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ORIGINAL PAPER

Identifying the Determinants of Hookah Smoking Among the Youth; A Mixed-Methods Study

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Abstract

Hookahs have been rising in popularity in the United States (U.S.) especially among the youth yet not much research has been carried out to understand the various predictors of hookah use among youth. We have thus conducted a cross-sectional study with a mixed-methods triangulation design to identify the hookah use determinants at different levels of the Social Ecological Model among youth. Participants between the ages of 18–24 years were sampled purposively, between April to November 2023, following a snowballing technique from various communities in Virginia and California, United States. Data were collected via a survey, one-on-one interviews, and focus groups. The study had a total sample size of 20. We found that participants smoked for a median of 5 times in the past 30 days. The main determinants of hookah smoking included the limited knowledge of health effects and addiction, positive attitude, family and peer influence, use as a means to socially connect with others, culture, social acceptability, lack of education at school and work place, access to hookah bars and smoke shops, and lack of strict enforcement of laws to ban smoking of youth. Educational interventions should be implemented by public health authorities to target the youth, their social and communities to provide education on hookah harm and addictiveness and to restrict access to- and the production, distribution, marketing and sales of hookahs.

Keywords Determinants · Hookah smoking · Social Ecological Model · Youth

Background

Population-based tobacco control interventions have succeeded in reducing cigarette smoking prevalence in the past few decades [76], yet the use of other tobacco products, such as electronic cigarettes and hookahs, has been on the rise [16]. Hookahs, also known as argileh, shisha, narghile, hubble-bubble, and goza, are water pipes used for smoking specially-made tobacco. Hookah smoking, which originated from ancient Persia and India, involves the passage of smoke through water prior to inhalation [16]. Research indicates that hookah use is highly detrimental and can increase the risk of morbidity and mortality for smokers and those around [8].

Despite the health risks associated with hookah smoking, hookahs have been rising in popularity in the United

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States (U.S.) especially among the youth [16]. According to the CDC, almost 8% of high school students reported using hookah to smoke tobacco in 2018 [16] yet there are very few public health interventions to address this issue. Additionally, the U.S. Food and Drug Administration (FDA) does not have strict regulations for the production, distribution, marketing and sales of hookahs [25]. A review of smokefree laws indicated that many of the major U.S. cities that prohibit indoor cigarette smoking had exemptions for hookah smoking [59]. Leading brands of many tobacco products, such as hookah and e-cigarettes, utilize the social media extensively as a platform to increase sales. Brand pages on social media mostly did not display health warnings, seldom used an age verification system, and displayed images of youth using the products to appeal to the younger generation [5, 45, 56]. Youth and young adults are frequent users of social media which places them at high susceptibility to misinformation about the health effects of these products.

Assessing the prevalence and main predictors of hookah smoking is thus highly critical as it would highlight the urgency of conducting family- and policy-wide interventions. Various systematic reviews have highlighted the correlates of hookah smoking including affordability and accessibility, substance, culture, mental health, positive social appearance, and misconceptions about its lack of health impacts [2, 18, 31, 50]. However, not much focus has been placed on the individual and societal/policy determinants of hookah smoking among youth [2, 18, 31, 50]. We have thus conducted a study to identify the various factors associated with the use of hookah at different individual, interpersonal, and policy levels among youth using the Social Ecological Model (SEM) [17] as a framework.

Methods

Study Design

A cross-sectional study using a mixed-methods triangulation design was carried out to identify various behavioral and environmental determinants of hookah smoking (Fig. 1). The study included a survey, interviews, and 2 focus groups to collect data on the factors that influence behaviors and explain the use of hookah at the different levels of the SEM including the intrapersonal, interpersonal, organizational, community and policy levels.

Study Recruitment and Participants

Participants

To be eligible, participants had to be between the ages of 18–24 years [75], had to have a minimum hookah smoking frequency of once per month, and had to be willing to complete the survey. Individuals not willing to complete the survey, those who were below the age of 18 or above the age of 24 years, and those who did not smoke hookah at least once per month were excluded from the study.

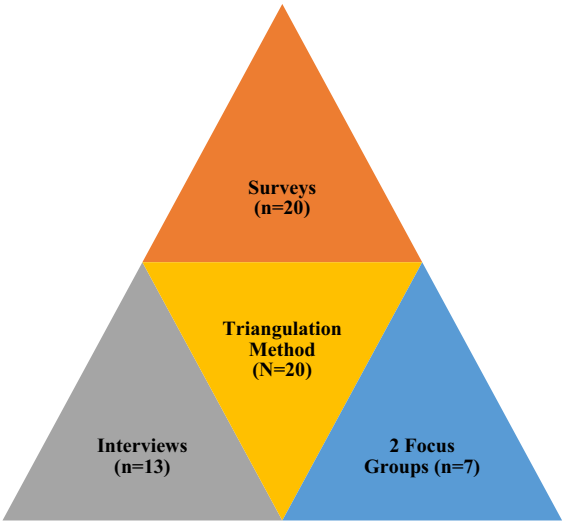

Fig. 1 Triangulation method to examine the predictors of hookah use among youth. A mixed-methods approach using triangulation was used. All 20 subjects completed the questionnaire, with 13 participating in individual one-on-one interviews, and 7 participating in focus groups (group #1: 4 participants; group #2: 3 participants)

Recruitment

Participants were sampled purposively between April to November 2023, following a snowball technique [35] from hookah lounges, universities, cafes, places of worship, restaurants, and malls in various communities in Virginia (east coast) and California (west coast), United States. Participants were encouraged to invite their friends and family to participate in the study and/or provide the principal investigator (PI) with contact information for potential candidates. The research assistants communicated with the participants via email to explain the rationale for the study, invite them to participate, provide the informed consent document, and schedule a zoom meeting.

Data Collection

Data collection was carried out between April to November 2023 during which the PI met with the participants on Zoom for 30–35 min. During the first 10–15 min, all participants (n = 20) were asked to scan a QR code in order to access and complete the hookah smoking survey. Then, the PI either conducted the interviews or focus groups. Each participant received $40 visa card as an incentive. The study

was approved by the Institutional Review Board of James Madison University (IRB # 23–4010) and California State University Dominguez Hills (IRB # 2024–57).

Hookah Survey

The entire study population had to complete a comprehensive survey on hookah use. Questions of the survey were developed based on the SEM model and on the World Health Organization-Global School-based Student Health Survey [10, 41]. The validity and reliability of this survey were confirmed in a previous investigation [41]. The first section of the survey included questions for background information and basic characteristics such as age, gender, race, ethnicity, family income, and employment status. The next section encompassed questions on the participants' first hookah experiences, and on the frequency, duration, perception, knowledge of health impacts, attitude, smoking location, environment, social aspect, smoking reasons, comparison to cigarette smoking, frequency of visits to hookah lounges, and favorite flavor and brand. It also included a set of questions to examine future hookah use intention and readiness to quit hookah smoking.

