

## Interplay of family, friends and teachers' smoking habits and their effect on smoking behaviors of in-school adolescents in Nasarawa State, Nigeria

### Authors

\*Dennis Kudu Egga<sup>1,2</sup>, Omobola Wopora<sup>1</sup>, Alheri Alaku<sup>3</sup>, Anna Hosea Chiroma<sup>4</sup>, Jonah Jonathan<sup>5</sup>, Ijanada Aliyu Jacob<sup>1</sup>, Bright I. Nwaru<sup>6</sup>

### Affiliations

1. Department of Public Health, Babcock University, Ilishan-Remo Ogun State, Nigeria
2. School of Allied Health Sciences, Nasarawa State University, Keffi, Nigeria
3. College of Education Zuba, FCT Abuja, Nigeria
4. College of Nursing Sciences, Lafia, Nasarawa State, Nigeria
5. Hospitals Management Board Lafia, Nasarawa State, Nigeria
6. Krefting Research Centre, Institute of Medicine, University of Gothenburg, Sweden

### Corresponding author

Dennis Kudu Egga

E-mail: [eggadennis@gmail.com](mailto:eggadennis@gmail.com)

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### ABSTRACT

Adolescent smoking is strongly influenced by social networks. This cross-sectional study examined the contribution of family, friends, and teachers to the smoking habits of secondary school students aged 10-19 years in Nasarawa State, Nigeria. A total of 1,600 students were surveyed. Descriptive statistics summarized participant characteristics. Binary logistic regression assessed the independent and combined associations between smoking in the social network and students' own smoking habits. Of the 1,600 students surveyed, nearly all of them responded. Of those who responded, just over half were boys, and the majority were aged 16–18. More than half of the respondents attended private schools, and most of them attended mixed-sex schools. The adjusted associations between smoking by a family member and students' smoking were: ever tried smoking (OR 11.52, 95%CI 8.39-15.81), tried during the last 12 months (OR 10.98, 95%CI 7.85-15.37), and tried during the last 30 days (OR 11.28, 95%CI 7.93-16.06). These estimates were similar whether either parent, both parents, or both parents and a sibling smoked. The odds of concomitant smoking by a

family member, teacher and best friend were: ever tried smoking (OR 9.61, 95%CI 6.34-14.57), tried during last 12 months (OR 7.51, 95%CI 4.80-11.72), and tried during the last 30 days (OR 8.41, 95%CI 5.30-13.35) with the impact more on girls than on boys. When no family member smoked, the influence of a smoking teacher and/or friend was insignificant such that it could not be estimated in this study. In this Nigerian setting, family smoking behavior is the most consistent correlate of adolescent smoking. These findings highlight the potential importance of family-centered prevention programs.

**Keywords:** *Adolescent, smoking, family, friends, teachers, students, social network, Nasarawa State, Nigeria*

## INTRODUCTION

Cigarette smoking is a significant contributor to preventable deaths and diseases (Gan et al., 2022; Steinberg et al., 2008) such as lung cancer and chronic respiratory diseases (CRDs). It accounts for about 8 million deaths globally each year (Centers for Disease Control, 2018; Ordunez & Campbell, 2020; UN-SDG1, 2015). Tobacco use is thought to have contributed to about 100 million premature deaths in the 20<sup>th</sup> century (Ritchie & Roser, 2013). Furthermore, cigarette smoking is associated with increased risk of and/or complications of various cancers, cardiovascular and respiratory diseases, and other chronic conditions (Gan et al., 2022; Loretan et al., 2022; Wang et al., 2019). In addition, smoking harms non-smokers exposed to second-hand smoke, particularly children and adolescents (Edwards, 2016; Obeng et al., 2023; Tan et al., 2022). Adolescence is a critical physical, social, and psychological developmental period of the human individual. It is a period during which behaviors develop, and habits are formed, including the initiation and experimentation with smoking (WHO (World Health Organization), 2011). According to the Global Youth Tobacco Survey (GYTS) WHO report in 2018), the prevalence of tobacco use (in any form) among adolescents aged 13–15 was 10.7% globally, with regional rates of 12.7% in Europe and 8.8% in Africa (World Health Organization, 2018). In Nigeria, a scoping review showed disparate prevalence estimates, ranging from 0.2% to 32.5% (Oyewole et al., 2018), highlighting a wide variability across the country. In addition, one study found the prevalence of adolescent smoking to be 11.1% (Fagbule et al., 2021) while a study by Egga and colleagues found that cigarette smoking was common among secondary school students in Nasarawa State, with approximately 16.0% of boys and 13.7% of girls having tried smoking (Egga et al., 2024). Several interrelated or independent social factors influence the smoking behaviors of adolescents, including personal, interpersonal, and environmental factors. Among the interpersonal factors, the roles of the social networks, including family (Alves et al., 2017) but its causes are not fully understood. This study investigates the association between parental and adolescent smoking, and whether this association is socially patterned. Methods we used data from a survey administered in 2013

to students aged 14-17 years old of six European cities (n = 10 526, teachers (Nurmansyah et al., 2021), and friends (Scalici & Schulz, 2017), are particularly important. These serve as social support, models, and norms for the adolescents which is consistent with Bandura's Social Learning Theory (Lin et al., 2023). The social learning phenomenon was central to the development and treatment of addiction as demonstrated in the studies by Smith (2022) , Abbas et al 2014, Work 2017 (Heydari et al., 2014; Miller, 2017; Smith, 2022). However, the role of the concomitant influence of family (parent(s) and siblings, friends, and teachers on adolescents' smoking behavior in Nigeria is unknown. Furthermore, while social network influences are established, their relative hierarchy and potential interactions within the collectivist, family-centric social fabric of the sub-Saharan African context like Nigeria, remain unexamined.

