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Correlates of Nicotine Dependence Among Current Cigarette Smokers in Nigeria

Afolabi Oyapero¹, Olufemi Erinoso², Moyosoore Osoba, Olatokunbo Osibogun³

¹ Lagos State University Teaching Hospital

² University of Nevada, Reno

³ FIU Robert Stempel College of Public Health and Social Work

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Abstract

Background: The level of dependence on nicotine, the main addictive chemical in tobacco, is a substance-related disorder that can be used to characterize diverse populations of cigarette smokers and to determine the effectiveness of individualized smoking cessation intervention programs.

Aim: This study aimed to investigate the correlates of nicotine dependence among currently established cigarette smokers in Nigeria.

Setting: We conducted a cross-sectional survey among a cohort of current established cigarette smokers (≥ 100 sticks in a lifetime and someday/everyday cigarette smokers) in Lagos, Nigeria.

Methods: Nicotine dependence (ND) was measured using the Fagerstrom scale; independent measures were demographics, harm perception, binge alcohol drinking, and past year internalizing and externalizing problems. Logistic regression models were used to investigate the factors associated with severe nicotine dependence.

Results: The analytical sample was drawn from 487 adults. Within our sample, 69%, 27%, and 3.9% had low, moderate, and severe ND levels, respectively ($p = 0.02$), whereas among daily cigarette smokers, 48.1%, 44.3%, and 7.6% had low, moderate, and severe ND levels, respectively ($p < 0.001$). In the regression analysis, older age (aOR:1.03; 95% CI:1.01,1.06) and being male (vs. female) (aOR:3.70; 95% CI:1.58,8.15), and reduced cigarette harm perceptions (aOR:2.85; 95% CI: 1.75,4.66) were associated with increased odds of moderate/severe ND.

Conclusion: Older age, male sex, and those with reduced harm perceptions regarding cigarette use had increased odds of moderate/severe ND. Our preliminary findings provide baseline results characterizing use behaviors among relatively understudied current-established cigarette smokers in Nigeria.

Contributions: All Authors were involved in the conceptualization, data curation, formal analysis, writing–review and editing, and project administration.

Afolabi Oyapero^{1,2,*}, Olufemi Erinoso³, Moyosoore Osoba⁴, and Olatokunbo Osibogun⁵

¹*Smoking Cessation Clinic, Lagos State University Teaching Hospital*

²*Department of Preventive Dentistry, Lagos State University College of Medicine, Ikeja, Nigeria*

³*School of Public Health, University of Nevada, Reno., Reno, NV, USA*

⁴*African Center of Excellence for Genomics of Infectious Diseases (ACEGID), Owo, Ondo State, Owo, Nigeria*

⁵*Department of Epidemiology, Robert Stempel College of Public Health and Social Work, Florida, Florida, FL, USA*

***Corresponding author:**

Dr. Afolabi Oyapero, BDS, MPH, FMCDS (DrPH), TTS.

Senior Lecturer, Department of Preventive Dentistry, Lagos State University College of Medicine, Ikeja, Nigeria.

Email: afolabioyapero@lasucom.edu.ng, folaba@yahoo.com.

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Introduction

Tobacco use is a public health problem and the primary cause of avoidable morbidity and mortality globally. Approximately 8 million people are projected to die annually from tobacco-related diseases by 2030.^[1] Smoking is a substance use disorder related to nicotine in tobacco, which is characterized by a strong desire to use the substance after repeated and continuous use. Nicotine is a psychoactive drug that activates a cascade of neurobiological events in the reward areas of the brain and all over the body, which reinforces its use.^[2] Thus, even though the majority of smokers are desirous of quitting, there is an inverse relationship between successful quit attempts and the level of nicotine dependence.^{[3][4]} Dependence or addiction is characterized by a perceived loss of control, including compulsive use and difficulty abstaining. Research has shown that nicotine dependence indicators, including the number of cigarettes smoked daily and smoking the first cigarette within 30 minutes after waking up, are strongly correlated with the intention and success of quit attempts.^[5] Unfortunately, unlike other addictive drugs, tobacco is widely available, relatively cheap, and legal to use.