Interviews

Immediately upon survey completion, the PI performed 13 in-depth one-on-one interviews to learn more about the participants' hookah smoking habits and the factors associated with their hookah use. A semi-structured interview guide was developed according to the framework of the SEM of health promotion at five levels. The guide included sections for each of the SEM levels of influence. Under each SEM level, different constructs were developed based on literature. For instance, under "intrapersonal level" we included "beliefs" and "knowledge". Under the "interpersonal level" we included "family", "friends", and "other external factors". Under "organizational", we included "work" and "school". Under community, we included "Hookah Bars" and "Other Places". Under "Policy", we included "Media" and "Laws/Policies".

Then, a few questions were developed under each construct. For instance, for the "community level" under the "other places", we asked "What other places in your community did you see people smoking hookah before you started smoking?". For the "policy level" and under the construct "Media", we asked "Did you see ads for hookah before you started smoking?". Finally, after each question, probe questions such as "Would you explain more?", "Would you provide an example to clarify?" were asked to explore the depth of the matter. The interview continued until data saturation was reached.

Focus Groups

To dive even deeper into the issues and to explore additional hookah smoking determinants we and conducted two focus groups ($n=4$ and $n=3$, respectively). Similar to the interview process, participants were asked to scan a QR code and access and complete the hookah smoking questionnaire. Then, the PI conducted and moderated the focus groups to learn more about participants' hookah smoking habits and the factors associated with their hookah use. These included the main enticing factor behind hookah smoking; most frequent hookah location; parents' attitudes towards the participants' hookah smoking; correlation with other addictive habits; knowledge of harm, such as carcinogens, tar, and nicotine; accessibility in the community and in hookah bars; hookah regulations/laws; and plans for cessation.

Data Analysis

Data were analyzed using SPSS version 29 (IBM SPSS, Inc., Armonk, NY) with a level of significance set at $\alpha=0.05$.

Reliability

To assess reliability and provide a measure of the internal consistency of the hookah questionnaire, the values of Cronbach's alpha were computed for different constructs to examine the correlation between the different items of each construct of the questionnaire (location, health effects, and perception). Spearman rank correlation analyses were performed.

Demographics

The demographic characteristics of the participants were summarized and presented in Table 1. Based on distribution of the quantitative variables, data were displayed as either mean ± standard deviation or median (interquartile range). The categorical variables were presented as frequencies (percentage).

Survey Responses

The participants' survey responses related to hookah use, habits, frequency, location, etc. were displayed as frequencies (percentage) in a table and various graphs. To examine whether there are significant differences between each category of each question, chi-square goodness of fit test was performed and a p value was generated.

Table 1 Basic characteristics of the hookah study population (n = 20)

Variable[a]	
Age	21 ± 1.56
Family Income	$113,666.67 ± 78,250
Gender	
Male	12 (60)
Female	8 (40)
Employment Status	
Unemployed	13 (65)
Employed Part-Time	3 (15)
Employed Full-Time	4 (20)
Race	
White	17 (85)
Assian	3 (15)
Religion	
Christian	10 (50)
Muslim	8 (40)
Other	2 (10)
Marital Status	
Single	19 (95)
Living with a domestic partner	1 (5)
Student	
Yes	15 (75)
No	5 (25)
School Level /Grade	
Freshman	2 (10)
Sophomore	1 (5)
Junior	8 (40)
Senior	3 (15)
Graduate	1 (5)
Age of Hookah Smoking Initiation (yrs)	17 (2)
Hookah frequency the past 30 days	5 (6)

[a]Data are displayed as frequency (percentage) for nominal/categorical variables and as mean ± standard deviation or median (interquartile range) for scale variables

Qualitative Data

All interviews and focus groups were recorded and transcribed by Zoom. The PI and research assistant independently reviewed each Zoom-generated transcription twice line-by-line while listening to the corresponding recording to make corrections, thus ensuring verbatim transcripts. An open coding approach was employed to identify emerging themes in the participant responses, followed by a combination of topic and analytical coding. Under the broad topics of SEM constructs, subthemes were identified by analyzing respondent statements and extracting what was expressed. Analysis continued through comparison of the transcripts until saturation was reached [26]. The PI and research assistant then manually organized themes and subthemes.

Results

The study had a total sample size of 20. The entire sample completed the survey; 13 and 7 individuals completed the interview and focus groups, respectively.

Basic Characteristics

Table 1 summarizes the basic characteristics of participants. The study participants' mean age was 21 years and the mean family income was $113,666.67. Most of the subjects were males (60.0%), white (85%), unemployed (65%) unmarried (95%), students (75%), undergraduate juniors (40.00%), and of Christian faith (50%). The median age of hookah smoking initiation was 17 years. Participants smoked for a median of 5 times the past 30 days.

Reliability.

As displayed in Tables 2, 3, and 4, there are significant correlations between the different items of various constructs of the questionnaire (location, health effects, and perception, respectively). Furthermore, we see that each table

Table 2 Spearman rank correlation between different items of Hookah Questionnaire for Location

	Q14	Q23	Q48	Q49	Q50	Q51	Q56
Q14	1						
Q23	0.605*	1					
Q48	0.183	0.394	1				
Q49	0.076	0.218	0.677**	1			
Q50	−0.328	−0.309	−0.406	−0.336	1		
Q51	0.630**	0.659**	0.143	−0.014	−0.149	1	
Q56	0.307	0.588*	0.607**	0.664**	−0.341	0.114	1

Q14. Where were you when your first smoked hookah?, Q23. During the past 30 days, where did you typically smoke hookah?, Q48. I smoke hookah in a bar, Q49. I smoke hookah in a café, Q50. I smoke hookah at my house, Q51. I smoke hookah at my friend's house, Q56. Where do you mostly smoke hookah?, Cronbach's Alpha = 0.701

* $p < 0.05$, ** $p < 0.01$

Table 3 Spearman rank correlation between different items of Hookah Questionnaire for Health Effects

	Q35	Q36	Q37	Q38	Q39	Q40	Q41	Q71
Q35	1							
Q36	0.025	1						
Q37	0.518*	0.267	1					
Q38	0.023	−0.031	0.320	1				
Q39	0.350	0.192	0.138	0.127	1			
Q40	0.740**	0.635**	0.249	0.07	0.316	1		
Q41	0.349	0.505*	0.614**	0.248	0.514*	0.114	1	
Q71	0.201	−0.073	0.197	0.245	0.086	0.357	0.051	1

Q35. How do you compare the health effects of smoking hookah with the health effects of cigarette smoking?, Q36. How do you compare the addictive effects of smoking hookah with the addictive effects of cigarette smoking?, Q37. How do you compare the nicotine in the smoke from a hookah with the nicotine in the smoke from a cigarette? Q38. Compare to smoking cigarettes, how socially acceptable do you feel smoking hookah is, Q39. Compared to cigarette smoke, how much tar do you think hookah smoke contains?, Q40. Compared to cigarette smokers, how many carcinogens (cancer-causing agents) do you think hookah smokers are exposed to?, Q41. Compared to second-hand cigarette smoke, how harmful do you feel second-hand hookah smoke is?, Q71. Is Hookah Safe?

