ethical committee, Ibb University, Yemen (Ref #: B2021-078 H). All participants were informed about the purpose of the study, and informed consent was obtained from all participants. For the participation of those who were younger than 16 years old, we received formal consent from the relevant school authorities, as well as consent from their parents or guardians.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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