Prevalence of hookah pipe smoking in high-school learners in Johannesburg, South Africa

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Background. Hookah pipe (HP) smoking has become popular globally, especially among young adults and adolescents. There are misperceptions regarding the safety of HP smoking, relative to cigarettes.
Objectives. To assess the prevalence of HP use in grade 8 and 12 students and the factors associated with use in the different age groups.
Methods. A cross-sectional study was conducted in grade 8 and 12 high-school students from six randomly selected public schools in Johannesburg, South Africa. A self-administered structured questionnaire was completed by students after consent had been obtained from parents and students. The questionnaire focused on knowledge and awareness of HP smoking. Data were analysed using Stata/SE version 15. A p-value <0.05 was considered significant.
Results. A total of 347 grade 8 and 232 grade 12 students participated in the study. Of the sample, 26% in grade 8 and 70% in grade 12 had ever smoked an HP. In both grades a higher proportion of males smoked. Eleven percent of students in grade 8 and 37% in grade 12 were currently smoking the HP. Approximately 47% and 51% of grade 8 and grade 12 students, respectively, first started smoking at parties. The mean age of initiation was 8 and 12 years in grade 8 and 12, respectively. Grade 12 students had greater awareness of the risks of HP smoking. Having a family member who smoked an HP was significantly related to HP use in grade 8 students. Overall, factors associated with increased odds of smoking the HP were being in grade 12, not being aware of health effects, and seeing the health warnings on hookah tobacco package labels.
Conclusions. HP smoking increased significantly between grades 8 and 12. Increasing knowledge and awareness of the risks involved in HP smoking in children at an early age is recommended. One of the factors influencing uptake of HP smoking in young students was having a family member smoking it; adult anti-smoking and anti-HP campaigns are therefore also important.

S Afr Med J 2020;110(6):546-551. https://doi.org/10.7196/SAMJ.2020.v110i6.14333

Hookah pipe (HP) smoking is an ancient practice originating in Persia and India, where it was practised mostly by men.[1] In the past two decades or so, HP smoking has become increasingly popular, reaching global tobacco epidemic proportions.[2,3] HP smoking is socially appealing, especially to the youth, because of its affordability, the novelty of the flavoured tobaccos, and the social atmosphere in which smoking usually occurs; the mystic appeal associated with HP smoking is also alluring.[4] Because of the moist smoke, HP smoking is less harsh than cigarette smoking.[5] Hookah cafes or lounges, often located near college campuses, have become increasingly popular for socialising, and hookahs are commonplace at college parties.[1,6,7]

International studies have shown that the mean age for initiating HP smoking is ~17 years, with a high prevalence among college students, including medical students.[8-14] Studies in the USA have reported high levels of HP smoking in middle- and high-school students. Similarly, in South Africa (SA) a high rate of HP use has been reported among schoolchildren aged 13 - 15 years and university students, including health sciences students.[6,15-17]

Students of relatively high socioeconomic status and having tertiary education are more likely to smoke HPs than other students.[17,18] This is in contrast to some other tobacco products, where higher use is associated with low-income and low-education groups.[19,20]

The hookah (or waterpipe) device uses a water pipe to pass charcoal-heated air through a tobacco mixture and ultimately through a water-filled chamber. The smoke, which has been filtered through the water, is inhaled through a tube fitted with a mouthpiece.[1] According to historians, the HP was invented in about 1610 by an Indian physician, Hakim Abul Fath, who suggested that passing the smoke through water before inhalation would render it harmless.[21,22] This belief, still held by many hookah users today, is unsubstantiated.[23] Nicotine is delivered via flavoured and sweetened products in socially appealing settings where substantial misinformation about the practice is passed along.[24] Other substances that may be added to hookah tobacco include marijuana and alcohol.[15]