Cronbach's Alpha = 0.713

* $p < 0.05$, **$p < 0.01$

Table 4 Spearman rank correlation between different items of Hookah Questionnaire for Perception

	Q71	Q72	Q73	Q74	Q75	Q76	Q77	Q78
Q71	1							
Q72	0.138	1						
Q73	−0.081	0.270	1					
Q74	0.197	0.08	−0.004	1				
Q75	−0.073	0.253	0.575*	0.036	1			
Q76	−0.127	0.218	0.475*	0.224	0.512*	1		
Q77	−0.164	0.282	0.403	0.344	0.247	0.922**	1	
Q78	0.280	0.672**	0.158	-0.025	0.331	0.177	0.229	1

Q71. Is hookah safe?, Q72. Is smoking hookah respectful of traditions?, Q73. Does smoking hookah look familiar?, Q74. Does smoking hookah make one look energetic?, Q75. Does smoking hookah a sign of good social status?, Q76. Is smoking hookah a sign of stability and balance?, Q77. Does smoking hookah make one look attractive?, Q78. Does smoking hookah make one look social?, Cronbach's = 0.701

* $p < 0.05$, **$p < 0.01$

has a relatively high level of Cronbach's alpha (> 0.7) which implies a good measure of internal reliability or consistency of the items within each scale and indicates that they are measuring the same construct.

Hookah Smoking Frequency & Predictors

The three methods were in consensus in-terms of the major predictors of hookah smoking of youths. It showed that the main determinants include limited knowledge of health effects and addiction, positive attitude, family and peer influence, use as means to socially connect with others, culture, social acceptability, lack of health education at school and work place, access to hookah bars and smoke shops, and lack of strict enforcement of laws to ban smoking of youths (Fig. 2).

Hookah Survey Findings

Table 5 displays the frequencies and % of participants for various questions related to different constructs such as location, frequency, social aspect, etc.

Location Majority of the participants smoked hookah at home the past 30 days (55%; p = 0.011). The most frequently reported location for hookah smoking was the home or at a friend's house (65%; p = 0.011). Half of the study population indicated never or rarely smoking in a hookah bar (50% and 20%, respectively; P < 0.027). Moreover, the majority stated that they do not carry hookah with them when they go out (75%; p = 0.025) and that hookah is not important when choosing which restaurant or café to visit (80%; P = 0.007) (Table 5).

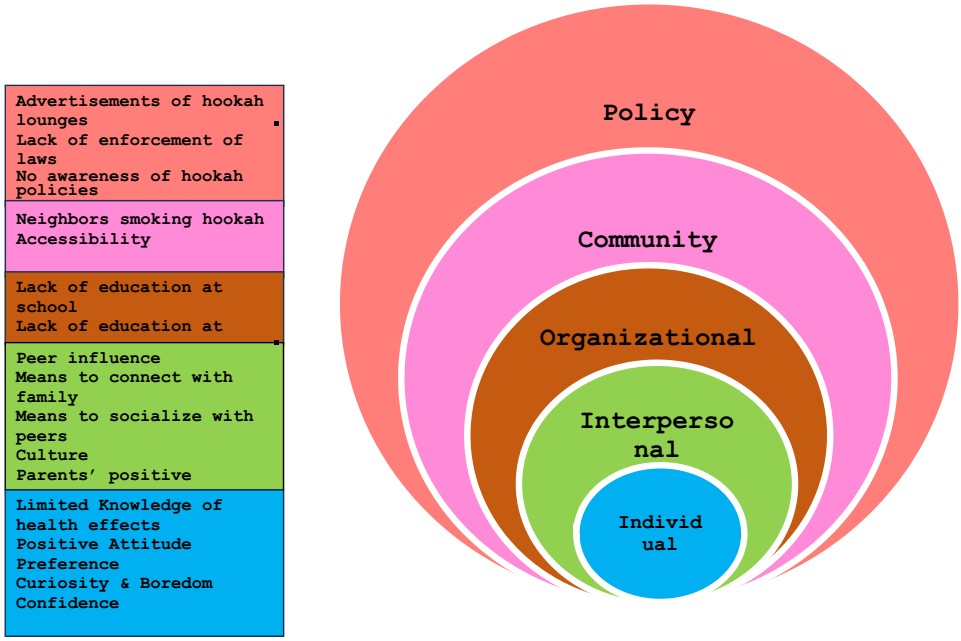

Fig. 2 SEM for predictors of hookah use among youth (N = 20)

Social Aspect The first time hookah was smoked was either with a friend or with a family member (50% and 35%, respectively; p = 0.013). During the past 30 days, half of the study population smoked hookah with a friend/friends while only 5% smoked alone (p = 0.014). Moreover, 90% and 85% indicated that they know someone else who owns a hookah (p < 0.001) and that they usually share it with others (p = 0.002), respectively. The social aspect was the main reason why the majority smoked hookah (75%; p = 0.025). Sixty percent (60%) and 65% of participants stated that they always smoke hookah with friends (p = 0.011) and that all of their closest friends approve of their hookah smoking habits (p = 0.008), respectively. Also, a majority of participants agreed that hookah makes one look more social (75%; p < 0.001) (Table 5).

Reasons for Smoking As displayed in Table 5, the main reasons why participants smoke hookah are the social aspect (75%; p = 0.025) along with flavor (70%; p = 0.074) and boredom (70%; p = 0.074). Additionally, 40%, 55%, and 30% of the study sample stated that they smoke hookah as an alternative to cigarette smoking, as means to relax or reduce stress, or as part of culture, tradition, or religion, respectively.

Health Effects 70% of the participants believed that cigarettes are more addictive than hookah (p < 0.001). Moreover, 40%, 25%, and 40% believed that cigarettes are more harmful and contain more nicotine and carcinogens, respectively. Sixty percent (60%) of the participants indicated that "concern for their own health" is the main reason why they may be interested in quitting hookah smoking (p < 0.001) one day. Most agreed that hookah is not safe (60%; p = 0.01) and that their physician never mentioned the issue of smoking and the need to quite (90%; p < 0.001) (Table 5).

Perception of Hookah Hookah is perceived by most as harmful (60%; p = 0.01) yet respectful of traditions (60%; p = 0.022). Moreover, hookah smoking makes one look social (75%; p < 0.001) yet, neither energetic (65%; p = 0.008) nor attractive (60%; p = 0.022). Seventy percent of the participants did not consider themselves hooked on hookah smoking (p = 0.002) (Table 5).

Current & Future Use 60% of the participants smoke hookah at least once a week (p = 0.035). Most of the participants indicated that, in 5 years, they will smoke hookah less frequently (55%; p = 0.011) and that they will certainly not smoke hookah daily (75%; p < 0.001 (Fig. 3). However, 35 and 40% of the participants indicated that currently they either do not intend to or are unsure whether they wish to quit hookah, respectively.

Confidence, Reasons, & Challenges to Quitting Most of the participant stated that they are very confident of being able to quit hookah smoking (60%; p = 0.022) at any time. The main reason for possibly quitting is a concern for their own health (60%; p < 0.001). Main challenges of quitting hookah smoking included losing social connections, boredom, enticing flavor, etc. (Fig. 4).