To achieve a higher rate of smoking cessation during treatment, an understanding of nicotine dependence and its correlation among smokers is desirable. Transition from experimentation with cigarettes to regular smoking among adolescents, for example, is associated with having a poor relationship with parents, poverty, poor academic performance, and having friends that smoke.^[6] Other correlates of nicotine dependence include alcohol consumption, the use of other addictive substances, exposure to secondhand smoke exposure, genetic predisposition to addiction, and the use of multiple tobacco products.^{[7][8]} Nicotine dependence is also strongly correlated with the age of initiation and extensiveness of smoking, sensitivity to and metabolism of nicotine, nicotine metabolism, age at onset of smoking a whole cigarette, a shorter latency between onset and daily smoking, as well as mental illness.^{[9][10]}

Clinical studies have consistently documented high rates of cigarette smoking and nicotine dependence among patients with internalizing and externalizing disorders.^[11] It has been hypothesized that nicotine is used by these patients to self-medicate. It stimulates dopamine release by nicotinic receptors, and addresses cognitive deficits by regularizing P50 auditory gating and to enhance prepulse inhibition.^[12] Proxy measures for dependence includes the number of cigarettes smoked daily and a strong craving or urge to smoke and these are often associated with high rates of relapse after treatment.^[13] However, a globally accepted normative measure, which is reproducible, accurate and easy to use for evaluating nicotine dependence is the Fagerström test for nicotine dependence (FTND).^[14]

At the turn of this century, cigarette smoking was reduced by 26% in Western Europe, which mirrors the pattern in other high-income countries, while it increased by about 60% in African and Middle Eastern countries.^[15] Africa and other Low- and middle-income countries (LMIC) have become key targets for tobacco companies due to their weak regulatory oversight over tobacco demand reduction policies and supply side restrictions.^[16] Moreover, many African countries like Nigeria have weak health systems, vulnerable populations, and very limited resources to provide necessary assistance such as quit lines to tobacco users. Nigeria is the most populated country in Africa and has one of the leading tobacco markets in Africa, with over 18 billion cigarettes sold annually, costing Nigerians over US\$ 931 million.^[17] Nicotine replacement therapies and medication to assist cessation efforts are also mainly unavailable and priced beyond the reach of most Nigerians.

To develop and implement effective measures to control tobacco smoking, the reasons and risk factors for smoking initiation and dependence must be recognized. Public health programs are presently designed to identify and reach subgroups with very high rates of tobacco use, especially those with mental illness and addiction. Thus, it is desirable to identify vulnerable populations in the country and to design appropriate preventive interventions. The level of dependence on nicotine, the main addictive chemical in tobacco, is a substance-related disorder that can be utilized to characterize diverse populations of cigarette smokers and determine the effectiveness of individualized smoking cessation intervention programs. This study investigated the correlation of nicotine dependence among currently established cigarette smokers in Nigeria.

Methods

Study design and settings

This study used a cross-sectional design comprising adult cigarette smokers (18+ years) in Nigeria. Participants were enrolled from the Smoking Cessation Clinic of the Preventive Dentistry clinic at the Lagos State University Teaching Hospital between February and December 2023 and were selected by simple random sampling (balloting), using the clinic attendance register as the sampling frame.

The data inclusion criteria were adults aged 18 years and above at the time of enrollment. Our sample was restricted to established combustible cigarette users. Established smokers were individuals who smoked at least 100 cigarettes in their

lifetime and currently smoked cigarettes on some or every day. We excluded respondents who used other tobacco products, but were non-cigarette smokers.

Dependent variable

Nicotine dependence: The Fagerström Test for Nicotine Dependence (FTND) is a validated instrument for assessing nicotine dependence in adult smokers.^{18,19} The FTND comprises six items that assess the quantity of cigarette use and compulsion to use. Response options are “yes/no” with scores of 1 and 0 respectively, and multiple-choice items have response options scored 0-3 providing a total score of between 0 and 10. Respondents with a score of 0-4 had low or low-moderate dependence, 5-7 had moderate dependence, and 8 or above had a high level of nicotine dependence. ^{[18][19]} Participant nicotine dependence levels were collapsed into binary variables categorized as low or low-moderate dependence AND moderate/ High nicotine dependence levels.

Independent variables

Harm perception of smoking: All respondents were asked, “What is the effect of cigarettes on your overall health?”. Response options were on a 4-item Likert scale: very harmful, harmful, harmless, and very harmless. The 4-item Likert scale was collapsed into two response options for analysis: very harmful/harmful and harmless/very harmless.