The knowledge gap and misperceptions around the safety of HP smoking are well documented.[4,6,8,14,25,26] Compared with cigarettes, where a smoking session lasts 5 - 7 minutes, hookah smokers are exposed to tobacco smoke for 20 - 80 minutes.[23] The two methods of tobacco use (HPs and cigarettes) are equally damaging and likely to share some of the same health risks, including respiratory illnesses, heart disease, lung cancer, pregnancy-related complications, low birthweight and periodontal disease.[5,27-29] Nicotine, tar, particulate matter, and toxic substances such as metals and carcinogens are efficiently delivered through HPs together with high levels of carbon

monoxide and smoke exposure.[4,27-29] In addition, hookah use is associated with initiation of and susceptibility to cigarette smoking among young adults, as well as consumption of alcohol, marijuana, and other illicit substances.[20,30]

Objectives

To assess the prevalence of HP smoking in grade 8 (first year of high school) and grade 12 (last year of high school) at selected schools in Johannesburg, SA.

Methods

Population and sampling

A cross-sectional study was conducted in grade 8 and grade 12 classes at schools in Johannesburg. A comprehensive list of schools was obtained from the Gauteng Department of Education, from which 15 schools were randomly chosen. Each school was estimated to have four classes per grade and 25 students per class. It was then estimated that ~3 000 students would be eligible to participate. At the time of sampling, prevalence data for HP smoking were not available. A prevalence rate of 50% was used, with a precision of 2% and a 95% confidence interval (CI), to obtain a sample of 1 334 participants. However, only six schools consented to participate in the study, and a total of 579 students with parental consent participated. A response rate of 43% was obtained.

Prior to the study, information sessions were arranged with teachers at the participating schools to explain the study and the associated requirements. The principals and teachers were given consent forms and information letters to distribute to parents of the eligible students. All eligible students who returned signed consent forms and completed questionnaires were included in the study. Students aged >18 years were able to provide their own consent to participate.

Data collection

A self-administered questionnaire was given to each student participating in the study during school hours. The questionnaire took ~30 minutes to complete. A member of the research team was available to explain questions that were not clear to students. Class teachers were not present during the completion of questionnaires. On completion, questionnaires were collected by a member of the research team.

Questionnaires included questions on demographics (including family asset ownership), HP smoking practices among students, friends and family members, perceptions of HP smoking, and knowledge of potential health effects.

Statistical analysis

Data were entered into Excel 2013 (Microsoft Corp., USA) and subsequently exported into the Stata Statistical Software, Release 15 SE (StataCorp, USA) statistical package for analysis of the data. Quality assurance was performed by double entry of the data. Descriptive analyses used numbers and percentages for categorical variables, and means and standard deviations or medians and interquartile ranges were calculated for continuous variables. Bivariate and multivariate regression analyses for the associations between various factors and HP smoking in grade 8 compared with grade 12 students were undertaken. Adjusted odds ratios (AORs) and 95% CIs were calculated. A p-value <0.05 was considered statistically significant.

Results

A total of 579 students participated in the study, with 347 in grade 8 and 232 in grade 12. The mean age in grade 8 was 14 years (range 12 - 17) and that in grade 12 was 18 years (range 16 - 22). The average age of first use of an HP was ~8 years and ~12 years among grade 8 and grade 12 students, respectively. In grade 8, the majority of students were female (64%), compared with only 47% in grade 12. Grade 12 students' family asset ownership for >3 assets was 88%, compared with 51% for students in grade 8. Ownership of household assets (such as motor vehicles, microwave ovens, smart phones and computers), as a proxy for socioeconomic status, was not significantly associated with HP smoking in either grade.

In grade 8, 26% (n=89) of the sample had ever smoked an HP, compared with 70% (n=162) in grade 12. In both grades, a higher proportion of male students had tried the HP (28.0% of all males in grade 8 and 76% in grade 12). The difference in prevalence of HP smoking between males and females was significant in grade 12 only (p=0.04).

