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# Factors associated with shisha smoking: Results from a cross-sectional telephone-based survey among the general population adults in Nigeria

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## ABSTRACT

**INTRODUCTION** In Nigeria, there is very limited evidence on factors that influence shisha smoking, and this hinders effective tobacco control policymaking. We, therefore, aimed to identify factors associated with shisha smoking among the general population adults in Nigeria.

**METHODS** We conducted a telephone-based, cross-sectional survey between 28 July and 11 September 2022 in 12 states of Nigeria. Our outcome of interest was self-reported current shisha smoking status, and the independent variables included potential behavioral, biological, mental health, environmental, and social determinants of shisha smoking. We performed logistic regression analysis, with adjusted odds ratios (AORs) and 95% confidence intervals (CIs) as the measures of association.

**RESULTS** We surveyed 1278 individuals: 611 who currently smoked shisha and 667 who did not. The following increased the likelihood of being a person who currently smokes shisha: being a person who currently smokes cigarettes (AOR=5.54; 95% CI: 2.57–11.90) or consumes alcohol (AOR=3.46; 95% CI: 1.91–6.28); and having a family member (AOR=2.32; 95% CI: 1.23–4.40), or one (AOR=22.81; 95% CI: 9.99–52.06) or more (AOR=78.85; 95% CI: 22.50–276.33) close friends who smoke shisha. The following reduced the likelihood of being a person who currently smokes shisha: being older (AOR=0.92; 95% CI: 0.89–0.95) and screening positive for possible generalized anxiety disorder (AOR=0.60; 95% CI: 0.41–0.88). We found sex differences in the factors associated with shisha smoking, particularly on the effects of household wealth, employment status, having family members who smoke shisha, and mental health.

**CONCLUSIONS** Strategies to curb shisha smoking need to account for the associated biological, social and behavioral factors, including age, cigarette smoking, alcohol consumption, and having family members or close friends who smoke shisha. They should also account for sex differences, and differences that exist between shisha smoking behavior and the smoking of other tobacco products.

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## KEYWORDS

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## INTRODUCTION

Shisha smoking is becoming more common worldwide<sup>1</sup>, despite its negative health consequences such as cancers, lung and cardiovascular problems, infertility, and adverse pregnancy outcomes such as low birth weight in babies born to mothers

who smoke shisha<sup>2</sup>. The smoke contains carcinogens and other toxicants such as nitric oxide and heavy metals, and high levels of carbon monoxide from the burning charcoal<sup>3</sup>. For Nigeria, studies among young people have reported high shisha smoking prevalence rates ranging from 3% to 7%<sup>4-6</sup>. Nigeria has made a number of commitments to addressing tobacco use, including shisha smoking, through evidence-informed interventions. These include signing and ratifying the World Health Organization Framework Convention on Tobacco Control (WHO FCTC)<sup>7</sup>; and signing into law the National Tobacco Control (NTC) Act in 2015<sup>8</sup> and the NTC implementing Regulations in 2019<sup>9</sup>. Achieving the country's tobacco control objectives is, however, highly dependent on the availability of context-specific evidence to inform policy decisions.

Unfortunately, population-based, national-level data on shisha smoking is scarce in Nigeria, including on the smoking patterns and factors that influence the behavior. The few studies that exist focus on specific populations such as secondary school and university students, medical professionals or nightclub patrons, and cover a few geographical areas<sup>4-6,10-15</sup>. For example, we identified only five studies in Nigeria on factors associated with shisha smoking<sup>4,10,12,15,16</sup>, and none of them was conducted in the general population: four were among secondary school and university students<sup>4,10,15,16</sup>, whilst one was among nightclub patrons<sup>12</sup>. Three of these five studies were conducted solely in Oyo state<sup>10,12,16</sup>, with one study each for Rivers state<sup>15</sup> and Lagos state<sup>4</sup>. They, therefore, only cover three out of Nigeria's 36 states and Federal Capital Territory (FCT). These shortcomings severely limit the generalizability of the evidence and its usefulness for policy decisions. The objective of this study was to address this existing evidence gap by investigating shisha smoking patterns, and the reasons for and factors associated with shisha smoking, in a large sample of general population adults in 12 states across all six geopolitical zones in Nigeria. The smoking patterns and reasons for shisha use have been reported elsewhere<sup>17</sup>. Here we report the factors associated with shisha smoking.