Binge Alcohol use: Respondents were assessed for binge drinking with a single question: “During the past 30, on how many days did you have four [five for males] or more alcoholic drinks on the same occasion? By ‘occasion,’ we mean at the same time or within a couple of hours of each other.” Respondents were provided the following response options: I have not drank alcohol in the past 30 days/ 0-7 days/ 8-14 days/ 15-21 days/ 22-30 days. The measure was adapted from the National Survey on Drug Use and Health (NSDUH).^[20]

Internalizing and externalizing problems: Internalizing disorders and their antecedents are often associated with fear, contemplation, and emotional distress, while externalizing disorders are linked to oppositional, belligerent, impetuous, disorderly, and rule-breaking conduct. Mental distress of participants was our primary outcome variable, and was measured using the GAIN-Short Screener (GAIN-SS) for internalizing (four questions) and externalizing problems (seven questions).^[21] Based on the severity of internalizing and externalizing problems increased with their respective scores. For every internalizing or externalizing problem reported in the past year, the participant’s GAIN-SS score increased by one point. Data on mental distress were treated using a model in a prior study by Kaplan et al.^[22] Participants with internalizing or externalizing problems were categorized into no/low (0-1 problem) vs. moderate/high (2 or more problems). Participants were categorized into two groups according to their responses to the internalizing and externalizing problem questions on the GAIN-SS: 1) respondents who indicated at least one internalizing and externalizing problem in the past year, and 2) respondents who did not indicate a problem (internalizing and externalizing) in the past year.

Covariates: Demographic data comprised age, biological sex (male/female), and educational attainment (less than high

school/high school graduate/college undergraduate/graduate degree).

Data analyses: Participant characteristics were analyzed descriptively using percentages and frequencies. Cigarette smoking status and severity of nicotine dependence were analyzed using chi-square statistics and presented as percentages. Bivariate and multivariable logistic regression models were used to determine the association between high nicotine dependence among established cigarette smokers and demographic factors (covariates), past-month binge alcohol use, harm perception, internalizing and externalizing symptoms. The outcome measure “nicotine dependence” was derived from the FTND score and treated as a binary variable with low/low-moderate nicotine dependence (0) and moderate/high nicotine dependence (1). In the multivariable logistic regression models, we adjusted for demographic factors (age, sex, and education), binge drinking, harm perception, and internalizing and externalizing symptoms, and examined the effect of nicotine dependence on these factors. Adjusted odds ratios (aOR) and 95% confidence intervals (CIs) were calculated for logistic regression models. P-values were considered significant at <0.05. Data analyses were conducted using the Stata 17 software (StataCorp, 2021).

Ethical approval: Ethical approval was obtained from the Lagos State University Teaching Hospital Health Research Ethics Committee: LREC/06/10/2330

Patient and Public Involvement Statement: During the development, progress, and writing of the submitted editorial, Patient and Public Involvement were included at all stages.

Results

The study sample comprised 487 adults. The mean age of the participants was 33.8 years (± 10.2). Based on sex, there was a higher proportion of males (76.7%) than females (23.3%). Most participants had binge alcohol use in the past month (84.3%), and more than half (60.2%) perceived cigarette smoking as harmful to health. Additionally, most participants had severe internalizing (51.7%) or externalizing symptoms (52.3%), while more than two-thirds (73.7%) had low or low-to-moderate nicotine dependence levels [Table 1].

Table 1. Participant characteristics

Variable	n (%)
Mean Age (\pm SD)	33.76 (\pm 10.22)
Sex	
Female	112 (23.33)
Male	368 (76.67)
Highest level of education	
Less than high school diploma	100 (20.83)
High School diploma	126 (26.25)
College undergraduate	147 (30.63)
Graduate degree	107 (22.29)
Binge Alcohol use	
I have not drank alcohol in the past 30 days	76 (15.70)
0-7 days	99 (20.45)
8-14 days	148 (30.58)
15-21 days	69 (14.26)
22-30 days	92 (19.01)
Harm perception of smoking	
Very harmful	31 (6.60)
Harmful	252 (53.62)
Harmless	175 (37.23)
Very harmless	12 (2.55)
Internalizing symptoms	
Low/ No	81 (16.88)
Moderate	151 (31.46)
High	248 (51.67)
Externalizing symptoms	
Low/ No	67 (14.02)
Moderate	161 (33.68)
High	250 (52.3)
Nicotine dependence	
Low/ low to moderate	359 (73.72)
Moderate	112 (23.0)
High	16 (3.29)

Low/ low-moderate: score of <4. Moderate: score of 5-7. High: score of \geq 8.