Among grade 8 students, 63% knew what an HP was, compared with 90% in grade 12. Table 1 illustrates the differences in demographic and behavioural characteristics that could potentially influence the uptake of HP smoking between grade 8 and grade 12. There was a significant difference between grade 8 (26%) and grade 12 (70%) in the proportion of students who had ever smoked an HP (p<0.001; 95% CI 1.457 - 1.759). In grade 12, 53% of students who had tried an HP continued to smoke regularly, compared with 42% in grade 8. Overall in the total sample, 49% of students who had ever tried an HP continued to become current users. Relatively low proportions of the sample in both grades reported currently smoking cigarettes: cigarettes only or a combination of cigarettes and the HP. The majority of HP smokers in both grades did not smoke cigarettes.

A party was the setting for first use of an HP for 47% and 51% of grade 8 and grade 12 students, respectively (Table 1). The three most common reasons for smoking HPs in grade 8 were the taste and smell (45%), pressure or appeal from seeing friends using HPs (42%), and because they were at parties where HPs were being used (35%). For grade 12 students the reasons were similar: when at parties (63%), with friends (48%), and the taste and smell of the product (25%). A higher percentage of students in grade 8 than in grade 12 smoked with their families (11% v. 5%). In both grades, students' use of HPs was significantly associated with family use of the device (grade 8: p=0.004; grade 12: p=0.029). In addition, students in both grades reported the addition of substances such as tobacco, alcohol and marijuana (44% in grade 12) to HPs.

Grade 12 students had a higher level of awareness of the risks associated with smoking an HP than those in grade 8 (Table 2). Over 20% of students in both grades who had ever smoked the HP would recommend smoking it to friends. Less than half of the grade 8 students had observed warnings on HP tobacco packages, compared with 54% of grade 12 students. In both grades ~70% reported believing that they would stop smoking if they knew it was harmful to their health. This finding contrasts with 63% (n=102 of the 162 students who had ever smoked an HP) of grade 12 students reporting that they believed HP smoking to have similar detrimental health effects to cigarette smoking (among grade 8 students who had ever smoked an HP, ~18% believed that cigarettes and HP tobacco had similarly detrimental ill-health effects). Of those who currently smoked the HP, 32% in grade 8 and 52% in grade 12 continued to smoke despite being aware that HP smoking had a similar health effect to cigarette smoking.

The knowledge and awareness factors were included in multiple regression analyses. In grade 12, there was a significantly increased AOR (3.26; 95% CI 1.633 - 6.546) for HP smoking despite seeing the health warning on the package. The AOR was lower for HP smoking

Table 1. Differences in behavioural factors associated with HP smoking (ever and current) between grade 8 and grade 12 students

Variable	Grade 8 (*N*=347), *n* (%)	Grade 12 (*N*=232), *n* (%)	*p*-value
Age (years)			
Mean	13.9	18.1	
Median	14	18	
Range	12 - 17.4	16 - 22	
Sex, *n* (%)*			
Male	125 (36.1)	119 (51.3)	
Female	221 (63.7)	109 (46.9)	<0.001
Ever smoked an HP, *n* (%)	89 (25.6)	162 (69.8)	<0.001
Currently smoking an HP, *n*(%)	38 (10.9)	86 (37.1)	<0.001
Smoking cigarettes, *n* (%)	19 (5.5)	32 (13.8)	0.001
Smoking HP and cigarettes, *n* (%)	13 (3.7)	28 (12.1)	0.001
Setting of first use of HP, *n*/*N* (%)			
At a party	42/89 (47.2)	82/162 (50.6)	0.001
Friends	16/89 (17.9)	15/162 (9.3)	0.001
Home	16/89 (17.9)	5/162 (3.1)	0.856
School (ref.)	11/89 (12.4)	11/162 (6.8)	-
Where do you normally smoke the HP, *n*/*N* (%)			
School (ref.)	1/89 (1.1)	0	-
Home	12/89 (13.5)	17/162 (10.5)	0.036
Party	42/89 (47.2)	97/162 (59.9)	<0.001
Neighbourhood	24/89 (26.9)	23/162 (14.2)	0.196
With friends	5/89 (5.6)	30/162 (18.5)	<0.001
HP smoking frequency, *n*/*N* (%)			
Daily	1/38 (2.8)	1/86 (1.2)	
≥1 times a week	6/38 (16.7)	6/86 (6.9)	
<1 times per week	20/38 (55.6)	15/86 (17.7)	
Only now and then	8/38 (22.2)	63/86 (74.1)	<0.001
Substances added to the HP, *n*/*N* (%)			
Tobacco	53/89 (59.6)	44/162 (27.2)	<0.001
Alcohol	42/89 (47.2)	72/162 (44.4)	<0.001
Marijuana (dagga)	10/89 (11.2)	71/162 (43.8)	<0.001
Top six reasons for smoking the HP, *n*/*N* (%)			
Boredom	24/89 (27.0)	32/162 (19.8)	<0.001
At a party	31/89 (34.8)	102/162 (62.9)	0.035
With friends	37/89 (41.6)	77/162 (47.5)	<0.001
For pleasure	9/89 (10.1)	33/162 (20.4)	0.004
When you want to relax	17/89 (19.1)	16/162 (9.9)	<0.001
Taste and smell	40/89 (44.9)	41/162 (25.3)	<0.001
Family smokes the HP, *n* (%)	96 (27.7)	90 (39.7)	0.018
Smoke HP as a family activity, *n* (%)	39 (11.2)	42 (4.7)	0.026