In this study, we examined the independent and concomitant roles of parents, sibling, friends, and teachers' smoking on the smoking behaviors of secondary school students in Nasarawa State, North Central Nigeria. The objective of the study was to examine the independent and concomitant roles of parents, sibling/s, friends, and teachers smoking habit on the smoking behaviors of secondary school students in Nasarawa State, Nigeria.

## **MATERIAL AND METHODS**

A cross-sectional design was employed for this study using an adapted version of the GYTS questionnaire to measure the prevalence of smoking among the adolescent social network and their (students') smoking habits (Ayedi et al., 2021; Bao et al., 2016). The study was conducted in Nasarawa State, North-Central Nigeria. Nasarawa State has 13 local government areas as administrative units. With 2.9 million inhabitants, the state is primarily based on subsistence farming and has significant solid mineral reserves. Nasarawa State has several higher education institutions, including five universities, with over 200 secondary schools- either private or government, residential or non-residential, and boys' only, girls' only or mixed. Due to its proximity to Abuja, multi-ethnic and multi-religion status, and typology of common Nigerian challenges (from rural subsistence to urban educational access) made it an excellent setting for research intended to produce transferable insights. The study population was secondary school students in Nasarawa State. All students in Junior Secondary School (JSS) 3 and Senior Secondary (SS) 1-3, usually within the age range of 10 -19 years, were eligible to participate in the study. Students in JSS 1 and 2 (usually <9 years) were excluded from participating in the study because they lacked the cognitive, social, and emotional development to adequately respond to the survey questions. This study used a multi-stage sampling approach to select participants. First, 26 schools (one public and one private from each of the 13 local government areas) were randomly selected. Secondly, 104 classes were selected from these schools by census. Last, within each class, 13 students were systematically selected to participate using attendance registers

as a sampling frame. A random starting point was determined, and every  $k^{\text{th}}$  student was then selected, ensuring a representative sample within each class. A sample of  $N = 1,600$  students was used. The large target sample was justified on three grounds: the multi-stage sampling design spans 13 local government, 26 schools, and 104 classes. A sufficiently large  $N$  was required to ensure stability at each stage. Subgroup analyses (by sex, age, and school type) and logistic regression with interaction terms further demanded adequate statistical power; particularly for rare exposure combination. Finally, the diversity of the source population across public and private, residential and non-residential, and single sex and mixed sex schools necessitated a sample broad enough to capture meaningful variation.

An adapted version of the GYTS (Bao et al., 2016) questionnaire was used for data collection. The adaptation involved adding culturally appropriate socio-demographic questions and by selecting only questions relevant to the research objective. The consistency and reliability were determined to ensure that the questionnaire was culturally appropriate. The questionnaire was divided into two parts: demographics of the respondents' and their social networks' history of cigarette smoking. Printed questionnaires were distributed and collated by research assistants. The students self-administered the questionnaires. Data collection took place between April 3 and July 9, 2023.

The outcome variables comprised participants' smoking history, defined as: (1) ever tried smoking, (2) tried smoking within the last 12 months, and (3) tried smoking within the last 30 days. Independent variables included smoking behaviors of family members (parents and siblings), best friends, and teachers, along with participants' demographic characteristics. Parental smoking was operationalized into five distinct categories: (1) only the mother smokes, (2) only the father smokes, (3) neither parent smokes, (4) either parent smokes, or (5) both parents smoke. Smoking by a family member was defined as tobacco use by at least one parent or a sibling. Additionally, composite variables were created to assess concomitant smoking exposure across family members, best friends, and teachers.

IBM SPSS version 21 was used for data analysis. Descriptive statistics was used to describe the demographic characteristics of the respondent and their exposure to smoking in the family and among the friends and teachers. The Pearson Chi-square test was used to describe the relation of the demographic variables and smoking in the social circle with the cigarette smoking behaviors of the students. To determine the adjusted association of the independent and concomitant exposure to smoking among parents, siblings, friends, and teachers with adolescents' cigarette smoking behavior, binary logistic regression was employed, adjusting for other demographic factors, including age and sex. The odds ratios (OR) were accompanied by their respective 95% confidence interval (95% CI). Statistical significance was defined as a 2-sided P-value of  $<.05$  for all analyses. The results were presented in the form of text, tables, and forest plots.

The ethical approval for the study was obtained from Babcock University Health Research Ethics Committee (BUHREC 778/22). Unwritten permission to conduct the study was also obtained from the authority of each participating school. Participants signed a written consent and were informed of the right to decline or withdraw from participating at any point. Parents or guardians consented on behalf of minors with the same rights. Confidentiality was maintained throughout the research with all responses anonymized in the report. No rewards were given or denied for participation or refusal.

## RESULTS

In total, 1,600 questionnaires were distributed, of which 1,518 (94.9%) were completed and made available for analysis. The proportion of boys (51.3%) who participated in the study was slightly higher than the girls (48.7%). The majority (55.3%) of the students was 16-18 years; nearly three-quarters attended non-residential schools (70.4%), and more than half attended private schools (54.4%). More than three-quarters (79.3%) of the students attended mixed-sex schools with the majority (37.3%) in the Senior Secondary (SS2) class. Most students were Christians (83.4%), and most of their parents were literate (69.9%), married (77.9%), and living in monogamous families (73.2%) (Table 1).

