



CORRELATION BETWEEN SMOKING BEHAVIOR AND NICOTINE DEPENDENCE AMONG COLLEGE STUDENTS

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Received: 02 July 2026

Revised: 11 August 2026

Accepted: 13 September 2026

Published: 29 September 2026

DOI: <https://doi.org/10.5281/zenodo.23294763>

Abstract:

Smoking among college students is a significant public-health concern involving both behavioral and physical aspects of nicotine dependence. This cross-sectional study aimed to assess smoking behavior and nicotine dependence among 253 college students using the Glover–Nilsson Smoking Behavioral Questionnaire (GN-SBQ) and the Fagerström Test for Nicotine Dependence (FTND). The mean GN-SBQ score was 15.25 ± 10.43 , while the mean FTND score was 3.94 ± 2.80 . A significant positive correlation was observed between GN-SBQ and FTND scores ($\rho = 0.507$, $p < 0.001$). Significant associations were also found between smoking frequency and GN-SBQ categories ($\chi^2 = 95.76$, $p < 0.001$) and between smoking frequency and FTND categories ($\chi^2 = 37.62$, $p < 0.001$). The findings indicate that higher smoking frequency and behavioral dependence were associated with greater nicotine dependence among the participants. Assessing both behavioral and nicotine dependence may provide a better understanding of smoking patterns among college students and support appropriate smoking-cessation interventions.

Keywords: Smoking Behaviour, Nicotine Dependence, College Students, Glover–Nilsson Smoking Behavioural Questionnaire (GN-SBQ), Fagerström Test For Nicotine Dependence (FTND), Tobacco Use, Smoking Frequency, Behavioural Dependence.

1. Introduction

Smoking is an important public-health concern, particularly among adolescents and young adults. College students represent an important population for studying tobacco use because this period may involve changes in social environment, lifestyle, peer relationships, academic pressures, and exposure to new behavioral influences. Studies conducted among college and university students have documented tobacco use and nicotine dependence across different populations and academic settings (1, 2). Research has also demonstrated variation in the use of cigarettes, waterpipe, and other tobacco products among university students, indicating that smoking behavior is not uniform within this population (3, 4).

Nicotine dependence is a multidimensional phenomenon involving both physiological and behavioral components. Repeated nicotine exposure may be accompanied by habitual patterns, psychological associations, and behavioral routines that contribute to continued tobacco use. The Glover–Nilsson Smoking Behavioral Questionnaire (GN-SBQ) was developed to assess behavioral aspects of smoking dependence and to provide information about smoking-related behaviors beyond simple measures of cigarette consumption (5). Subsequent research has evaluated the reliability and validity of the GN-SBQ in different populations, including studies conducted in clinical and adult-smoking populations (6, 7). More recent validation research has further examined the application of the GN-SBQ in clinical settings, supporting its potential usefulness for evaluating behavioral aspects of tobacco dependence (8).

The Fagerström Test for Nicotine Dependence (FTND) is a widely used instrument for assessing physical or nicotine-related dependence. It incorporates smoking characteristics that provide an indication of the degree of nicotine dependence among smokers (9). A systematic review of the psychometric properties of the FTND has examined its reliability and validity across different populations and highlighted the continued use of the instrument in tobacco-dependence research (10). Research comparing different dependence scales has also demonstrated that individual instruments may assess related but distinct dimensions of smoking dependence (11). Therefore, assessment using both GN-SBQ and FTND may provide a broader understanding of behavioral and nicotine-related aspects of smoking dependence.

Smoking behavior among college students may be associated with a variety of psychological, social, and environmental factors. Research among university students has examined nicotine dependence in relation to psychological characteristics, including anxiety, while other studies have investigated changes in smoking behavior during the COVID-19 pandemic (12, 13). Studies among health-science students and dental students have also documented tobacco use and nicotine dependence within university populations (14, 15). In addition, research among college students has investigated tobacco use together with cessation attempts and behavioral factors related to quitting (16). These findings suggest that student smoking should be considered in terms of both the frequency of tobacco use and the degree and nature of dependence.

The tobacco-use landscape among young adults has also become increasingly diverse. In addition to conventional cigarettes, university students may use waterpipe tobacco and other tobacco products. Studies among university students have investigated waterpipe use and associated risk factors, as well as the use of cigarettes, waterpipe, and other tobacco products (4, 17). More recent research has examined electronic-cigarette dependence and nicotine dependence among undergraduates using nicotine-salt-based electronic cigarettes (18, 19). Research examining psychological profiles and smoking-dependence motives among university students has further indicated that tobacco dependence may involve several behavioral and psychological dimensions (20, 21). These developments emphasize the importance of evaluating dependence using appropriate standardized measures rather than relying only on smoking frequency.

Although previous studies have examined tobacco use, nicotine dependence, behavioral dependence, and cessation-related factors among college and university students, there remains a need to examine the relationship between behavioral smoking dependence and nicotine dependence using complementary standardized instruments. Research in Indian college populations has documented tobacco use and dependence (1, 2), while studies in other populations have investigated different dimensions of dependence and smoking behavior (22,

23). In addition, smoking-cessation research has demonstrated the relevance of addressing tobacco dependence through behavioral and therapeutic approaches (24). Therefore, the present study aimed to assess smoking behavior and nicotine dependence among college students using the GN-SBQ and FTND. The study further examined the relationship between GN-SBQ and FTND scores and evaluated the associations of smoking frequency with behavioral and nicotine-dependence categories.

2. Materials and methods

2.1 Study design and study period

A cross-sectional study was conducted to assess the relationship between smoking behavior and nicotine dependence among college students. The study was carried out over a period of approximately two months, from 22 July 2026 to 22 September 2026. Data were collected through an online questionnaire distributed among college students.