HP = hookah pipe.
*Missing data, so totals do not add up to 100%.

among students who reported being aware of the addictive nature of HP smoking (0.24; 95 % CI 0.088 - 0.638). In grade 8, the AOR was significantly decreased only if students were aware that HP smoking is associated with cancer (0.28; 95% CI 0.086 - 0.908).

Although a high proportion of students in both grades shared mouthpieces, over 60.0% knew that they needed to clean the mouthpiece when sharing.

Using grade 8 as a baseline, in grade 12 there was a significant AOR (4.63; 95% CI 2.337 - 9.166) for HP smoking (Table 3). Among students who had observed health warning labels, there was a 2.1 times increased odds ratio (95% CI 1.427 - 3.447) for continuing to smoke an HP. Students who were aware that health effects of the HP are similar to cigarette smoking were significantly less likely to currently be smoking an HP. However, 38% of students overall would still recommend smoking the HP (AOR 5.38).

Discussion

The results indicate that in this sample, 26% of students in grade 8 had tried HP smoking, and 11% reported currently smoking HPs. Around 43% of grade 8 students who had ever smoked HPs were currently using the device. Among grade 12 students, significantly elevated proportions had tried smoking HPs (70%) and were currently using the device (37%). The prevalence of HP smoking in both groups is much higher than that reported in New York City, USA, in 2014, where 5% in the middle-school age group (12 - 14 years) smoked the HP. In the same USA study, among high-school students overall, 6%

Table 2. Differences in knowledge and awareness of effects of HP smoking between grade 8 and grade 12 students

	Grade 8 (*N*=347)		Grade 12 (*N*=232)		
Variable	***n* or *n*/*N* (%)**	**Crude OR (95% CI)†**	***n* or *n*/*N* (%)**	**Crude OR (95% CI)†**	***p*-value**
Does HP smoking affect health?	156 (44.9)	0.48 (0.290 - 0.803)*	168 (72.4)	0.67 (0.341 - 1.356)	<0.001
Is it possible to get addicted to smoking HPs?	172 (49.6)	0.577 (0.345 - 0.952)*	157 (67.6)	0.17 (0.071 - 0.427)**	<0.001
Do you think smoking HPs can cause the following					
Similar health effects to cigarette smoking	160 (46.1)	0.49 (0.278 - 0.885)*	153 (65.9)	0.41 (0.191 - 0.872)*	0.079
Cancer	175 (50.4)	0.37 (0.216 - 0.665)**	159 (68.5)	0.50 (0.247 - 1.028)	0.061
Coughing	180 (51.9)	0.67 (0.371 - 1.199)	174 (75.0)	0.53 0.237 - 1.168)	0.027
Mouth sores	125 (36.0)	0.41 (0.229 - 0.751)**	119 (51.3)	0.480 (0.258 - 0.893)*	0.556
Influenza (flu)	103 (29.7)	0.74 (0.411 - 1.322)	84 (36.2)	0.93 (0.510 - 1.709)	0.517
Would you recommend the use of HPs to friends?	20/89 (22.5)	4.58 (2.219 - 9.464)	45/162 (27.8)	12.41 (2.915 - 52.862)**	<0.01
Have you seen health warnings on HP tobacco packaging?	32/89 (35.9)	2.04 (1.195 - 3.509)**	88/162 (54.3)	2.62 (1.431 - 4.793)**	0.01
Would you stop using HPs if you knew it was harmful to your health?	64/89 (71.9)	1.088 (0.511 - 2.319)	110/162 (67.9)	0.478 (0.104 - 2.189)	0.123
Have you tried to give up smoking HPs?	50/89 (56.2)	3.93 (1.988 - 7.759)**	37/162 (22.8)	0.46 (0.109 - 1.951)	<0.01
Do you share an HP mouthpiece with others?	54/89 (60.7)	-	131/162 (80.9)	-	<0.001