Table 5 Hookah smoking habits, location, reasons, and perception (N = 20)

Variable[a]	Frequency N = 20 (%)	p-value[b]
Location		
Where do you mostly smoke hookah?		
Home or Friends House	13 (65)	0.011*
Clubs	3 (15)	
Café or bar	4 (20)	
Where were you when first smoked hookah?		
Own house	5 (25)	0.478
Family member's house	4 (20)	
Friend's house	6 (30)	
Café or restaurant	4 (20)	
Park	1 (5)	
During the past 30 days, where did you typically smoke hookah?		
Home	11 (55)	0.011*
Café/Restaurant	5 (25)	
Friend's house	3 (15)	
Home/Friends house	1 (5)	
Do you smoke hookah in a bar?		
Never	10 (50)	< 0.027*
Rarely	4 (20)	
Sometimes	7 (35)	
Always	2 (10)	
Do you smoke hookah in a cafe?		
Never	7 (35)	0.308
Rarely	4 (20)	
Sometimes	7 (35)	
Always	2 (10)	
Do you smoke hookah at your house?		
Never	4 (20)	0.572
Rarely	3 (15)	
Sometimes	7 (35)	
Always	6 (30)	
Do you smoke hookah at your friend's house?		
Never	2 (10)	0.004*
Rarely	12 (60)	
Sometimes	4 (20)	
Always	5 (25)	

Table 5 (continued)

Variable[a]	Frequency N = 20 (%)	p-value[b]
Is hookah important for your when choosing which restaurant or café to visit?		
Yes	4 (20)	0.007*
No	16 (80)	
Social Aspect		
Who were you with when first smoked hookah?		
Alone	1 (5)	0.013*
With Friends	10 (50)	
With Family	7 (35)	
With Friends & Family	2 (10)	
During the past 30 days, with whom did you most often smoke hookah?		
Alone	1 (5)	0.014*
With family	4 (20)	
With Friends	10 (50)	
With Friends and family	3 (15)	
Alone & Friends	2 (10)	
Do you know anyone else who owns a hookah?		
Yes	18 (90)	< 0.001*
No	2 (10)	
When you use hookah, do you usually share it with others?		
Yes	17 (85)	0.002*
No	3 (15)	
With whom do you share it?		
Friends	8 (40)	0.161
Family	2 (10)	
Family & Friends	7 (35)	
Why do you smoke hookah? Social aspect?		
Yes	15 (75)	0.025*
No	5 (25)	
Do you smoke hookah alone?		
Never	11 (55)	
Rarely	4 (20)	0.116
Sometimes	5 (25)	
Do you smoke hookah with friends?		

Table 5 (continued)

Variable[a]	Frequency N = 20 (%)	p-value[b]
Never	1 (5)	0.011*
Sometimes	7 (35)	
Always	12 (60)	
Do you smoke hookah with your romantic partner?		
Never	12 (60)	< 0.001*
Rarely	1 (5)	
Sometimes	6 (30)	
Always	1 (5)	
How many of your closest friends approve your smoking hookah habits?		
Half	2 (10)	0.008*
Most	5 (25)	
All	13 (65)	
Is smoking hookah a sign of good social status?		
Yes	8 (40)	0.074
No	10 (50)	
I do not know	2 (10)	
Does smoking hookah makes one look social?		
Yes	15 (75)	< 0.001*
No	4 (20)	
I do not know	1 (5)	
Reasons for Smoking		
Why do you smoke hookah, is it for flavor?	14 (70)	
Yes	6 (30)	0.074
No	8 (40)	
Why do you smoke hookah? Social aspect?		
Yes	15 (75)	0.025*
No	5 (25)	
Why do you smoke hookah? Boredom?		
Yes	14 (70)	0.074
No	6 (30)	
Why do you smoke hookah? Craving?		
Yes	3 (15)	0.002*
No	17 (85)	
Why do you smoke hookah? Trying something new or different?		

Table 5 (continued)

Variable[a]	Frequency N = 20 (%)	p-value[b]
Yes	3 (15)	0.002*
No	17 (85)	
Why do you smoke hookah? To relax or reduce stress?		
Yes	11 (55)	0.655
No	9 (45)	
Why do you smoke hookah? Is it related to culture, tradition, or religion?		
Yes	6 (30)	0.074
No	14 (70)	
What do you think is the main reason behind the current increase in hookah popularity?		
Social Aspect		
Culture	11 (55)	0.002*
Less harmful alternative	4 (20)	
Curiosity	3 (15)	
Do not know	1 (5)	
Is hookah important for your when choosing which restaurant or café to visit?		
Yes	4 (20)	0.007*
No	16 (80)	
Health Effects		
How do you compare the health effects of smoking hookah with the health effects of cigarette smoking?		
Cigarettes are more harmful	8 (40)	0.158
Hookah is more harmful	6 (30)	
The same	5 (25)	
I do not know	1 (5)	
How do you compare the addictive effects of smoking hookah with that of cigarette smoking?		
Cigarettes more addictive	14 (70)	< 0.001*
Hookah more addictive	1 (5)	
The same	4 (20)	
I do not know	1 (5)	
How do you compare the nicotine in the smoke from a hookah with the nicotine in the smoke from a cigarette?		

Table 5 (continued)

Variable[a]	Frequency N = 20 (%)	p-value[b]
Cigarettes have more nicotine	5 (25)	0.940
Hookah has more nicotine	5 (25)	
The same	6 (30)	
I do not know	4 (20)	
Compared to cigarette smoke, how much tar do you think hookah smoke contains?		
Cigarettes have more tar	6 (30)	0.572
Hookah has more tar	7 (35)	
The same	3 (15)	
I do not know	4 (20)	
Compared to cigarette smokers, how many carcinogens do you think hookah smokers are exposed to?		
Cigarettes have more	8 (40)	0.327
Hookah has more	3 (15)	
The same	6 (30)	
I do not know	3 (15)	
Compared to second-hand cigarette smoke, how harmful do you think second-hand hookah smoke is?		
Cigarette smoke is more harmful	9 (45)	0.104
Hookah smoke is more harmful	2 (10)	
The same	9 (45)	
Why are you interested in quitting hookah?		
Own Health	12 (60)	< 0.001*
Expenses	3 (15)	
Family Health	1 (5)	
My or my family's health	1 (5)	
All of the above	1 (5)	
Not interested	2 (10)	
Did your physician ever mention to you the issue of smoking and the need to quit?		
Yes	2 (10)	< 0.001*
No	18 (90)	
Is hookah safe?		
Yes	7 (35)	0.01*
No	12 (60)	
I do not know	1 (5)	

Table 5 (continued)

Variable[a]	Frequency N = 20 (%)	p-value[b]
Do you inhale when you smoke hookah?		
Never	3 (15)	
Rarely	1 (5)	0.046*
Sometimes	7 (35)	
Always	9 (45)	
Perception of Hookah		
Is hookah respectful of traditions?		
Yes	12 (60)	0.022*
No	6 (30)	
I do not know	2 (10)	
Does smoking hookah look familiar?		
Yes	15 (75)	< 0.001*
No	2 (10)	
I do not know	3 (15)	
Does smoking hookah make you look energetic?		
Yes	5 (25)	0.008*
No	13 (65)	
I do not know	2 (10)	
Is smoking hookah a sign of good social status?		
Yes	8 (40)	0.074
No	10 (50)	
I do not know	2 (10)	
Is smoking a sign of stability and balance?		
Yes	5 (25)	0.008*
No	13(65)	
I do not know	2 (10)	
Does smoking hookah makes one look attractive?		
Yes	6 (30)	0.022*
No	12 (60)	
I do not know	2 (10)	
Does smoking hookah makes one look social?		
Yes	15 (75)	< 0.001*
No	4 (20)	
I do not know	1 (5)	
Do you consider yourself hooked on hookah?		