## METHODS

### Study design and sites

This was a telephone-based, cross-sectional,

quantitative survey conducted between 28 July and 11 September 2022. We conducted the study in states where the prevalence of shisha smoking was high in order to increase the chances of enrolling enough people who smoke shisha. In the absence of national- or state-level data on shisha smoking in Nigeria, we considered urbanization rate, characterized by the presence of bars, modern restaurants, and social clubs, as well as a more educated and younger population as a proxy for shisha smoking prevalence<sup>12</sup>. Using data from Nigeria's Demographic and Health Survey conducted in 2018<sup>18</sup>, we selected the two most urbanized states/FCT in each of the six geopolitical regions for a total of 12 states/FCT. If, for a geopolitical zone, the most urbanized state was judged as not feasible for study implementation, for example, due to recurring security challenges such as civil unrest or terrorism, it was replaced by the state with the next highest urbanization rate. Where such security challenges exist, we found that most potential participants were not willing to speak to strangers and give any information on the phone. Each participating state had its enumeration areas (EAs) stratified into rural or urban EAs. Seven urban EAs and three rural EAs were then randomly selected in each participating state for data collection.

### Study sample

The eligibility criteria for study participation were as follows: 1) aged  $\geq 18$  years; 2) a resident in one of the study areas; 3) having a phone number listed in the 2018/19 Nigeria Living Standard Surveys (NLSS) sampling frame; and 4) no other household member already participating in the study (this was ensured through checking their household details with those of other study participants). The 2018/19 NLSS was an in-person survey where phone numbers of up to three household members were collected, and the sampling frame is representative at national-, zonal-, and state-level including the FCT<sup>19</sup>. Other available information includes the state, local government area, rural/urban status, and EA within which each household in the frame belongs, and other background information of respondents.

We aimed to call 8000 phone numbers in our sampling frame. In Nigeria, phone surveys through computer-assisted telephone interviewing (CATI), have been found to have a response rate of about

15%<sup>20</sup>. Therefore, assuming a 15% response rate, we would be able to achieve our target sample size of 1200 needed to make the comparison between our two groups of interest (i.e. 600 people who currently smoked shisha and 600 who did not smoke shisha currently), within a 3% margin of error with associated 95% confidence levels<sup>21</sup>. Using simulations and the number of events per variable approach, this sample size was adequately powered to produce accurate estimates that represent the target population parameters<sup>21</sup>. We aimed to enroll 10 individuals (five who currently smoked shisha and five who did not smoke shisha currently; about three females and seven males) from each of the 120 participating EAs.

### Participant recruitment and enrolment

For each participating EA, phone numbers were randomly drawn from the NLSS sampling frame and called until 10 eligible individuals had been enrolled and completed the questionnaire. If the call was answered, the respondent was given brief information on the study aims and objectives and screened for eligibility if they were willing to continue with the conversation. If they were eligible, they were given more detailed information about the study including what participation would involve, the types of information collection, how the information would be used, time taken, confidentiality, voluntary nature of participation and anonymity of their responses. Verbal consent was obtained before data collection commenced. Any participants who consented to the survey but were unable to participate at that time were asked for an appointment at a time convenient to them. For some EAs, random selection of phone numbers could not yield enough people who currently smoked shisha, and this was complemented by recruitment from adjacent EAs in the same state or snowball sampling.

### Measures

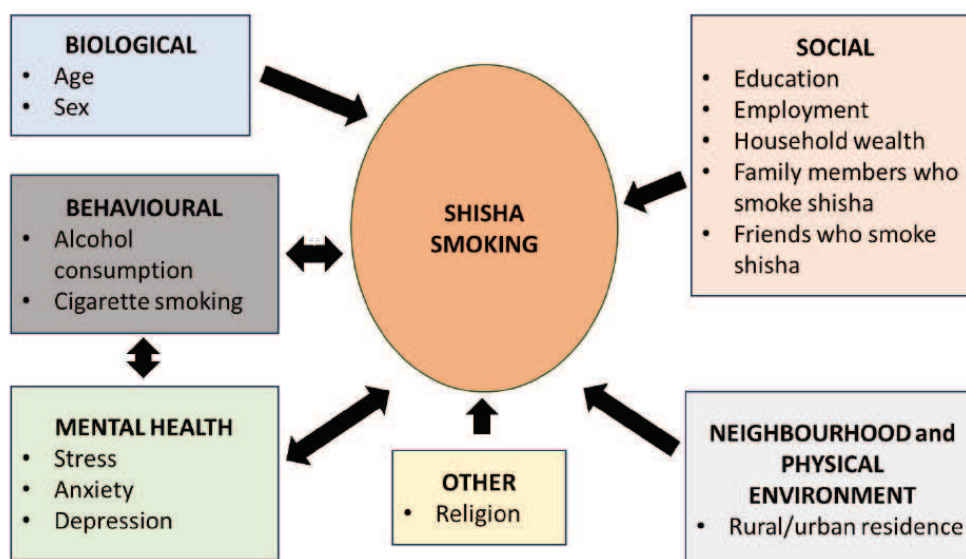
The development of the questionnaire and the questions included, have been described in detail elsewhere<sup>17</sup>. Briefly, the questionnaire was informed by literature reviews, the Theory of Planned Behaviour<sup>22,23</sup>, and a qualitative study that preceded this survey<sup>17</sup>. The questionnaire comprised eight main sections covering the following and based on widely