HP = hookah pipe; OR = odds ratio; CI = confidence interval.
*p<0.01 (refers to significant differences within a grade), **p<0.001 (refers to significant differences within a grade).
†Crude OR presented for the OR in each grade between those who had ever smoked and those who had never smoked.

Table 3. Factors associated with current use of the HP in the total sample (*N*=124)

Variable	***n* (%)**	**Crude OR (95% CI)**	**AOR (95% CI)**
Grade 8 (ref.)	38 (30.6)		
Grade 12	86 (69.4)	4.789 (3.117 - 7.359)**	4.629 (2.337 - 9.166)**
Sex			
Male	66 (53.2)		
Female	55 (44.4)	0.859 (0.574 - 1.286)	
Does HP smoking affect health?	72 (58.1)	0.969 (0.645 - 1.457)	
Is it possible to get addicted to smoking HPs?	69 (55.6)	0.760 (0.503 - 1.149)	
Do you think smoking HPs can cause the following			
Similar health effects to cigarette smoking	57 (45.9)	0.432 (0.277 - 0.675)**	0.734 (0.182 - 0.770)**
Cancer	71 (57.3)	0.722 (0.466 - 1.118)	
Coughing	80 (64.5)	0.769 (0.480 - 1.233)	
Mouth sores	42 (33.9)	0.456 (0.291 - 0.714)**	1.010 (0.517 - 1.974)
Influenza (flu)	38 (30.6)	0.712 (0.453 - 1.119)	
Would you recommend the use of HPs to friends?	47 (37.9)	6.749 (4.088 - 11.142)**	5.381 (2.450 - 11.816)**
Have you seen health warnings on HP tobacco packaging?	61 (49.2)	2.153 (1.427 - 3.247)**	2.409 (1.249 - 4.646)**
Would you stop using HPs if you knew it was harmful to your health?	89 (71.8)	0.521 (0.245 - 0.922)*	0.257 (0.115 - 0.573)**
Have you tried to give up smoking HPs?	45 (36.3)	0.738 (0.454 - 1.202)	

HP = hookah pipe; OR = odds ratio; AOR = adjusted odds ratio; CI = confidence interval.
*p<0.01, **p<0.001.

of students reported current smoking of HPs.[31] In North Carolina high schools, the prevalence of HP smoking was reported to be 6% in 2013.[32] In Iran, which has a longstanding HP smoking tradition, 6% of high-school students aged 14 - 19 years (mean 15.7) regularly used HPs.[33] The average age of initiating HP smoking in our study was between 8 and 12 years overall, which is much lower compared with international and local research.[8,9,15] In the USA, the average age of initiating HP smoking was 14.1 years.[34] Research has shown that younger age of initiating tobacco smoking can increase the risk of lifetime addiction to tobacco products.[34] Socioeconomic status was not significantly associated with HP smoking in either grade. However, previous studies have shown higher levels of HP use among students of relatively elevated socioeconomic status.[20] In SA, research by Combrink *et al.*,[15] conducted in a socioeconomically disadvantaged community in Johannesburg, indicated a prevalence of ever smoking a HP of 60% among grade 10 students. In certain SA settings, it therefore appears that levels of use of HPs are highly elevated relative to other parts of the world, including relatively low-resource settings.