Table 5 (continued)

Variable[a]	Frequency N = 20 (%)	p-value[b]
Yes	2 (10)	0.002*
No	14 (70)	
I do not know	4 (20)	
Compared to smoking cigarettes, how socially acceptable do you feel smoking hookah is?		
Hookah is more acceptable	11 (55)	0.086
Hookah is less acceptable	3 (15)	
The same	6 (30)	

[a]Data are displayed as frequency (percentage) for nominal/categorical variables and as mean ± standard deviation for scale variables [b]Chi-square goodness of fit (comparing observed with expected values) generated P value

*P value < .05

Interview

Thirteen (13) interviews were conducted with a subset of participants. The interviews identified the following main themes and subthemes under the different SEM levels.

Intrapersonal Level

Findings revealed that participants had *limited knowledge on the health effects* of hookah smoking, such that many believed hookah smoking to be less addictive and less harmful than cigarette smoking. This was due in part to the belief that tobacco used in hookah smoking contains fewer chemicals and carcinogens. Participants also believed that the infrequency of hookah smoking puts one at lower risk of harm, and that the passing of tobacco smoke through a water-filled chamber is less harmful compared to smoking traditional cigarettes. One participant stated:

"Hookah being filtered through water makes it less potent – while cigarettes are considered a more direct method of inhaling". A small number of participants who took part in the interview believed hookah smoking to be more harmful than cigarette smoking. While all interview participants had a general knowledge of nicotine, a subset of participants believed that an individual is exposed to more nicotine while smoking hookah due to the longer smoking sessions. One participant shared:

> *"Cigarettes have more nicotine per puff than hookah – hookah smoking session has more nicotine compared to cigarettes since smoker can include higher quantity of nicotine in the bowl"*.

Within intrapersonal factors, *preference* was revealed to play a large role in a youth's decision to smoke hookah over other forms of tobacco. Hookah smoking was preferred over other types of tobacco use, such as vaping or traditional cigarettes, for a variety of reasons. Hookah is a social activity that can be shared with others, does not lead to unfavorable odors like cigarettes do, has fun flavors, lasts longer than cigarettes, and is less harmful, intense, and addictive than cigarette smoking or vaping.

> *"I prefer hookah over cigarettes because of the smell of cigarettes and the fun flavors of the hookah–I enjoy the smell and taste of hookah"*

Participants generally had a *favorable attitude* towards hookah smoking. Hookah was viewed as a socially acceptable activity that is part of the youth culture. In fact, participants shared that hookah smoking is tolerated and accepted

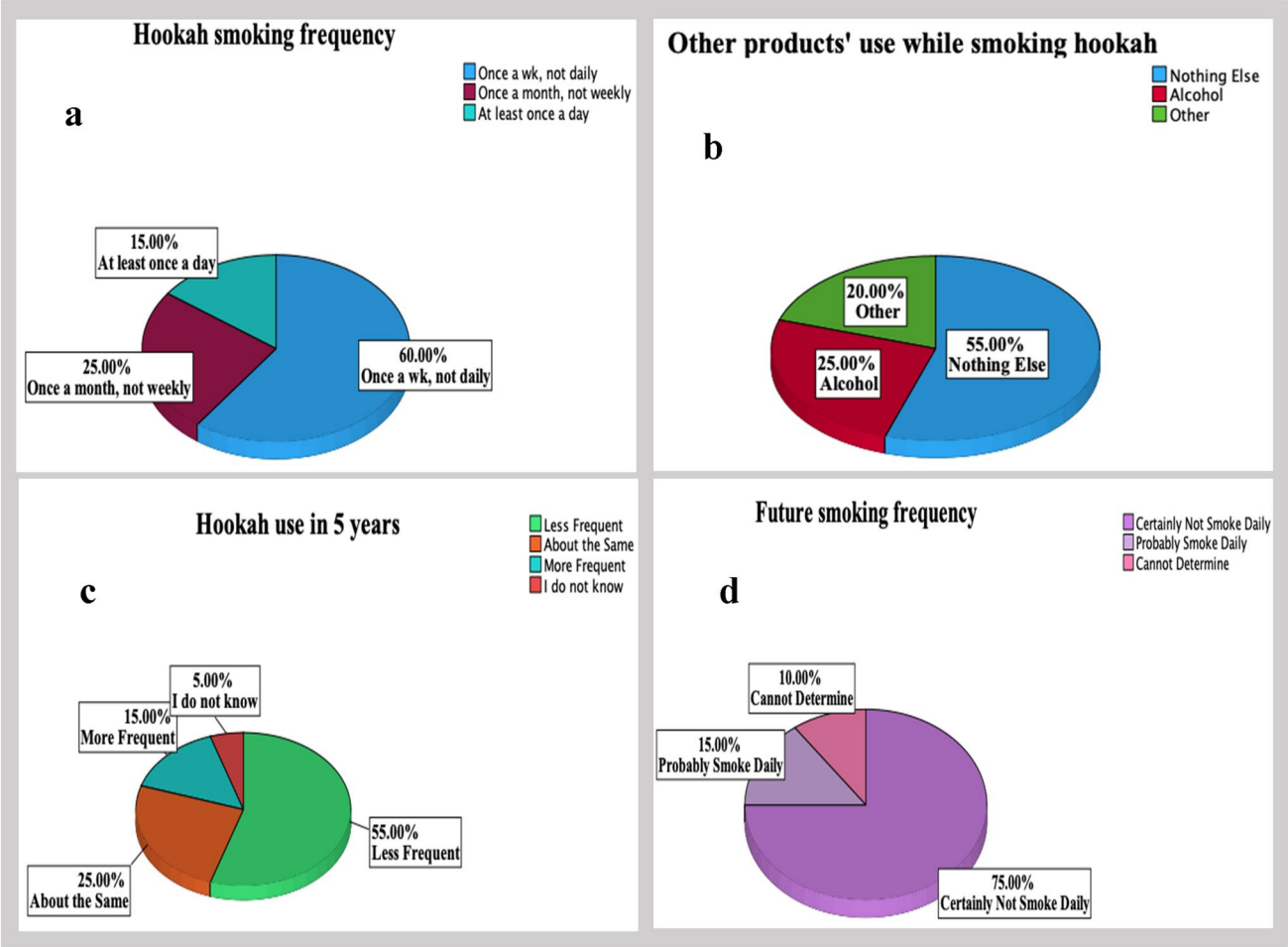

Fig. 3 Current & Future Use of Hookah (N = 20), **a** Hookah smoking frequency, **b** Use of other products while smoking hookah, **c** Anticipated hookah use in 5 years compared to present, **d** Anticipated hookah smoking frequency in 5 years

by their peers and family as a social activity. According to participants, hookah use is viewed as a shared experience among friends compared to smoking/vaping tobacco. While using other forms of tobacco products can take place in a social setting, the act of smoking traditional cigarettes, for example, is individualized, since cigarettes are less likely to be shared. This social aspect of hookah smoking has led to more positive attitudes towards hookah use among youth, compared to their attitudes towards other tobacco products.