Lifetime smoking experimentation (ever tried) was more common among male students (16.0%) than female students (13.7%). More older students (26.1%) and those in SS2 class (17.0%) reported they have ever tried smoking than younger students e.g., 8.6% for those <16 years and those in lower classes (7.0% in students in JSS3), respectively. Furthermore, more students attending government-funded (17.8%), mixed-sex (17.7%), and non-residential schools (18.0%) have reportedly tried smoking than those in private (11.2%), single-sex (girls-only: 2.9%), and residential (7.3%) schools, respectively. Additionally, more Muslim students (17.6%) have ever tried smoking than Christian students (13.0%). Finally, more students from polygamous families (16.9%) have tried smoking than those from monogamous families (13.2%), and more students whose parents were unmarried (21.4%) have tried smoking than those whose parents were married (10.8%). These results were similar for tried smoking during the last 12 months and smoking within the last 30 days (Table 1).

Among participants, the reported exposure rates were 14.9% (either parent), 9.6% (both parents), 11.7% (sibling), 16.0% (teacher), and 13.2% (best friend). No sex differences (all  $p > 0.05$ ). Age differences were significant except best friend smoking. Students older than 18 years had highest exposure to smoking (either parent: 27.7%; teacher: 25.2%), 16–18 years lowest (both parents: 8.4%; sibling: 10.0%). Non-residential had higher exposure to smoking than residential students (either parent: 18.6% vs. 4.9%,  $p \leq 0.005$ ). Siblings smoking was reported to be higher in government compared to private schools (13.5% vs.

10.2%,  $p < 0.001$ ). Mixed-sex students had higher exposure than single-sex (all  $p < 0.001$ ); lowest in girls' only schools (best friend: 0.6% vs. 15.7%). JSS3 students had the highest exposure (teacher: 28.2%; best friend: 21.4%), SS3 lowest (both parents: 6.9%; best friend: 10.7%, all  $p \leq 0.019$ ). Non-Christians had higher exposure than Christians (sibling: 22.8% vs. 9.6%,  $p \leq 0.001$ ). Unmarried parents had higher than married ones (teacher: 25.7% vs. 13.2%; best friend: 19.6% vs. 11.3%, all  $p < 0.001$ ). Non-monogamous families had higher rate for parent and sibling smoking (either parent: 20.0% vs. 12.5%,  $p < 0.001$ ) but not teacher or best friend. Unspecified parental literacy was higher than for literate parents (teacher: 25.9% vs. 14.0%, all  $p < 0.001$ ) (Supplementary Table 1).

Figures 1–3 and Table 2 present adjusted odds ratios for trying to smoke ever, in the last 12 months, and in the last 30 days. Across all three, associations were consistently stronger among girls than boys. For trying smoking ever (Figure 1), either parent smoking: OR 6.33 (95% CI: 3.26–10.06) in boys vs. 22.51 (13.27–38.20) in girls; both parents: 5.24 (3.01–9.14) vs. 22.10 (12.27–39.81); any family member: 5.73 (3.68–8.96) vs. 27.41 (15.50–48.46); both parents and a sibling: 4.80 (2.53–9.11) vs. 31.44 (15.21–64.99).

For trying smoking in the last 12 months (Figure 2), similar patterns emerged: either parent: 6.33 (3.26–10.06) vs. 22.51 (13.27–38.20); both parents: 5.24 (3.01–9.14) vs. 22.10 (12.27–39.81); any family member: 5.73 (3.68–8.96) vs. 27.41 (15.50–48.46); both parents and a sibling: 4.80 (2.53–9.11) vs. 31.44 (15.21–64.99). Teacher smoking showed the weakest associations across all time frames (boys: OR 2.10–2.22; girls: OR 3.85–5.52).

For trying smoking in the last 30 days (Figure 3): either parent: 5.85 (4.10–10.81) vs. 21.70 (12.65–37.50); both parents: 4.90 (2.78–8.93) vs. 22.23 (12.18–40.57); any family member: 5.80 (3.50–9.96) vs. 28.61 (19.13–54.35); both parents and a sibling: 4.78 (2.45–9.33) vs. 34.98 (16.43–74.51). For combined exposures, using adolescents with no family, teacher, or friend smoking as the reference, those with at least one family member who smoked (but no teacher or friend smoking) had significantly higher odds across all outcomes, with overall ORs of 10.60 (95% CI: 6.61–16.99) for ever tried, 12.14 (95% CI: 7.47–19.72) for last 12 months, and 12.16 (95% CI: 7.36–20.08) for last 30 days. Again, associations were substantially stronger among girls than boys.

Finally, adolescents with at least one family member who smoked and with both a teacher and a friend who smoked also had significantly elevated odds, though the estimates were slightly lower but comparable with those for family-only exposure; the overall OR was 9.61 (95% CI: 6.34–14.57) for ever tried, 7.51 (95% CI: 4.80–11.72) for last 12 months, and 8.41 (95% CI: 5.30–13.35) for last 30 days. For the category “No family member smokes BUT teacher AND friend smoke” as indicated by “A” in the cells indicating the prevalence was insignificant to be estimated as per the sample size (Table 2). Across Figures

1–3, associations were consistently larger and more precise for girls, indicating that while exposure to smokers is common in both sexes (Table 2), the association with smoking initiation whether ever, in the last 12 months, or in the last 30 days is markedly stronger among girls.