used validated questionnaires: sociodemographic characteristics based on questions from Nigeria's 2018 Demographic and Health Survey<sup>18</sup> and 2012 Global Adult Tobacco Surveys (GATS)<sup>24</sup>; shisha use behaviors and patterns based on the current GATS questionnaire<sup>25</sup>; reasons for shisha use<sup>25</sup>; attitudes towards shisha smoking based on the 18-item Attitudes Towards Smoking Scale<sup>26</sup>; capacity to quit smoking shisha based on the 12-item Smoking Self-efficacy Questionnaire<sup>27</sup>; knowledge on shisha and health consequences of use; mental health including perceived stress measured using the 4-item Perceived Stress Scale (PSS-4)<sup>28</sup>, possible major depressive disorder using the Patient Health Questionnaire-2 (PHQ-2)<sup>29</sup>, and possible generalized anxiety disorder using the General Anxiety Disorders-2 (GAD-2)<sup>30</sup>; and media exposure using GATS questions<sup>25</sup> and knowledge of regulations on shisha in Nigeria. Additional GATS questions included subjective norm-related questions, specifically having family members or close friends who smoke shisha and current cigarette smoking status (smoked cigarettes/not in the last year)<sup>25</sup>. We also asked about current alcohol consumption status (drank alcohol/not in the last year).

The dependent variable, current shisha smoking status, was self-reported from two questions adapted from the current GATS questionnaire<sup>25</sup>: 1) 'Have you ever smoked shisha, even one or two puffs?'; and 2) 'Do you currently smoke shisha on a daily basis, less than daily or not at all?'. Those who responded 'no' to the first, and those responding 'not at all' to the second question were classified as people who did not smoke shisha currently. Those who responded 'yes' to the first, and 'daily' or 'less than daily' to the second question were classified as people who currently smoked shisha.

The independent variables that were considered and their relationship with shisha smoking are shown in Figure 1. These included demographic and socioeconomic characteristics such as age, sex, rural/urban residence, education level, religion, employment status, and household wealth. In the qualitative study preceding this survey<sup>17</sup>, we also identified that shisha smoking was sometimes used as a way to cope with stress, anxiety and depression, and often co-occurred in a mutually reinforcing manner with alcohol consumption and cigarette

Figure 1. Logic model of risk factors of shisha smoking that were considered for logistic regression



smoking. In addition, having family members or close friends who smoke shisha resulted in the perception that it was socially acceptable, and social pressure/support to smoke it. It also made it difficult to stop smoking it.

### Data collection

Data were collected by 23 enumerators who had received a 5-day training, using CATI. The piloted questionnaire was programmed using the SurveyCTO software (<https://www.surveyccto.com/>) which offers end-to-end encryption of data, on password-protected android tablets. The questionnaire was administered in English as well as the four major local languages in Nigeria, i.e. Hausa, Igbo, Yoruba and Pidgin English. English data collection tools were translated to these languages by an independent professional translator, and back translated to English by another independent professional translator to ensure accuracy of the translations. We pilot tested the questionnaires before use. The training of enumerators covered the questionnaire content and administration, safeguarding principles, research ethics and other relevant topics. The training involved classroom training, role-playing and field practice and testing. During field practice and testing, each enumerator collected data from one shisha smoker and one non-smoker using the CATI devices under supervision.