> "*I enjoy smoking hookah since it is part of my culture and since it is a fun and social activity*"

At the intrapersonal level, *curiosity and boredom* emerged as reasons for hookah initiation. Participants indicated that what raised their curiosity was observing their friends and/or family members smoke hookah. Participants viewed hookah use as a means to have fun, spend time with friends, and overcome boredom. One participant stated:

> *"[I have] fun when smoking hookah because of bubbles and the gradual buzz."*

Interpersonal

Viewing hookah smoking as a *social activity* emerged as a subtheme within the interpersonal level. Interview participants viewed hookah smoking as a means to socialize, be around people, and connect with others. Most often, hookah is smoked in a group setting with friends and/or family members and is rarely smoked in isolation. One participant shared:

> *"Hookah smoking is associated with positive social experience."*

While hookah is viewed as a social activity, a majority of participants noted that their decision to smoke was not related to peer pressure but rather to peer or family influence. When discussing reasons for initial uptake,

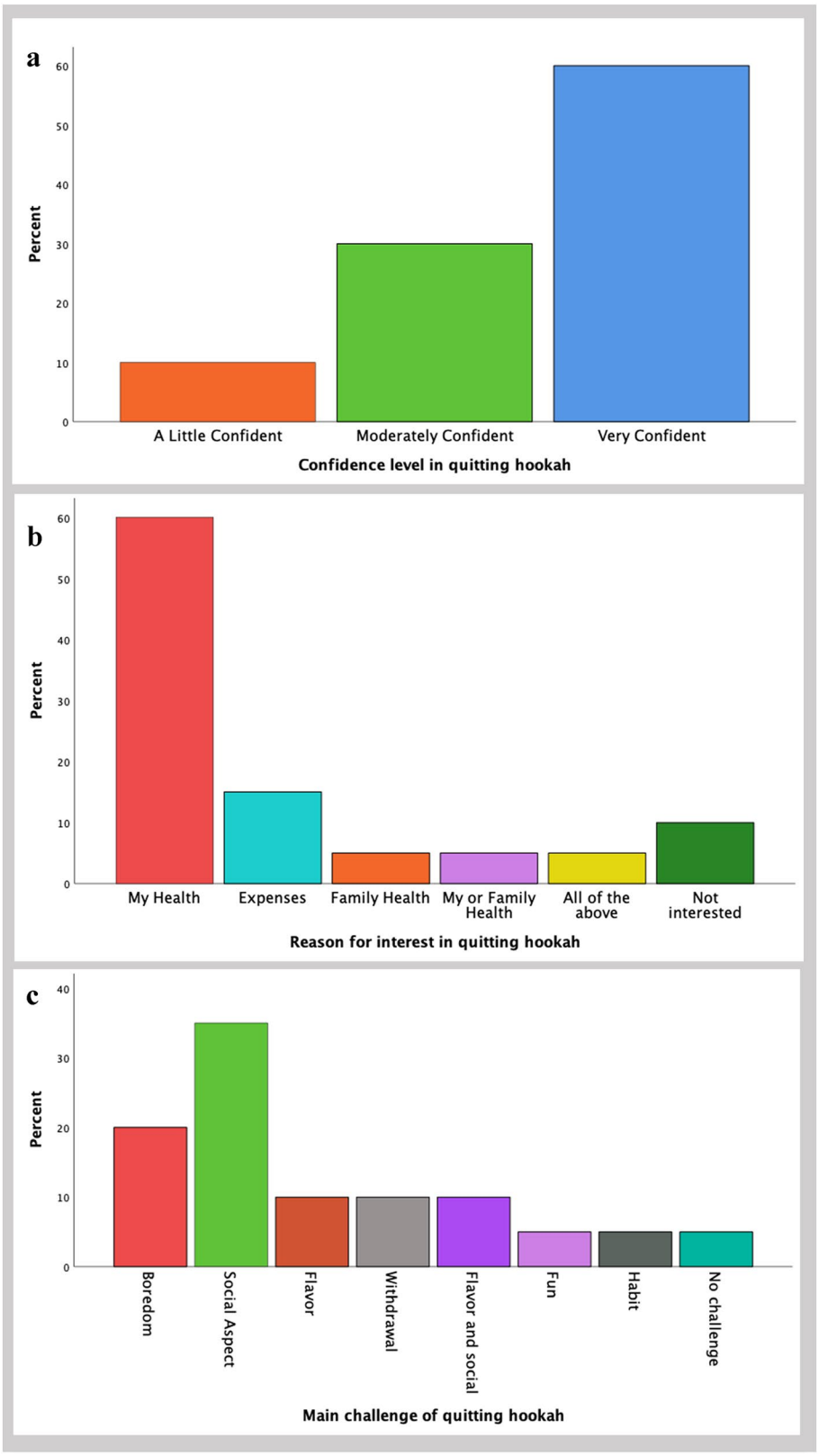

Fig. 4 Confidence, Reasons, and Challenges to Quitting Hookah Use (N = 20), **a** Confidence level in quitting hookah smoking, **b** Reason for interest in quitting hookah, **c** Main challenge of quitting hookah smoking

participants highlighted the role of individual autonomy in their decision to smoke. More specifically, participants shared that their decision to smoke was not due to being pressured by others, but it was influenced by the behavior of other smokers, such that seeing others smoke made them want to try hookah.

"I saw others smoking hookah and found that interesting–no one pressured me to smoke hookah"

Interview participants were asked to share their experience of trying smoking hookah for the first time and responses revealed aspects that are connected to the interpersonal level of the SEM. A majority of participants tried hookah for the first time in the presence of friends or family members, such as an older sibling or a cousin, and most noted that they tried hookah due to a *desire to engage in a shared activity* with friends and family, as noted by the quotes below:

"I became curious when I saw my cousin smoking hookah and wanted to try i –my cousin shared the hookah with me."
"I started smoking hookah because of family–before I started smoking hookah, I would see people smoking at our friends and family houses."

When asked why they continue to smoke hookah, participants shared that their continued behavior is due to the desire to spend time with friends and family, and to engage in a shared activity. Participants also noted that the smoking behavior of friends and family was a driving force behind their own behavior. Several participants stated that their smoking frequency is *influenced by the behavior of others*, such that they are now frequent smokers, since their older sibling/family member, roommate, and/or friends smoke often.

"I was influenced by my older sister-I look up to her and see her as role model."
"I smoke hookah since I have many friends who are Pakistani and smoke hookah themselves."

Other participants cited cultural and religious influences as playing a large role in their hookah smoking behavior. Hookah smoking is deeply ingrained in tradition in many cultures such as Indian, Persian, Turkish, and Middle Eastern cultures, and is frequently connected to momentous occasions or celebrations.