When participants' smoking status was stratified by the severity of their nicotine dependence, those who reported daily cigarette smoking in the past 30-days had the highest proportion of high nicotine dependence (87.5%), followed by those who smoked someday (73.2%) [Figure 1].

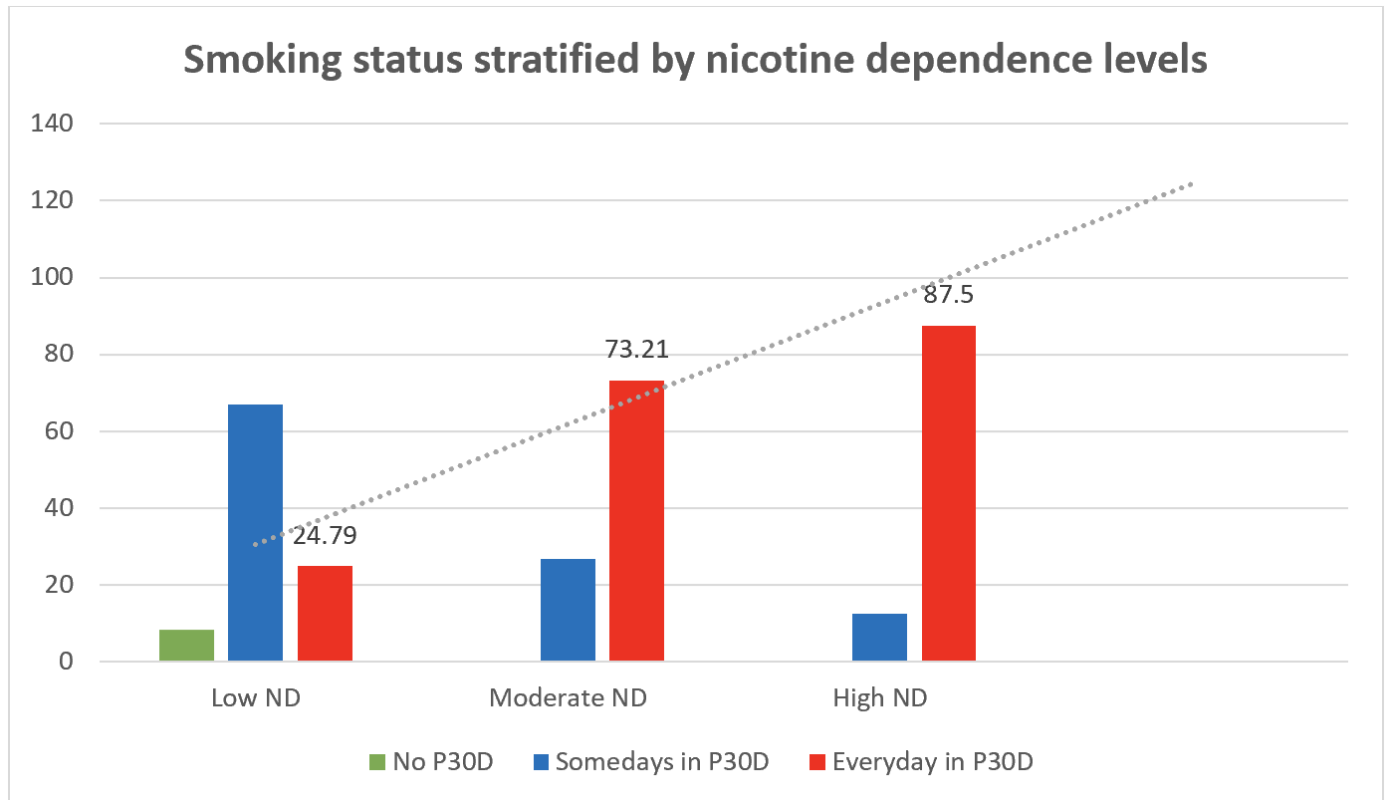


Figure 1. Past 30-day (P30D) smoking status of participants stratified by nicotine dependence levels.

p-value: <0.001. **Notes:** P30D: past 30-day cigarette smoking status. ND: Nicotine dependence levels measured using the Fagerstrom Nicotine Dependence Scale (low/low-moderate, moderate, high ND).