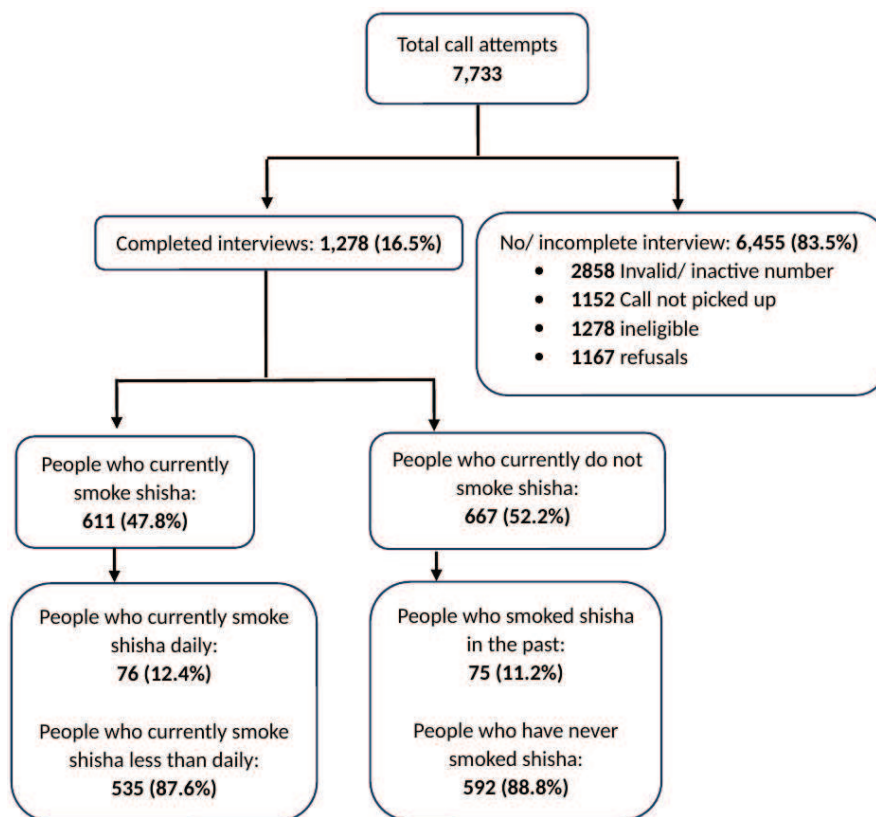
The research team then used the feedback from this exercise to revise and finalize the data collection tools and procedures. Data were collected from a call center and the questionnaire took up to 35 minutes to administer. Each participant received five hundred Naira (about US\$1.2 at the time of the study) worth of airtime as compensation for their time.

### Data analysis

We summarized and presented categorical variables as percentages and continuous variables as means and standard deviations (SDs). We used adjusted odds ratios (AORs), with 95% confidence intervals (CIs), as the measures of association. Bivariate analysis was conducted between each independent variable and the dependent variable, and all independent variables with a  $p < 0.2^{31}$ , and those that were known, theoretically or empirically, to be associated with smoking status were included in multivariable logistic regression analysis. The following variables were, therefore, included in the final multivariable logistic regression model: age, sex, rural/urban residence, education level, religion, household wealth, employment status, having family members who smoke shisha, the number of close friends who smoke shisha, current cigarette smoking status, current alcohol consumption status, stress, depression and anxiety. Sample weights were applied, with the weight of each observation being



Figure 2. Flow of participants in the study



equal to the inverse of the probability of selection. For competing multivariable logistic regression analysis models, the best model was determined using Akaike's information criteria (AIC), while the Hosmer-Lemeshow test was run to test the model's goodness-of-fit. Variance Inflation Factor (VIF) analysis was used to test for multicollinearity in the regression models. We conducted subgroup analysis by sex. Analyses were conducted in STATA version 18 (<https://www.stata.com/>).

## RESULTS

### Participant characteristics

A total of 7733 phone numbers were called from which 1278 (16.5%) survey questionnaires were successfully completed (Figure 2); 611 (47.8%) survey participants currently smoked shisha and 667 (52.2%) did not smoke shisha currently; 12.4% of the people who currently smoked shisha smoked it daily and 87.6% smoked it less than daily. Among the people who did not smoke shisha currently, 88.8% (n=592) had never smoked shisha and 11.2% (n=75)

had smoked it in the past.

The distribution of current shisha smoking status by geopolitical zone and the states where data were collected from in each geopolitical zone are provided in the Supplementary file Figure 1.

The average age of the survey participants was 32.3 years, and 69% were male with 31% being female (Table 1); 72% and 28% were from urban and rural areas, respectively. Over 90% of participants had a minimum of secondary education. The majority of participants (about 73%) were employed. Distribution by religion and wealth are also given in Table 1.