"Several of my Middle Eastern family members and friends have been purchasing tobacco for many years and smoking hookah in my house which have influenced me to try hookah one day."

Organizational

Schools and workplaces play an important role in health behavior, serving to prevent, or at times facilitate, negative health behaviors, such as substance use. However, all interview participants indicated that *neither their school nor workplace provided health education* to increase awareness of the health risks of continued use or the resources to quit hookah smoking. Participants further shared that their school and/or workplace, in fact, hold no bearing on their decision to smoke, as the behavior occurs in other settings.

Community

Identifying where hookah smoking takes place is crucial when examining the factors that influence uptake and continuation of the behavior. The most common hookah smoking locations were reported to be the homes or friends' houses.

Many of the participants indicated that they do not smoke at hookah bars/lounges often. Reasons for not smoking hookah in hookah bars were related to ***accessibility***. Participants shared that there were not many hookah bars or lounges in their community and the cost of visiting these establishments was too high. For these reasons, participants shared that smoking hookah often took place at home using a privately-owned hookah, as highlighted by the quote below:

"I do not smoke in hookah bars since my friend himself does not go to hookah bars and owns a hookah."

When asked about where in the *neighborhood* they or their peers engaged in hookah smoking, a small number of participants shared that they have observed residents in their community smoke hookah either in restaurants/cafés or in front of homes. Despite these highly visible locations, participants shared that the location at which hookah smoking takes place does not influence their smoking behavior, as it holds less importance than the individuals with which they socialize while smoking.

Policy

There was a general awareness of tobacco control policies among interview participants, particularly the change in policy that increased the age restriction for tobacco purchases from 18 to 21 years. However, participants were *not aware* of any other laws and regulations that restrict access to or use of hookah specifically.

In California, hookah lounges that meet the definition of a "retail or wholesale tobacco shop" or "private smokers' lounge" are exempt from the state's smoke-free workplace law, thus creating an environment that exposes non-smokers to the harmful effects of secondhand smoke. Further, there is *no age limit to enter* these establishments. Participants who have visited hookah lounges shared that the majority of establishments do not ask to see identification to verify age. One participant noted that among hookah lounges that did ask for identification, individuals under 21 years of age were still allowed to enter and smoke while inside. As highlighted by the quote

below, the decision to ask for identification varied, even at the same establishment:

"Some bars would ask for I.D. card if management were there or if the bar were very crowded."

Participants were asked about their awareness of the age limit to purchase tobacco for hookah and to share how difficult or easy it was for them to *purchase hookah-related products.* Many participants indicated that they purchase tobacco for hookah from local smoke shops and were not aware of an age limit for hookah-related purchases, since store owners rarely checked their identification card to verify age. This finding revealed that local smoke shops do not strictly enforce the Tobacco 21 law that restricts the sale of tobacco products to individuals under the age of 21 years. Though this law was passed in 41 states, including California and Virginia, lack of enforcement results in continued access to tobacco products among those under 21 years of age. One participant shared:

"The smoke shop owner never checked my ID card before selling hookah tobacco"

Many states have passed tobacco control policies that address predatory marketing practices, such as tailoring images and messages used on advertisements to appeal to specific segments of the population. When asked to describe hookah advertisements in the community or online, participants reported not seeing any advertisements for hookah smoking or for hookah tobacco brands on television, social media, or any other media outlets, and therefore, were unable to comment on marketing strategies by the tobacco industry. However, several participants noted that they have seen promotional material for hookah lounges on social media, which sparked their curiosity and led them to visit these places.

Focus Group

Two focus groups (n = 4 and n = 3) were held to fill in gaps of knowledge from the interviews and to explore additional factors within the SEM that influenced hookah smoking.

Intrapersonal

Contradictory to findings from the interviews, 4 of focus group participants shared a higher level of knowledge about the harmful effects of hookah and tobacco.

Focus group participants believed that hookah smoking is just as harmful or even more harmful than cigarette smoking, especially as it relates to pulmonary health. One participant noted symptoms of continued use:

"Hookah affects lung functioning and leads to shortness of breath or trouble breathing."

Participants correctly described carcinogens and defined them as "cancer-causing agents". They further shared the belief that hookah tobacco has either an equal or higher level of carcinogens than tobacco in traditional cigarettes. However, participants of both focus groups were unable to correctly describe tar and were unaware of its cancer-causing effects. Most participants believed that hookah smoking exposes an individual to an equal amount of tar or even more tar than smoking traditional cigarettes. All of the focus group participants were generally familiar with nicotine and described it as an "addictive chemical", but none of the participants were able to provide an accurate definition.

Participants believed that hookah smoking is much *less addictive* than smoking traditional cigarettes. As such, focus group participants had *no plans to quit* hookah smoking, particularly since they see it being less harmful than traditional cigarettes and have not yet experienced any health effects, as highlighted by the quote below:

"I think about it sometime. I can't see how it is affecting me because I am athletic and healthy. I am not really hooked on it."

Similar to interview participants, focus group participants can be defined as social smokers and use hookah as a means of socializing with peers. Due to the belief that hookah is less addictive and because of their infrequent use, participants demonstrated high *confidence to quit smoking*:

"I don't feel like I'm at the point where I need to quit smoking hookah since I do not even smoke much."

Consistent with the interview findings, most focus group participants indicated that their *preference for hookah smoking* over other types of smoking has to do with the social aspect. It is viewed as a way to overcome boredom and to spend time with friends and/or family by engaging in a fun social activity. Lastly, tobacco used for hookah smoking is often flavored, ranging from fruit flavors to mint and vanilla. Participants shared that their preference for hookah smoking is based on the wide variety of flavors compared to traditional cigarettes. This is a particularly important finding for states that ban the sale of flavored tobacco products, as these laws do not apply to hookah tobacco.

While most focus group participants stated that they do not use/take other substances while smoking hookah, a small number of participants indicated *co-use of alcohol and hookah.*

"When under the influence of alcohol, I become more susceptible to smoking hookah and less in-control."

Interpersonal

Focus group findings confirmed the social aspect of hookah smoking as the main determinant of the behavior. Hookah was viewed as a *social activity* and as a way to connect and spend time with others:

> *"Everyone kind of does it; all my family members and friends smoke hookah, so I gave it a try."*

When participants were asked about trying hookah smoking for the first time, responses were consistent with what emerged during the interviews. Focus group participants shared that they were *introduced to hookah by a friend or a family member*, specifically an older sibling, and their decision to try was influenced by the behavior of others.

Participants shared that their *parents' attitude* about hookah smoking changed over time, such that they were initially against smoking hookah, but became more acceptant and lenient as the behavior continued. Participants shared that their parents were tolerant of hookah smoking for a variety of reasons, including culture, infrequent use, and parents' own hookah smoking behavior, as highlighted by the quote below:

> *"My mom never minded it. My dad initially didn't want me to start smoking, but he wasn't very strict, though. I believe it has to do with the fact that he also smokes hookah."*

Organization

Focus group participants shared that neither their school nor their workplace had any influence on their decision to smoke. They also noted that their schools *did not provide health education* on the harmful health effects of hookah smoking and believed it to be a missed opportunity.