Similarly, adolescents were more likely to have ever tried smoking if their best friend smoked (OR = 5.09, 95% CI: 3.85–7.10) or if their teacher smoked (OR = 3.52, 95% CI: 2.57–7.47) compared to those whose friends or teachers did not smoke. The influence of parental, friend, and teacher smoking was stronger among girls than boys, whereas sibling smoking had a greater influence on boys than on girls (Figure 1 and Table 2). Furthermore, the odds of ever trying smoking associated with concurrent smoking exposure from a family member (any parent or sibling), best friend, and teacher (OR = 9.61, 95% CI: 6.34–14.57) were comparable to those associated with smoking by a family member alone (OR = 10.60, 95% CI: 6.61–16.99; Figure 1 and Table 2). In the absence of smoking in the family, the influence of smoking among teachers and friends was insignificant such that study data could estimate it.

## DISCUSSION

In this cross-sectional study of the association between smoking by social networks and smoking habits of in-school adolescents from Nasarawa State, Nigeria, the study found that smoking by parents, siblings, teachers, and best friends were each associated with an increased likelihood of adolescent smoking. However, maternal smoking exerted the most influence than other social networks, with greater impact on the girls than on the boys. When smoking by a family member was considered in concomitance with smoking by friends and teachers, the risk estimates were similar to those observed when only a family member smoked. Conversely, when no family member smoked, the influence of smoking by friends or teachers was negligible. These findings were consistent across all smoking statuses examined, including ever tried smoking, smoking within the last 12 months, and smoking within past one month.

With adequate and representative sample, this study provides a comprehensive picture of the influence of the social networks on the smoking behaviors of in-school adolescents from diverse schools in Nasarawa State, encompassing different ages, religions, and ethnicities. Since the sample was large and representative, and the findings may be generalized to the source population (Leonardi-Bee et al., 2011) particularly in the family, is a strong determinant of risk of smoking uptake. A systematic review and meta-analysis of the magnitude of these effects is reported. Methods: Studies were identified by searching four databases to March 2009 and proceedings from international conferences. Meta-analyses were performed using random effects, with results presented as pooled ORs with 95%

CIs. Results: 58 studies were included in the meta-analyses. The relative odds of uptake of smoking in children were increased significantly if at least one parent smoked (OR 1.72, 95% CI 1.59 to 1.86). We used a standard and validated instrument, globally recognized for measuring smoking habits and behaviors in adolescents (Hall & Valente, 2007).

The influence of family, friends, and teacher on adolescent smoking behavior has been widely studied (Cheng et al., 2022), yet the study findings revealed both similarities and differences with previous studies. The results showed that smoking by a family member, particularly by parents, was the strongest determinant of adolescent smoking compared to the smoking friends or teachers. This pattern was consistent across time. This aligns with the findings of Leonardi-Bee et al. (2011), which demonstrated that children exposed to at least one smoking parent had 1.72 times higher odds (95% CI 1.59–1.86) of starting smoking compared to those with non-smoking parents. In the review maternal smoking exerted a stronger influence (OR 2.19, 95% CI 1.73–2.79) than paternal smoking (OR 1.66, 95% CI 1.42–1.94). However, their analysis revealed greater odds, likely due to the Nigerian cultural and contextual factors, as most of the studies in the review were conducted in Western populations. This suggests that the impact of parental smoking may vary across different socio-cultural settings (Leonardi-Bee et al., 2011) particularly in the family, is a strong determinant of risk of smoking uptake. A systematic review and meta-analysis of the magnitude of these effects is reported. Methods: Studies were identified by searching four databases to March 2009 and proceedings from international conferences. Meta-analyses were performed using random effects, with results presented as pooled ORs with 95% CIs. Results: 58 studies were included in the meta-analyses. The relative odds of uptake of smoking in children were increased significantly if at least one parent smoked (OR 1.72, 95% CI 1.59 to 1.86). Similarly, Gilman and colleagues (Gilman et al., 2009) found that adolescents with at least one smoking parent faced a dose-dependent risk of starting to smoke with the intensity of parental smoking and duration of exposure increasing the likelihood—compared to their peers with non-smoking parents.

Notably, this study found maternal smoking (OR 36.37, 95%CI 8.08 - 163.63) had a more pronounced impact on both boys and girls than paternal smoking (OR 6.26, 95%CI 3.71 - 10.58), especially among girls (OR 39.86, 95%CI 4.75 - 334.53) if mother smoked. This finding is consistent with findings by Kandel et al. (1994) and Mayeux et al. (2008) who attributed such effect to prenatal exposure and gender-specific modelling, respectively. However, this contrasts with Gilman and colleagues' (Gilman et al., 2009) who found that the influence of paternal smoking on male adolescent smoking was stronger than that of maternal smoking.