As shown in Table 2, approximately 16% of participants had at least one family member who smokes shisha, and approximately 60% had at least one close friend who smokes shisha; 12% of the participants currently smoked cigarettes whilst 47% currently consumed alcohol. The mean PSS-4 score was 7.0 (SD=2.5), 41% of the study participants screened positive for possible major depressive disorder, and 39% screened positive for possible

generalized anxiety disorder. Characteristics by current shisha smoking status are also provided in Tables 1 and 2.

### Factors associated with current shisha smoking status

The likelihood of being a person who currently smokes shisha throughout the results and discussion section decreased with increasing age (AOR=0.92; 95% CI: 0.89–0.95, p=0.000) (Table 1). Whilst there was no clear relationship between household wealth and current shisha smoking status across all wealth quintiles; those who belonged to the ‘richer’

quintile were less likely to be people who currently smoke shisha compared to those who belonged to the ‘poorest’ quintile (AOR=0.41; 95% CI: 0.18–0.97, p=0.043). Students were more likely to be people who currently smoke shisha than those currently unemployed (AOR=2.21; 95% CI: 1.38–3.53, p=0.004). There was no statistically significant association between sex, education level, religion, or rural/urban residence and current shisha smoking status.

Those who currently smoked cigarettes had higher odds of being people who currently smoke shisha than those who did not currently smoke cigarettes

**Table 1. General demographic characteristics and their association with current shisha smoking status**

Characteristics	Overall (N=1278)	Currently smoke shisha (N=611)	Currently do not smoke shisha (N=667)	OR (95% CI)	AOR (95% CI)
	n (%)	n (%)	n (%)		
Age (years), mean (SD)	32.3 (9.7)	28.8 (6.0)	35.6 (11.1)	0.91 (0.89–0.94)	0.92 (0.89–0.95)
<b>Sex</b>					
Female ®	394 (30.8)	145 (23.7)	249 (37.3)	1	1
Male	884 (69.2)	466 (76.3)	418 (62.7)	1.92 (1.39–2.65)	0.92 (0.56–1.52)
<b>Residence</b>					
Rural ®	361 (28.2)	140 (22.9)	221 (33.1)	1	1
Urban	917 (71.8)	471 (77.1)	446 (66.9)	1.66 (0.99–2.80)	1.26 (0.62–2.54)
<b>Education level</b>					
No education ®	44 (3.5)	4 (0.7)	40 (6.0)	1	1
Primary	73 (5.8)	8 (1.3)	65 (9.7)	1.29 (0.36–4.64)	0.47 (0.15–1.50)
≥Secondary	1161 (91.7)	599 (90.0)	562 (84.3)	10.47(3.67–29.87)	0.54 (0.17–1.65)
<b>Religion</b>					
Christianity ®	803 (62.8)	417 (68.2)	386 (57.9)	1	1
Islam	450 (35.2)	182 (29.8)	268 (40.2)	0.62 (0.45–0.85)	0.99 (0.67–1.47)
None	25 (2.0)	12 (2.0)	13 (1.9)	0.94 (0.29–3.03)	0.75 (0.17–3.33)
<b>Wealth quintiles</b>					
Poorest ®	257 (20.1)	184 (30.1)	73 (11.0)	1	1
Poorer	350 (27.4)	200 (32.7)	150 (22.5)	0.53 (0.41–0.69)	0.82 (0.49–1.36)
Middle	165 (13.9)	84 (13.8)	81 (12.1)	0.44 (0.29–0.68)	0.71 (0.34–1.49)
Richer	266 (20.8)	89 (14.6)	177 (26.5)	0.21 (0.12–0.35)	<b>0.41 (0.18–0.97)</b>
Richest	240 (18.8)	54 (8.8)	186 (27.9)	0.12 (0.08–0.19)	0.49 (0.15–1.57)
<b>Employment status</b>					
Unemployed ®	108 (8.6)	32 (5.2)	76 (11.4)	1	1
Employed	928 (72.6)	440 (72.0)	488 (73.2)	2.21 (0.98–5.01)	1.72 (0.78–3.81)
Student	161 (12.6)	106 (17.4)	55 (8.2)	4.62 (2.16–9.90)	<b>2.21 (1.38–3.53)</b>
Apprentice	81 (6.3)	33 (5.4)	48 (7.2)	1.67 (1.04–2.69)	1.45 (0.45–4.68)

AOR: adjusted odds ratios. ® Reference categories.