Community

No significant subthemes emerged when participants were asked to share *neighborhood aspects* that they feel are contributing factors to hookah smoking. A small number of participants shared that they have noticed several community members engage in hookah smoking. However, they also shared that their neighborhood is predominantly comprised of Middle Eastern residents, so it may be related to culture rather than to characteristics of the community, such as location and accessibility.

Policy

Consistent with interview findings, focus group participants demonstrated low awareness of tobacco control policies. Participants were aware of the Tobacco 21 law that raised the age restriction to 21. However, they were not aware that this law also extended to the purchase of hookah-related products, nor were they aware of any other laws or regulations related to hookah smoking.

Participants shared that they had no difficulty in accessing hookah bars or lounges, as these establishments often allow youth to enter without asking for their identification card. As indicated previously, there is no age requirement to enter hookah bars and lounges and focus group findings revealed that participants may not be aware of this.

> *"Sometimes I'll go to a hookah lounge with friends - they never ask for an ID"*

Among those who were familiar with the breadth of coverage of tobacco control policies, the focus group findings revealed *low enforcement*. For example, when discussing age restrictions for the purchase of tobacco products, participants shared that smoke shop owners rarely asked to see identification cards before selling hookah-related products.

Prior to concluding the focus group, participants were asked to share how often they come across tobacco or *hookah advertisements*, and to describe these advertisements. Consistent with interview findings, participants indicated never being exposed to advertisements for hookah smoking or for hookah-related products on any media outlet, including social media. A small number of focus group participants stated that they have seen promotional material for hookah lounges on social media only.

> *"I have never seen ads for hookah on TV or social media; I have seen hookah lounge ads on Instagram".*

Discussion

Our study revealed the main determinants of hookah smoking among youth which include lack of knowledge on the addictive properties and the harm of hookah, culture, attitude, parents' attitude, the social connection with others, social acceptability, boredom, lack of education on hookah provided by the physician, lack of education on hookah provided by the school and place of employment, and the lack of enforcement of prohibiting laws for accessing hookah bars and for purchasing hookah tobacco.

Existing studies have also confirmed that a plethora of individual and social factors can predict hookah smoking including the limited knowledge on its harmfulness and

addictiveness [6, 20, 27, 28, 39, 40, 47, 57, 61, 63, 66, 71, 73, 79], accessibility, cultural habits, flavor [1, 9, 21, 22, 28, 42, 49, 55, 60, 62], positive attitude [1, 11, 12, 24, 30, 34, 51, 54, 68, 69], sensation seeking [14, 29, 36, 44, 46, 53, 65, 70, 78], social acceptability [3, 14, 32, 42, 63, 70, 77, 78], and means to socialize, connect with others [2, 18, 31, 50] and manage stress [36, 43, 48, 64, 78]. Moreover, having friends and/or family members who smoke hookah was a major predictor of hookah use among youth[7, 32, 33, 36, 52, 53, 58, 65, 77].

Targeting the high prevalence and increasing popularity of hookah smoking among youth is exigent since it is highly detrimental, can place the smokers and those around them at serious health risks, and can lead to morbidity and mortality[8]. The American Lung Association stated that contrary to what many individuals believe, smoking hookah, just like smoking cigarettes, is associated with various acute and chronic health conditions since hookah smoke contains no less than 82 toxic chemicals and carcinogens [8]. Short-term use raises the heart rate and leads to reduced pulmonary function, carbon monoxide intoxication, and hypertension. Long-term use leads to a variety of chronic diseases including impaired pulmonary function, chronic obstructive pulmonary disease, heart disease, along with a variety of cancers such as lung, gastric, and oral cancers [8].

Combating the rising popularity of hookah among the youths entails providing education to increase knowledge regarding its harmful health effects, its addictiveness, and its chemical and carcinogen contents. Educational interventions on hookah use among youth can successfully reduce the prevalence of hookah smoking [38, 72] by enhancing self-efficacy [15, 67], attitude, and intention to quit [13, 37, 38, 67]. Moreover, targeting the youths' immediate surroundings such as family members to modify their attitude, perception, and knowledge of hookah smoking is important [49] since they play a key role in introducing the youths to hookah smoking, and controlling their relationships and leisure time. Family-based interventions can significantly decrease the number of youths who tried smoking [74]. Moreover, targeting the social environment is also required since youth' smoking habits are influenced and shaped by their peers. Peer-to-peer prevention initiatives are recommended. These entail the selection and training of several socially-influential student leaders to enhance their communication skills and techniques, in order to effectively communicate with their peers about the harmful and addictive impacts of hookah use [19]. Schools and universities should provide education to students on hookah smoking and its harmful and addicting qualities, and discuss available prevention and treatment options for tobacco addiction [27]. Furthermore, laws prohibiting individuals below the age of 21 should be strictly enforced to reduce youth access to hookah bars and smoke shops. Strict regulations should be set for the production, distribution, marketing and sale of hookahs [25].

To our knowledge, this study is one of few to utilize a mixed-methods design (across two states), triangulating and collecting data through surveys, interviews, and focus groups, to gain a more comprehensive understanding of the determinants of hookah smoking among the youth. The consistency of findings across the three methods signifies good reliability and construct validity. Secondly, the use of a validated survey and the high level of Cronbach's alpha enhances validity and is indicative of good internal reliability, respectively. Moreover, a comprehensive approach was taken to examine the predictors of hookah use. The environmental factors were also explored according to SEM model in addition to the individual factors and interpersonal factors. The study highlighted the ease of access to hookah and tobacco at hookah lounges and smoke shops among youth, and the lack of strict policy enforcement to reduce access.

The study also had various limitations including the small sample size which could have led to type 2 error, thus undermining the internal and external validity of the study [23]. Nevertheless, the data saturation was reached and findings were consistent across the three data collection methods which is indicative of internal validity. Moreover, the PI recruited from more than one community in the U.S. to ensure generalizability. Even though most of the participants where white and had high income, the study sample was representative of the larger population of hookah users who are mostly white Middle Eastern Americans [4].

Future studies with larger sample sizes are required to increase statistical power. These investigations should measure urine biomarkers to not only validate the use of hookah but also the smoking frequency. Moreover, since hookah smoking is commonly smoked at home, research should also be conducted to accurately assess the exposure of youth to second hand hookah tobacco smoking and its health implications.

Conclusion

The main determinants of hookah use among youth include lack of knowledge, attitude, interpersonal factors such as having friends and/or family members who smoke hookah, social acceptability, parental attitude, accessibility, and lack of enforcement of prohibiting laws. Educational interventions should be implemented by public health authorities, universities, and other stakeholders and targeted to reach individuals, families, social environment, communities and policies, for the purpose of correcting the misconception related to hookah smoking's harm and addiction and restricting access to- and the production, distribution, marketing and sales of hookahs.

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Data availability The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Code availability N/A.

Declarations

Competing interests The authors declare no competing interests.

Ethical approval The study was approved by the Institutional Review Board of James Madison University (IRB # 23–4010) and California State University Dominguez Hills (IRB # 2024–57).

Consent to participate All participants provided a written consent to participate in the study.

Consent for publication All authors provided consent for publication.

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