Beyond parents, the results showed that adolescents of either sex with smoking siblings were five times more likely to have tried smoking (OR 5.56, 95%CI 3.88 - 7.96) than those without

a smoking sibling, aligning with longitudinal sibling comparison study by Slomkowski et al. (, 2005) focusing on sibling relationship processes (social connectedness who attributed this to sibling effect. Students of either sex whose best friends smoked exhibited significantly higher odds of trying smoking themselves (OR 4.29, 95%CI 3.03 - 4.06). This finding was consistent across all time frames studied. This finding is consistent with prior research demonstrating bidirectional mechanisms. First, social selection, whereby smoking adolescents preferentially befriended peers who already smoke. Second, peer influence, whereby exposure to friends' smoking behavior increases adoption of smoking habit. This finding aligns with Hall and Valente (2007) who used network selection methodology (N = 880) to identify friends' selection and influence as drivers of smoking among pupils in 6<sup>th</sup> and 7<sup>th</sup> grades. However, current study findings contradicts a 5-year longitudinal study of California schools with strict tobacco policies that found no significant peer influence on smoking initiation, suggesting that environmental restrictions may decouple the peer-adolescent smoking link (MISTRY, 2020) measured as community compliance with tobacco control policies and community density of tobacco vendors and advertisement, are associated with adolescent tobacco use initiation in urban India. The project will also assess how family level factors moderate and individual level factors mediate the associations between CTE factors and adolescent tobacco use. Annually, an estimated 1million deaths in India are attributable to tobacco use making it a leading cause of premature mortality. India became an early adopter of the WHO Framework Convention for Tobacco Control. A key set of India's tobacco control policies pertain to Articles 8, 13 and 16 of the FCTC regarding second hand smoke exposure, access totobacco products and tobacco promotion. India's policies include smoke-free laws; restrictions on tobacco advertisements; bans on the sale of tobacco products to minors and within 100 yards of educational institutions, recent bans on the sale of gutkha (a particularly dangerous smokeless tobacco product. Furthermore, a genetic study among students of European ancestry found that smokers naturally cluster due to shared inherited traits like risk-taking propensity rather than social causation (Zheng et al., 2022).

Similarly, smoking by teachers doubled the likelihood of smoking among the students (OR 2.87, 95%CI 2.03 -4.06), particularly among girls (OR 5.52, 95%CI 2.74 - 7.42) compared to boys (OR 2.10, 95%CI 1.23 -3.57)—a result consistent with Alexander et al. (2001) and Roohafza et al. (2014) but at odds with studies emphasizing peers' influence in a Finnish population-based cross-sectional study (Saari et al., 2014) or a systematic review of similar studies reporting no sex differences on the smoking behaviors of adolescents (Aveyard et al., 2004).

Concomitant exposure to smoking from family, friends, and teachers is associated with approximately a nine-fold increase in the likelihood of the students ever tried smoking

regardless of the sex. This finding supports Simons-Morton and Farhat's (2010) systematic review of similar studies which concluded that multiple exposures to smoking within the social network increased the risk of adolescent smoking. The finding of negligible (not possible to estimate in this study) impact of smoking by a best friend or teacher, is similar to findings by Liao et al. (2013)(Liao et al., 2013). However, this contrasts the findings by Avenevoli et al. (2003) ), who found that the influence of smoking by peers remained even after controlling for smoking within the family. Also contrasting with the study findings, Alexander et al. (2001) demonstrated through analysis of National Longitudinal Study of Adolescent Health (United States of America) data that the smoking by a teacher exerted an independent influence on adolescent smoking outcomes, even when controlling for parental smoking status.

The association between parental smoking and adolescent smoking matches the established theoretical frameworks of intergenerational behavioral transmission (Leonardi-Bee et al., 2011; Gilman et al., 2009). Also, the primacy of maternal smoking supports social learning mechanisms (Bandura, 1977) (Bandura, 1977), where gender-matched modelling may be particularly salient for daughters observing maternal behavior. The finding that maternal smoking exerted a stronger on both boys and girls- and particularly on girls (OR 39.86, 95%CI 4.75 - 334.53)- extends previous works by Kandel et al. (1994) (Kandel et al., 1994) on prenatal nicotine exposure and Mayeux et al.'s (2008) (Mayeux et al., 2008) gender socialization theories. However, the finding contrasts with the study by Gilman and colleagues (2009) (Gilman et al., 2009), who emphasized greater paternal influence for boys. Our analysis demonstrated that smoking within the family circle, rather than smoking by peers or teachers, was the primary risk factor of smoking by in-school adolescents in Nasarawa State. This suggests that in collectivist cultural contexts like Nigeria, the family may serve as the primary socialization agent that moderates external influences. The attenuation of peer and teachers' effects when considered together with smoking by a family member contrasts the study by Avenevoli et al.'s (2001), possibly indicating that peer selection processes in our setting are more constrained by familial oversight and contextual differences (Avenevoli & Merikangas, 2003). Moreover, the temporal consistency of effects across lifetime, past 12 months, and previous 30 days smoking reinforces the enduring nature of familial influences, supporting a developmental pathway model (Mayhew et al., 2000), which proposes that youth progress through sequential stages of smoking behavior, influenced by dynamic interactions between individual, society, and environment. Public health initiatives should prioritize family-based cessation programs. These programs should be integrated with school health services through partnerships offering parental smoking intervention. Gender-sensitive approaches are crucial as maternal smoking disproportionately affects girls than girls. Teacher smoking bans within the school surrounding and peer education programs should complement family-focused efforts, especially in government-funded and mixed-

sex schools. Routine screening for parental smoking during pediatric visits can identify high-risk households, enabling timely referrals to cessation programs, with particular focus on maternal smoking due to its outsized impact. Therefore, the study contributes by [1] providing the evidence of this influence hierarchy in Nigeria, [2] introducing the “family as gatekeeper” concept for this context, and [3] highlighting a key gender dynamic. However, the reliance on self-reported data can introduce potential limitations, including biased recall and inaccuracies in reporting the smoking behaviors of the students and their social networks, due to social sensitivity or fear (Brenner & DeLamater, 2016; Latkin et al., 2017). Finally, the cross-sectional design limits the establishment of causal relationships (Van der Stede, 2014). The findings should be interpreted in light of these shortcomings.