In a bivariate regression model (Table 2), older participants had 7% increased odds of having a moderate or high level of nicotine dependence (95% CI: 1.05, 1.09; $p < 0.001$). Similarly, males had increased odds of a moderate/high level of nicotine dependence compared to females (95% CI: 2.81, 12.67; $p < 0.001$). Furthermore, participants who perceived the health effect of cigarettes to be harmless or very harmless had significantly increased odds of a moderate/high level of nicotine dependence compared to those who considered cigarettes to be harmful or very harmful (95% CI: 2.53, 5.97; $p < 0.001$). In addition, participants with severe internalizing (95% CI: 2.60, 13.39; $p < 0.001$) and externalizing symptoms (95% CI: 2.76, 18.41; $p < 0.001$), suggesting that mental disorders had increased odds of moderate/high nicotine dependence.

Table 2. Bivariate regression model of factors associated with moderate/high Nicotine Dependence.

Variables	Odds ratio	<i>p</i> -value	95% Confidence Interval
Age in years	1.07	<0.001	1.05, 1.09
Sex			
Female	1 (reference)		
Male	5.96	<0.001	2.81, 12.67
Education			
Less than high school diploma	1 (reference)		
High School diploma	0.93	0.78	0.54, 1.59
College undergraduate	0.19	<0.001	0.10 0.36
Graduate degree	0.37	0.002	0.20, 0.70
Binge Alcohol use			
No alcohol use in past month	1 (reference)		
0-17 days	1.71	0.188	0.77, 3.82
8-14 days	2.87	0.004	1.39, 5.93
15-21 days	3.17	0.005	1.41, 7.13
22-30 days	1.44	0.383	0.64, 3.26
Harm perception of cigarette smoking			
Harmful/ Very harmful	1 (reference)		
Very harmless/ Harmless	3.89	<0.001	2.53, 5.97
Internalizing problems			
Low/ No	1 (reference)		
Moderate	2.42	0.048	1.01, 5.82
Severe	5.9	<0.001	2.60, 13.39
Externalizing problems			
Low/ No	1 (reference)		
Moderate	2.3	0.105	0.84, 6.29
Severe	7.12	<0.001	2.76, 18.41

OR: odds ratio. *P*-values <0.05 were in Bold.

Table 3 shows a multivariable regression model adjusted for age, sex, education, past-month binge alcohol use, harm perception of cigarettes, and internalizing and externalizing symptoms. Age, sex, and harm perception were significantly associated with increased odds of moderate/high nicotine dependence levels in the study population. Participants who believed cigarettes had harmless/very harmless health effects had 2.8 times increased odds of moderate/high nicotine dependence compared to those who believed cigarettes had harmful or very harmful health effects (95% CI: 1.75, 4.66; p

<0.001). Similarly, older age and male sex remained significantly associated with moderate/high nicotine dependence levels.

Table 3. Full Model showing factors associated with moderate/high Nicotine Dependence.

Variables	aOR	<i>p-value</i>	95% Confidence Interval
Age in years	1.03	0.02	1.00, 1.06
Sex			
Female	1 (reference)		
Male	3.7	0.001	1.65, 8.31
Education			
Less than high school diploma	1 (reference)		
High School diploma	0.94	0.841	0.51, 1.74
College undergraduate	0.46	0.055	0.21, 1.02
Graduate degree	0.61	0.196	0.29, 1.29
Binge Alcohol use			
No alcohol use in past month	1 (reference)		
0-17 days	1.16	0.759	0.46, 2.90
8-14 days	1.28	0.564	0.56, 2.93
15-21 days	1.6	0.318	0.64, 4.04
22-30 days	0.65	0.366	0.25, 1.67
Harm perception of cigarette smoking			
Harmful/ Very harmful	1 (reference)		
Very harmless/ Harmless	2.85	<0.001	1.75, 4.66
Internalizing problems			
Moderate	1.69	0.276	0.66, 4.34
Severe	2.37	0.073	0.92, 6.09
Externalizing problems			
Moderate	2.2	0.16	0.73, 6.58
Severe	2.92	0.051	1.00, 8.57

aOR: adjusted odds ratio. *P-values* <0.05 were in **Bold**.