(AOR=5.54; 95% CI: 2.57–11.89, p=0.001) (Table 2). Those who currently consumed alcohol were more likely to be people who currently smoke shisha than those who did not currently consume alcohol (AOR=3.46; 95% CI: 1.91–6.28, p=0.001). Those who had a family member who smokes shisha had a higher likelihood of being people who currently smoke shisha than those who did not have any family member who smokes shisha (AOR=2.32; 95% CI: 1.23–4.40, p=0.015). Similarly, those who had one (AOR=22.81; 95% CI: 9.99–52.06, p=0.000) or more (AOR=78.85; 95% CI: 22.50–276.33, p=0.000) close friends who smoke shisha had higher odds of being people who currently smoke shisha than those

without any close friends who smoke shisha. Those who screened positive for possible generalized anxiety disorder had lower odds of being people who currently smoke shisha than those who screened negative (AOR=0.60; 95% CI: 0.41–0.88, p=0.014). Overall, the study findings did not show statistically significant associations between perceived stress scores or screening positive/negative for possible major depressive disorder and current shisha smoking status.

The results for males were similar to the overall results with respect to the association between the following and current shisha smoking status: age, current cigarette smoking status, current alcohol

**Table 2. Cigarette and alcohol use, mental health, shisha smoking by family or friends, and association with current shisha smoking status**

Variable	Overall (N=1278) n (%)	Currently smoke shisha (N=611) n (%)	Currently do not smoke shisha (N=667) n (%)	OR (95% CI)	AOR (95% CI)
<b>At least one family member smokes shisha</b>					
No ®	1071 (83.8)	430 (70.4)	641 (96.1)	1	1
Yes	207 (16.2)	181 (29.6)	26 (3.9)	10.55 (5.21–21.37)	2.32 (1.23–4.40)
<b>Number of shisha smokers among close friends</b>					
0 ®	403 (31.5)	11 (1.8)	392 (58.8)	1	1
1	61 (4.8)	28 (4.6)	33 (4.9)	27.80 (10.27–75.25)	22.81 (9.99–52.06)
≥2	691 (54.1)	565 (92.5)	126 (18.9)	160.30 (47.10–545.52)	78.85 (22.50–276.33)
Don't know	123 (9.6)	7 (1.1)	116 (17.4)	2.22 (0.28–17.70)	2.80 (0.32–24.38)
<b>Currently smoke cigarettes</b>					
No ®	1119 (87.6)	474 (77.6)	645 (96.7)	1	1
Yes	159 (12.4)	137 (22.4)	22 (3.3)	9.43 (4.17–21.34)	5.54 (2.57–11.90)
<b>Currently consumes alcohol</b>					
No ®	676 (52.9)	184 (30.1)	492 (73.8)	1	1
Yes	602 (47.1)	427 (69.9)	175 (26.2)	6.54 (4.74–9.02)	3.46 (1.91–6.28)
<b>PSS-4, mean (SD)</b>					
	7.0 (2.5)	6.5 (2.5)	7.5 (2.5)	0.85 (0.81–0.90)	0.89 (0.78–1.01)
<b>PHQ-2</b>					
Negative ®	751 (58.8)	390 (63.8)	361 (54.1)	1	1
Positive	527 (41.2)	221 (36.2)	306 (45.9)	0.67(0.52–0.85)	0.79 (0.52–1.21)
<b>GAD-2</b>					
Negative ®	778 (60.9)	413 (67.6)	365 (54.7)	1	1
Positive	500 (39.1)	198 (32.4)	302 (45.3)	0.57 (0.49–0.67)	0.60 (0.41–0.88)

AOR: adjusted odds ratios. PSS-4: Perceived Stress Scale-4. PHQ-2: Patient Health Questionnaire-2. GAD-2: General Anxiety Disorders-2. ® Reference categories.



consumer status, having a family member who smokes shisha, having one or more close friends who smoke shisha, screening positive/negative for possible major depressive disorder, rural/urban residence, education level, religion and household wealth (Supplementary file Figure 1). However, for employment status, both students (AOR=3.85; 95% CI: 1.43–10.41,  $p=0.013$ ) and those who were employed (AOR=2.53; 95% CI: 1.09– 5.89,  $p=0.034$ ) were more likely to be people who currently smoke shisha than those who were unemployed. In addition, the likelihood of being a person who currently smokes shisha decreased with increasing perceived stress scores (PSS-4) (AOR=0.85; 95% CI: 0.72–0.99,  $p=0.044$ ); and there was no statistically significant association between screening positive/negative for possible generalized anxiety disorder and current shisha smoking status.