## CONCLUSION

Based on the study findings, smoking within the social network of the adolescents increases their likelihood to smoke. However, smoking within the family circle is the primary determinant of students’ smoking behaviors in Nasarawa State. Though smoking among teachers and friends have collective and independent influence in adolescence smoking, familial influence eclipsed those influences when considered together. In the absence of familial smoking, the influence of external social networks is negligible. These findings suggest that adolescent smoking follows a distinctive intergenerational transmission pathway in a culturally diverse Nasarawa State, Nigeria. The maternal smoking emerged as the predominant influence. Given that adolescent smoking initiation is a socially learned behavior, primary prevention strategies must be family-centered, which should be integrated into the curriculum. This should be complemented by school smoke-free policies, teacher training, and adolescent counselling services. Future research should employ mixed method designs and biochemical validation to establish causality, explore cultural mechanisms underlying familial influence. Additionally, there is need to conduct comparative trials and intervention studies across Nigerian regions and cross-culturally to test the “family as gatekeeper” hypothesis.

### Declarations (if any)

- i. Conflict of Interest: The authors declare no conflict of interest related to this study.
- ii. Data Availability: The datasets generated and/or analyzed for this study are not publicly available due to confidentiality issues but are available from the corresponding author on reasonable request at [eggadennis@gmail.com](mailto:eggadennis@gmail.com).
- iii. Artificial Intelligent Declaration Statement: During the preparation of this work the author(s) used Deep Seek Chabot to ensure correct grammar and coherence. After using this tool/service, the authors reviewed and edited the content as needed and bear full responsibility for the content of the manuscript.

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## List of Tables

### Table 1. Background characteristics of the participants and prevalence of smoking

Background characteristic		N = 1518 n(%)	Ever tried smoking: n (%)	Tried smoking within last 12 months: n (%)	Tried smoking with- in last 30 days: n (%)
	All	1518 (100)	225 (14.8)	187 (12.3)	166 (10.9)
Sex	Girls	739 (48.7)	107 (13.7)	84 (10.8)	77 (9.9)
	Boys	779 (51.3)	118 (16.0)	103 (13.9)	89 (12.0)
	P-value		0.221	0.062	0.178
Age	<16 Years	559 (36.8)	76 (13.6)	56 (10.0)	48 (8.6)
	16 - 18 Years	840 (55.3)	118 (14.0)	102 (12.1)	92 (11.0)
	>18 Years	119 (7.8)	31 (26.10)	29 (24.4)	26 (21.8)
	P-value		0.002	<0.001	<0.001
School by resi- dence	Residential	451 (29.6)	33 (7.3)	33 (7.3)	27 (6.0)
	Non-residential	1067 (70.4)	192 (18.0)	154 (14.4)	139 (13.0)
			<0.001	<0.001	<0.001
School by funding	Government	830 (54.4)	148 (17.8)	125 (15.1)	111 (13.4)
	Private	688 (45.1)	77 (11.2)	62 (9.0)	55 (8.0)
	p-value		<0.001	<0.001	0.001
School by sex composition	Mixed-sex school	1210 (79.3)	214 (17.7)	176 (14.5)	158 (13.1)
	Boys' only school	166 (10.9)	7 (4.2)	7 (4.2)	4 (2.4)
	Girls' only school	138 (9.0)	4 (2.9)	4 (2.9)	4 (2.9)
	P-value		<0.001	<0.001	<0.001
Class of the student	JSS3	131 (8.6)	26 (9.8)	13 (7.0)	10 (7.0)
	SS1	454 (29.8)	71 (15.6)	63 (13.9)	59 (13.0)
	SS2	569 (37.3)	97 (17.0)	83 (13.9)	70 (12.3)
	SS3	364 (23.9)	31 (8.5)	28 (7.7)	27 (7.4)
	P-value		0.001	0.009	0.027

Religion of the student	Christianity	1272 (83.4)	177 (14.8)	145 (11.4)	128 (8.4)
	Islam	233 (15.3)	41 (17.6)	35 (15.0)	38 (2.5)
	Others	20 (1.3)	7 (1.9)	7 (1.6)	9 (0.0)
	P-value		<0.001	<0.001	<0.001
Marital status of parents	Married	1181 (77.9)	153 (13.0)	128 (10.8)	122 10.3
	Divorced/Separated/ Father died/Mother died/Never married	335 (22.1)	72 (21.4)	59 (17.6)	43 (12.8)
	P-value		<0.001	0.001	0.200
Family type	Monogamy	1117 (73.2)	145 (13.0)	117 (10.5)	100 (9.0)
	Polygamy	338 (22.2)	57 (16.9)	49 (14.5)	45 (13.3)
	Unspecified	70 (4.6)	23 (10.2)	21 (11.2)	21 (12.7)
	P-value		<0.001	<0.001	<0.001

**Supplementary Table 1: Background characteristics of students by smoking by parents, a sibling, teacher, and best friend smoking**