Discussion

Our findings suggest that older age, male sex, and misperceptions of cigarette harms were associated with moderate to high levels of nicotine dependence. There was a significantly higher proportion of males compared to females among them, as previously documented among smokers in Nigeria^[23]; this pattern also mirrors that in the USA, where current cigarette smoking was higher among men than women and was highest among the middle-aged and elderly,^[24] and also among those with lower educational attainment.^[24] While the prevalence of smoking in high-income countries (HICs) continues to decline through the implementation of comprehensive tobacco control policies,^[25] low-and middle-income countries (LMICs) still have relatively higher smoking prevalence and a less comprehensive and relatively weaker tobacco control environment.^[26] Moreover, nicotine replacement therapies and medication to assist cessation efforts are also mainly unavailable and priced beyond the reach of most smokers in LMIC, necessitating the early identification of those who are highly dependent and intervening appropriately.

A majority of the respondents had binge alcohol use in the past month, which further validates the findings of an increased odds of alcohol consumption among poly tobacco users in a previous research in Lagos.^[27] People who consume alcohol excessively are three times as likely to smoke, and this relationship may be bidirectional.^[28] Alcohol dependence and smoking, separately or together, are multifaceted forms of addictive behavior that may be influenced by a variety of genetic, neurobiological, conditioning, psychosocial mechanisms, and conditioning mechanisms, in which cravings for alcohol or nicotine are elicited by certain environmental cues; and psychosocial factors such as personality characteristics and coexisting psychiatric disorders. Internalizing disorders such as depression and anxiety, as well as externalizing disorders such as attention-deficit hyperactivity disorder (ADHD), oppositional defiant disorder (ODD), conduct disorder (CD), and antisocial personality disorder (ASPD),^{[29][30]} are significant mental health problems that have been regularly associated with tobacco use.

More than half of the participants perceived cigarette smoking as harmful to health, and most had severe internalizing or externalizing symptoms. This prevalence is far higher than that documented for mental health disorders among the general population who are not smokers.^{[31][32]} This corroborates previous research showing that individuals with mental health conditions, which include externalizing and internalizing disorders, are more likely to smoke,^[33] have an earlier age of smoking initiation onset, and smoke more heavily than others in the general population. Population-based studies among those with mental health conditions, especially those with past-month mental disorders have also documented higher rates of smoking and nicotine dependence among them.^{[34][35]} Moreover, researchers documented that over a third of cigarettes smoked in England and almost half of that in the United States are by those with mental health conditions, and other substance use disorders.^[36] Depression, anxiety, and stress, can be partially relieved by a variety of neurotransmitters released after stimulation of nicotinic cholinergic receptors.^[37] One of them, dopamine, signals a pleasurable experience and is critical for the reinforcing effects of nicotine,^[38] thus partly explaining the higher levels of nicotine dependence typically found among those with mental health conditions.^{[39][40]}

Approximately one-third of the study respondents had high levels of nicotine dependence. Cigarettes and other types of tobacco products are addictive, and the development of dependence on smoking progresses through stages that include

the experimental stage, regular smoking stage, and established or daily smoking stage.^[41] At this final stage, cessation efforts usually fail due to the level of dependence on the substance that has been developed. Nicotine dependence is a maladaptive stage in tobacco smoking in which there are withdrawal symptoms comparable that of other addictive disorders and it has been characterized by the fourth edition of the *Diagnosis and Statistical Manual of Mental Disorders*.^[42] Nicotine dependence is associated with an array of withdrawal symptoms such as depression, insomnia, irritability, anxiety, difficulty concentrating, restlessness when an attempt is made to stop smoking. This addiction is the main factor implicated in persistent cigarette smoking, with affected individuals characteristically smoking often during the day and every day. Cohort studies have consistently shown that smoking-related morbidity, especially lung cancer, increases exponentially with cigarette consumption levels and duration of smoking.^{[43][44]} Among established tobacco smokers, cessation results in a considerable reduction in risk, especially among those who cease smoking before 40 years of age.^[45] Our findings indicate that more than one-third of cigarette smokers had high nicotine dependence levels, underscoring the importance of public health spending on cessation aids and support.