Our study showed no significant differences in HP smoking prevalence by sex among grade 8 students; however, in grade 12, more males than females used HPs. This finding differs from the situation in certain other parts of the world. In the USA in 2014, for example, it was shown that in middle (around the grade 8 age group) and high school, females were significantly more likely than males to use HPs.[31] Similarly, among 17 - 19-year-olds in Serbia, the

prevalence of HP use was higher among females.[35] The situation in SA was more comparable with that in Iran, where HP use (ever and current smoking) was elevated among boys.[33] A study in Ontario, Canada, on the other hand, showed no difference in HP use between males and females.[36]

The three most widespread reasons for smoking HPs in grade 8 and grade 12 were similar: the taste and smell, because friends were smoking, and when at parties. In grade 12 in particular, social contexts such as parties were associated with HP use (~60% of grade 12 students reported smoking mainly at parties). Parties were also the setting for student initiation of HP use, as well as for continued HP smoking. Having a family member who smoked was significantly associated with student use of HPs in the univariate analyses (28% in grade 8 and 40% in grade 12), but the association did not retain significance in the regression analyses. Previous studies in Saudi Arabia, Serbia, Lebanon and Iran have reported similar findings.[35,37-39]

Levels of knowledge and awareness of HP smoking were higher among grade 12 compared with grade 8 students. For example, 72% of grade 12 as opposed to 45% of grade 8 students knew that HP smoking could detrimentally affect health. Awareness of associations between HP use and selected specific health effects was also higher in grade 12 than grade 8 students. Similarly, more grade 12 (68%) than grade 8 (50%) students knew that smoking an HP is addictive. Approximately 70% of students reported that they would stop smoking if they knew that HP use was harmful. It was noted in the Serbian study that adolescents were generally aware of the harmful effects of HP smoking.[35] The health warnings on HP tobacco packages had been seen by only 36% and 54% of our grade 8 and 12 students, respectively. However, despite seeing the health warnings, the grade 8 and grade 12 students continued to use the HP. Ly *et al.*[40] had similar findings in a qualitative study in young adults. The reason provided by the participants was that HP smoking was a social activity that was not practised daily, so it would not result in adverse health consequences.[40] HPs constitute a gateway to cigarette, drug and alcohol use (students in both grades reported adding substances such as alcohol, marijuana and tobacco to the HP; 44% of grade 12s added marijuana).[20,30]

The present study has highlighted the high prevalence of HP use among high-school students attending selected public schools in Johannesburg. The study also provides useful information on which to base the design and implementation of public awareness campaigns related to HP in high-school students in SA.

Study limitations

Among the limitations of the study were its small scale and cross-sectional design, and therefore its limited generalisability. Only public schools were included, and the prevalence of HP use in private schools with higher socioeconomic status may be even higher, as reported in international studies.[17,18] Interviewer bias could have affected the results. Smoking is a banned activity in schools, and students may not have fully disclosed their HP practices.

Conclusions

Relative to other parts of the world, the present study found highly elevated levels of use of HPs in high-school students, especially older males. Since the age of onset of HP use was reported to be between and 8 and 12 years, primary schools may be an important target for public education campaigns. Despite their having better awareness of its detrimental health effects, the prevalence of HP use was higher in grade 12 than grade 8 students. The findings point to an urgent need for awareness campaigns to alert students and their families to the hazards of HP use, especially given the evidence from this study that the HP may be serving as a gateway for exposure to substances such as alcohol and marijuana.

Declaration. None.

Acknowledgements. None.

Author contributions. NN and AM conceptualised the study. Methodology: NN, PA, AM. Data collection, supervision and management: PA. Data analyses: NN. Writing, review and editing: NN, JT, PA, AM. All authors read and approved the manuscript.

Funding. The study was funded by the South African Medical Research Council.

Conflicts of interest. None.

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Accepted 27 November 2019.