The results for females were similar to the overall results with respect to the association between the following and current shisha smoking status: age, current alcohol consumer status, having one or more close friends who smoke shisha, perceived stress score, rural/urban residence, education level, and religion (Supplementary file Table 1). However, the model fitted for females perfectly predicted the relationship between current cigarette smoking status and shisha smoking status (i.e. OR=1), i.e. all females who currently smoked cigarettes also currently smoked shisha and all females who did not currently smoke cigarettes also did not currently smoke shisha. Contrary to the overall results and those observed for males, there was no statistically significant association between household wealth, employment status or having a family member who smokes shisha and current shisha smoking status. There was also no statistically significant association between screening positive for possible generalized anxiety disorder and current shisha smoking status. However, those who screened positive for possible major depressive disorder were less likely to be people who currently smoke shisha than those who screened negative (AOR=0.36; 95% CI: 0.17–0.81,  $p=0.019$ ).

## DISCUSSION

This study aimed to identify factors associated with shisha smoking among the general population adults in Nigeria. We found that being a person who

currently smokes cigarettes, being a person who currently consumes alcohol, having a family member who smokes shisha, or having close friends who smoke shisha, increased the likelihood of being a person who currently smokes shisha than not being/not having. An increase in age reduced the likelihood of being a person who currently smokes shisha, and those who screened positive for possible generalized anxiety disorder were less likely to be people who currently smoke shisha than those who screened negative. There was no statistically significant association between the following and current shisha smoking status: sex, education level, religion, rural/urban residence, perceived stress score, and screening positive/negative for possible major depressive disorder. Although there was no clear relationship between household wealth and current shisha smoking status, those who were in the 'richer' category were more likely to be people who currently smoke shisha than those in the poorest category. Students were more likely to be people who currently smoke shisha than the unemployed.

Overall, our results align with those from other studies that have found a statistically significant, positive association between cigarette smoking status, alcohol consumption status, or shisha smoking among family members or close friends, and being a person who currently smokes shisha<sup>4,12,32,33</sup>. Other studies have also found a negative association between age and shisha smoking, with younger individuals more likely to be people who currently smoke shisha than older individuals<sup>1</sup>. However, the three studies in Nigeria that have looked at age, did not find any statistically significant relationship with shisha smoking status. Two of these studies were in much younger populations of secondary school and/or university students (mean age 20–23 years vs 32 years for our general population sample)<sup>4,15</sup>. The remaining one was also in a different population, i.e. nightclub patrons<sup>12</sup>. Many studies report that males are more likely to be people who currently smoke shisha than females<sup>34</sup>. However, as with our study, most studies in Nigeria have found no statistically significant difference between males and females in the likelihood of being a person who currently smokes shisha<sup>4,12,15</sup>. We identified only one study in Nigeria suggesting that males were more likely to be people who currently smoke shisha than females<sup>10</sup>. From our previous report using

qualitative interviews with 78 people who currently smoked shisha and 611 people who currently smoked shisha from the study being reported here, although shisha smoking was perceived as generally socially unacceptable in Nigeria, it was perceived as more accepted by society, and more comfortable to females when compared to cigarette smoking<sup>17</sup>. This makes it plausible that, unlike other smoked tobacco products such as cigarettes that are more commonly used by males than females, shisha smoking could be as common in females as it is in males in Nigeria. However, there are currently no general population, national-level data to confirm or refute whether this is indeed the case.

Although there is overwhelming evidence of a significant positive association between tobacco smoking and mental health problems such as anxiety, tension and depression<sup>35</sup>, we did not observe this relationship in our study. Instead, we found that those who screened positive for possible generalized anxiety disorder were less likely to be people who currently smoke shisha than those who screened negative. We have previously reported that our subsample of 611 people who currently smoked shisha, and the 78 people who currently smoked shisha we had qualitative interviews with, associated shisha smoking with pleasure and fun, and mostly smoked shisha with close friends in places that provided food and entertainment<sup>17</sup>. Only 13% of the 611 people who smoked shisha reported smoking shisha to cope with challenging life situations such as stress<sup>17</sup>. This suggests that the relationship between shisha smoking and mental health might be different from that which exists between smoking other tobacco products such as cigarettes and mental health.