In addition, participants with severe internalizing and externalizing symptoms, suggesting mental disorders, had increased odds of moderate/high nicotine dependence, although with marginal statistical significance. Tobacco use can progress to nicotine dependence, which can be highly comorbid with mood, anxiety, and personality disorders ^{[46][47]} while quitting smoking has been linked to significant improvements in symptoms of mental health conditions and overall well-being. ^[48] In the US, nicotine dependence severity is high among inpatients with psychosis who smoke cigarettes.^[49] A recently proposed bidirectional association suggests that smoking may be causally associated with an elevated risk of mental illness through shared genetic liability to smoking and mental disorders. ^{[50][51]} Moreover, people with mental health conditions may seek nicotine to alleviate the symptoms of their illness or the adverse effects of their medications.^[51]

Furthermore, age, sex, and harm perception were significantly associated with increased odds of moderate/high nicotine dependence levels in the study population. This aligns with previous research in LMICs and high-income countries (HICs) that have indicated that high dependence is associated with older age (36-45 years), manual occupations, and lower education.^{[52][53][54][55][56]} Furthermore, other studies have shown that nicotine dependence is more closely linked with the male sex,^{[54][55]} while another study,^[57] however, reported no difference in nicotine dependence based on sex. Our findings may be explained by social norms in Nigeria, which consider cigarette use a social habit for older men, and less so for women.

In addition, participants who believed cigarettes were harmless to their overall health had harmless health had more than two-fold increased odds of moderate/high nicotine dependence compared to those who believed cigarettes had very harmful health effects. Perceived risk plays an important role in predicting health behaviors as hypothesized in the Health Belief Model.^[58] Perceptions of harm and addictiveness of conventional cigarette smoking are important predictors of smoking behavior, which may differ depending on smoking status and may also influence the transition between tobacco products.^[59] Strong et al. ^[60] observed that youth at wave 1 of PATH with lower perceptions of harm or addictiveness of tobacco products were more likely to report trying the product. Other researchers have found that higher perceptions of

severity and vulnerability to smoking-related diseases are associated with higher odds of quitting attempts.^{[61][62]} Therefore, interventions such as plain packaging, cigarette stick health warnings, and increased access to cessation counselling should be considered by local policymakers, as they might encourage cigarette smokers to attempt to quit.

Studies on the harmful effects of tobacco in scientific studies across many nations have shown that those who are heavy smokers show more nicotine dependence, that older patients have higher odds of moderate or high levels of nicotine dependence, probably because they started smoking early in life when adverse effects of tobacco smoke were not well-known; a higher proportion of males are nicotine dependent, and those who perceive cigarettes as harmless have more odds of nicotine dependence. However, no such studies have been conducted in our nation, from which the sample population is sourced, giving merit and applicability to the study. Our study, however, has some limitations, and the results should be interpreted with caution. The use of self-report measures to determine nicotine dependence and internalizing and externalizing disorders could be subject to recall and social desirability bias, while our hospital-based cohort also precludes the generalization of our findings to the whole population in Nigeria or similar settings. Furthermore, the cross-sectional design of the study indicates association and not causality; therefore, we cannot establish a causal link between our independent measures, such as mental health conditions and nicotine dependence. The use of a single Smoking Cessation Clinic for participant recruitment may not provide a sample representative of the broader population of smokers in Nigeria, potentially limiting the generalizability of the findings. Nonetheless, our study provides findings regarding nicotine dependence in a cohort of cigarette smokers in a relatively understudied population. We also provide evidence about the factors (older age, being male, and harm perceptions) associated with nicotine dependence that can inform local policy.

Conclusion

In conclusion, our findings indicate that older age, males, and those with reduced harm perceptions of cigarette smoking had increased odds of moderate/severe ND. These results validate prior knowledge of nicotine dependence among current established smokers in the literature. Our preliminary findings provide baseline results characterizing use behaviors among relatively understudied current established cigarette smokers in Nigeria, and evidence for further research and targeted cessation interventions within this population.

Statements and Declarations

Competing interests: The authors declare no competing interests.

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