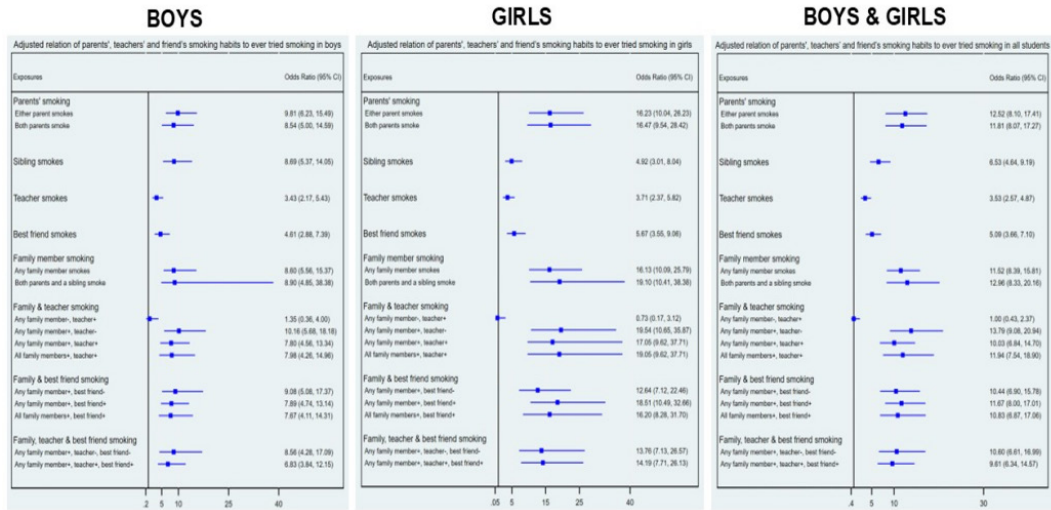
Characteristic	Category	n (%)	Either parent smokes n (%)	P-value	Both parents smoke n (%)	P-value	A sibling smokes n (%)	P-value	Teacher smokes n (%)	P-value	Best friend smokes n (%)	P-value
Sex	All	1518 (100)	220 (14.9)		145 (9.6)		178 (11.7)		243 (16.0)		200 (13.2)	
	Girls	739 (48.7)	109 (14.0)		74 (9.9)		84 (11.4)		110 (14.9)		96 (13.0)	
	Boys	779 (51.3)	111 (15.0)	0.570	71 (10.2)	0.894	94 (12.1)	0.672	133 (17.1)	0.245	104 (13.4)	0.836
Age	<16 Years	559 (36.8)	71 (12.7)		62 (11.3)		71 (12.7)		91 (16.3)		63 (11.3)	
	16 - 18 Years	840 (55.3)	116 (13.8)		66 (8.4)		84 (10.0)		122 (14.5)		116 (13.8)	
	>18 Years	119 (7.8)	33 (27.7)	<0.001	17 (16.5)	0.017	23 (19.3)	0.008	30 (25.2)	0.012	21 (17.6)	0.126
School by residence	Residential	451 (29.6)	22 (4.9)		15 (3.4)		20 (4.4)		54 (12.0)		286 (6.2)	
	Non-residential	1067 (70.0)	198 (18.6)	<0.001	130 (13.0)	<0.001	158 (14.8)	<0.001	189 (17.7)	0.005	172 (16.1)	<0.001
School by funding	Private	830 (54.4)	123 (14.8)		72 (9.2)		85 (10.2)		145 (17.5)		100 (12.0)	
	Government	688 (45.1)	97 (14.1)	0.691	73 (11.0)	0.27	93 (13.5)	<0.001	226 (18.7)	0.088	100 (14.5)	0.154
School by gender composition	Mixed-sex school	1210 (79.3)	207 (17.3)		137 (12.0)		167 (13.8)		198 (18.7)		190 (15.7)	
	Girls' only school	166 (10.9)	3 (1.8)		2 (1.2)		4 (2.4)		7 (4.2)		1 (0.6)	
	Boys' only school	138 (9.0)	8 (3.8)	<0.001	6 (4.4)	<0.001	6 (4.3)	<0.001	8 (5.8)	<0.001	9 (6.5)	<0.001
Class of the student	JSS3	131 (8.6)	26 (19.8)		22 (17.5)		22 (16.8)		37 (28.2)		28 (21.4)	
	SS1	454 (29.8)	61 (13.4)		41 (9.4)		46 (10.1)		53 (11.7)		56 (12.3)	
	SS2	569 (37.3)	91 (16.0)		52 (10.8)		80 (14.1)		97 (17.0)		77 (18.5)	
	SS3	364 (23.9)	42 (11.5)	0.071	24 (6.9)	0.009	30 (8.2)	0.009	56 (15.4)	<0.001	39 (10.7)	0.019
Religion of the student	Christianity	1272 (83.4)	168 (13.2)		98 (8.2)		122 (9.6)		181 (14.2)		140 (11.0)	
	Others	253 (16.6)	52 (21.1)	0.001	47 (19.5)	<0.001	56 (22.8)	<0.001	62 (25.2)	<0.001	60 (24.4)	<0.001
Marital status of parents	Married	1181 (77.9)	148 (12.5)		95 (8.4)		115 (9.7)		156 (13.2)		134 (11.3)	
	Others	335 (22.1)	72 (21.4)	<0.001	50 (15.9)	<0.001	63 (18.8)	<0.001	87 (25.7)	<0.001	66 (19.6)	<0.001
Family type	Monogamy	1117 (73.2)	140 (12.5)		89 (8.3)		113 (10.1)		170 (15.2)		141 (12.6)	
	Others	408 (26.8)	80 (20.0)	<0.001	56 (14.9)	<0.001	65 (16.2)	0.001	73 (18.2)	0.162	59 (14.7)	0.288