There were a number of sex differences in the results. Whilst for males the relationship between household wealth and current shisha smoking status was the same as the overall result, there was no statistically significant relationship for females. Among males, students and those who were employed were more likely to be people who currently smoke shisha than those who were unemployed; but for females, there was no statistically significant relationship between employment status and current shisha smoking status. We also found that for females, having close

friends who smoke shisha predicted shisha smoking status, and having family members who smoke shisha did not; but for males, both were predictors. This might stem from the fact that societal views are more negative (and therefore potentially more protective) towards females than males who smoke shisha, which potentially limits the impact of family members' shisha smoking on female behavior. In our previous analysis we found that many women who smoked shisha mainly smoked it privately or in safe spaces, particularly among close friends, where there was less likelihood of stigmatisation<sup>17</sup>. An increase in the perceived stress score decreased the likelihood of being a person who currently smokes shisha among males, but not among females. Whilst there was no association between screening positive/negative for possible major depressive disorder and current shisha smoking status among males, for females, those who screened positive were less likely to be people who currently smoke shisha than those who screened negative.

Interventions aimed at curbing shisha smoking in Nigeria should consider the influence of family and friends on shisha smoking behavior, and co-consumption with other tobacco products as well as alcohol. In addition, the interventions should also consider the differences that might exist between other smoked tobacco products and shisha, for example, differences in the influence of sex and mental health status. Sex differences in the factors that influence shisha smoking should also be accounted for in order to ensure that the needs of both males and females are catered for. In terms of future research, there is a need for nationally representative data on the prevalence of shisha smoking as well as shisha smoking patterns. The data need to allow for disaggregation by important demographic characteristics such as sex, age, rural/urban residence and socio-economic status in order to inform targeted responses where necessary. There is also a need to ascertain the differences between shisha smoking behavior and the smoking of other tobacco products, and the implications of those differences on tobacco control measures.

### Strengths and limitations

The sample was limited to those with phone numbers that were listed in the NLSS sampling frame, which

might restrict the applicability of the findings to the general population in Nigeria. However, the impact of this is reduced by the high phone penetration rates in Nigeria of more than 80%<sup>36</sup>, and the fact that NLSS sampling frame of households is representative at national-, zonal-, and state-levels including FCTs. In addition, the random selection of 10 EAs in each of the 12 participating states covering all six geographical zones of Nigeria also enhanced the generalizability of our study findings. The snowball sampling introduced in some EAs to get enough people who currently smoke shisha might have introduced selection bias. We anticipate that this did not affect the direction of effect of the results. However, this could have potentially led to an over estimation of the AOR for having family or friends who smoke shisha, if those who smoked shisha were more likely to refer other shisha smokers than those who did not smoke shisha. We were able to translate our data collection tools into local languages and also administer the questionnaire and interviews in local languages for those who preferred this, which enhanced the accessibility of the study, and hence generalizability.

## CONCLUSIONS

In our study, the following increased the likelihood of being a person who currently smokes shisha: currently smoking cigarettes or currently consuming alcohol, and having family members or close friends who smoke shisha. Those who were older and those who screened positive for possible generalized anxiety disorder were less likely to be people who currently smoke shisha. Interventions to curb shisha smoking need to take these factors into consideration. In addition, interventions should account for sex differences, as well as differences that might exist between shisha smoking behavior and the smoking of other tobacco products.

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### CONFLICTS OF INTEREST

The authors have completed and submitted the ICMJE form for Disclosure of Potential Conflicts of Interest. The authors declare that they have no competing interests, financial or otherwise, related to the current work. N. D. Mdege reports that since the initial planning of the work, this research has been supported by the Bill & Melinda Gates Foundation (INV-009670) and payment was made to the Development Gateway: An IREX Venture, and not to her as an individual.

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### ETHICAL APPROVAL AND INFORMED CONSENT

Ethical approval was obtained from the National Health Research Ethics Committee, Nigeria (NHREC) (Approval number: NHREC/01/01/2007-21/07/2022; Date: 21 July 2022). Participants provided informed consent.

### DATA AVAILABILITY

The data supporting this research are available from the following source: <https://doi.org/10.5281/zenodo.7775958>

### AUTHORS' CONTRIBUTIONS

NDM, SJA and AC: conceptualized and designed the study and the data collection tools. NDM and SO: contributed to data analysis and validation. All authors contributed to the interpretation of the results. NDM prepared the first draft of the manuscript, and all the other authors reviewed and provided feedback and editing during the manuscript preparation. All authors read and approved the final version of the manuscript.

### PROVENANCE AND PEER REVIEW

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