Literacy of the parents	Both of my parents can read and write	1066 (69.9)	128 (12.0)	80 (7.9)	99 (9.3)	156 (14.0)	107 (10.0)				
	Not specified	459 (30.1)	92 (20.4)	<0.001	65 (15.3)	<0.001	79 (17.5)	<0.001	87 (25.9)	<0.001	93 (20.6)

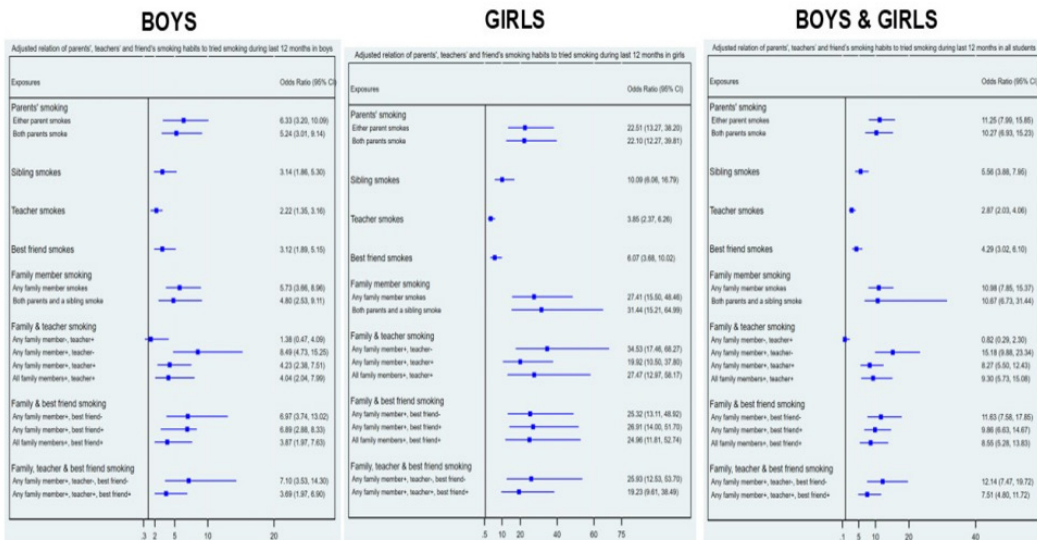
**Table 2: Adjusted relation of parental smoking habits to students' smoking by sex**

Parents' smoking	Ever tried smoking OR (95% CI)			Tried smoking last 12 months OR (95% CI)			Tried smoking last 30 days OR (95% CI)		
	All	Girls	Boys	All	Girls	Boys	All	Girls	Boys
No parent smokes	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Either parent smokes	12.52 (8.10 - 17.41)	16.23 (10.04 - 26.23)	9.81 (6.23 - 15.49)	11.25 (7.99 - 15.85)	22.51 (13.27 - 38.20)	6.33 (3.20 - 10.09)	11.50 (8.06 - 16.41)	21.78 (12.65 - 37.50)	6.66 (4.10 - 10.81)
Both parents smoke	11.81 (8.07 - 17.27)	16.47 (9.54 - 28.42)	8.54 (5.00 - 14.59)	10.27 96.93 - 15.23)	22.10 (12.27 - 39.81)	5.24 (3.01 - 9.14)	10.26 (6.83 - 15.42)	22.23 (12.18 - 40.57)	4.96 (2.76 - 8.93)
Only mother smokes	36.37 (8.08 - 163.63)	39.86 (4.75 - 334.53)	33.21 (3.96 - 278.53)	27.67 (7.64 - 100.13)	53.39 (6.35 - 449.18)	16.17 (3.10 - 84.520)	15.44 (5.11 - 46.66)	19.29 (3.68 - 100.97)	12.77 (2.80 - 58.16)
Only father smokes	6.26 (3.71 - 10.58)	6.06 (2.80 - 13.13)	6.36 (3.12 - 13.00)	5.98 (3.51 - 10.19)	7.07 (3.22 - 15.54)	5.11 (2.47 - 10.55)	6.10 (4.09 - 11.95)	7.92 (3.59 - 17.16)	6.20 (2.99 - 12.87)
Combined family, teacher's, and friends' smoking habits									
Neither family member NOR teacher NOR friends smokes	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
At least one family member smokes BUT NOT teacher OR friends	10.60 (6.61 - 16.99)	13.76 (7.13 - 26.57)	8.56 (4.28 - 17.09)	12.14 (7.47 - 19.72)	25.93 (12.53 - 53.70)	7.10 (3.53 - 14.30)	12.16 (7.36 - 20.08)	26.60 (12.43 - 56.91)	6.91 (3.34 - 14.27)
No family member smokes BUT teacher AND friend smoke	A	A	A	A	A	A	A	A	A
At least one family member smokes AND teacher AND friends smoke	9.61 (6.34 - 14.57)	14.19 (7.71 - 26.13)	6.83 (3.84 - 12.15)	7.51 (4.80 - 11.72)	19.23 (9.61 - 38.49)	3.69 (1.97 - 6.90)	8.41 (5.30 - 13.35)	23.20 (11.25 - 47.86)	3.78 (1.96 - 7.29)

**Figure 1. Adjusted association of family, teachers', and friends' smoking with students ever tried smoking, stratified by sex**



**Figure 2. Adjusted association of family, teachers', and friends' smoking with students smoking in the last 12 months, stratified by sex**



**Figure 3. Adjusted associated of family, teachers', and friends' smoking with students smoking behaviour in the last 30 days, stratified by sex**