2.2 Study population and sample size

The study population consisted of college students who reported smoking. A total of 253 completed responses were included in the analysis. Participation was voluntary, and respondents were informed about the purpose of the study before completing the questionnaire.

2.3 Data collection and recruitment procedure

Data were collected using an online questionnaire. Participants were recruited through WhatsApp, and the questionnaire link was circulated among college students through WhatsApp. Participants voluntarily completed the questionnaire after being provided with information regarding the purpose of the study. Only completed responses were included in the final dataset.

The questionnaire collected information regarding demographic characteristics and smoking-related behavior, including age at initiation of smoking, duration of smoking, smoking frequency, and previous attempts to quit smoking. The questionnaire also included standardized measures to assess smoking behavior and nicotine dependence.

2.4 Assessment of smoking behaviour

Smoking-related characteristics were assessed using questions regarding the participants' smoking history and behavior. Variables included age at first smoking, duration of smoking, frequency of smoking, and attempts to quit smoking. Smoking frequency was categorized as occasionally, weekly, or daily.

2.5 Assessment of behavioural smoking dependence

Behavioral aspects of smoking dependence were assessed using the Glover–Nilsson Smoking Behavioral Questionnaire (GN-SBQ). The questionnaire consists of 11 items, with the total score obtained by summing the individual item scores. Based on the total score, behavioral smoking dependence was categorized as:

- Mild: <12
- Moderate: 12–22
- Strong: 23–33
- Very strong: >33

The GN-SBQ total score was used for descriptive analysis and for assessing its relationship with nicotine dependence.

2.6 Assessment of nicotine dependence

Nicotine dependence was assessed using the Fagerström Test for Nicotine Dependence (FTND). The FTND consists of 6 items, with a total score ranging from 0 to 10. Nicotine dependence was classified according to the total score as follows:

- Very low: 0–2
- Low: 3–4
- Moderate: 5
- High: 6–7
- Very high: 8–10

The FTND total score was used for descriptive analysis and for examining its association with smoking behavior.

2.7 Statistical analysis

The collected data were analyzed using descriptive and inferential statistical methods. Frequencies and percentages were calculated for categorical variables, while means and standard deviations were calculated for GN-SBQ and FTND total scores. The relationship between GN-SBQ and FTND total scores was assessed using Spearman's rank correlation coefficient (ρ).

Pearson's chi-square test of independence was used to examine associations between GN-SBQ behavioral-dependence categories and FTND nicotine-dependence categories, between smoking frequency and FTND categories, and between smoking frequency and GN-SBQ categories. A p -value < 0.05 was considered statistically significant. Where expected cell frequencies were low, the corresponding Pearson chi-square results were interpreted with caution.

2.8 Ethical considerations

The study was conducted after obtaining approval from the Department Coordinator. Participation was voluntary, and participants were informed about the purpose of the study before completing the questionnaire. Responses were collected for research purposes and were included in the analysis only after completion of the questionnaire.

3. Results

A total of 253 college students participated in the online cross-sectional survey. The collected data were analyzed to assess the participants' smoking patterns, behavioral smoking dependence, and nicotine dependence. The Glover–Nilsson Smoking Behavioral Questionnaire (GN-SBQ) and the Fagerström Test for Nicotine Dependence (FTND) were used to obtain standardized scores for behavioral and nicotine dependence, respectively. Descriptive analysis was performed using frequencies, percentages, mean, and standard deviation.

The results were further analyzed to determine the relationship between smoking behavior and nicotine dependence. GN-SBQ and FTND scores were compared across smoking-frequency groups, and statistical tests were used to assess associations and correlations between the variables. The findings showed significant relationships between smoking frequency, behavioral smoking dependence, and nicotine dependence, indicating that these measures were related within the surveyed population.

The demographic and smoking-related characteristics of the participants were also examined. The study included both male and female college students, with a slightly higher proportion of male participants. Most participants reported occasional smoking, while smaller proportions reported weekly or daily smoking. The majority had been smoking for less than six months, and a substantial proportion reported having made at least one attempt to quit

smoking. These characteristics provided an overall profile of the participants and their smoking patterns before further analysis of dependence scores.

Table 1: Demographic and smoking characteristics (N = 253)

Characteristic	Category	n (%)
Gender	Male	139 (54.9)
	Female	108 (42.7)
	Prefer not to say	6 (2.4)
First smoking age	<15 years	46 (18.2)
	15–17 years	45 (17.8)
	18–20 years	77 (30.4)
	>20 years	85 (33.6)
Smoking duration	<6 months	112 (44.3)
	6–12 months	38 (15.0)
	1–3 years	49 (19.4)
	>3 years	54 (21.3)
Frequency	Occasionally	137 (54.2)
	Weekly	62 (24.5)
	Daily	54 (21.3)
Quit attempt	Yes	182 (71.9)
	No	71 (28.1)

3.1 Overall GN-SBQ and FTND scores

The mean GN-SBQ score was 15.25 ± 10.43 , with scores ranging from 0 to 44. The mean FTND score was 3.94 ± 2.80 , with scores ranging from 0 to 10.

Table 2: Mean and standard deviation of GN-SBQ and FTND scores

Measure	N	Mean $\pm$ SD	Minimum	Maximum
GN-SBQ score	253	15.25 ± 10.43	0	44
FTND score	253	3.94 ± 2.80	0	10

Table 3: GN-SBQ and FTND scores according to smoking frequency

Smoking frequency	n	GN-SBQ score, mean $\pm$ SD	FTND score, mean $\pm$ SD
Occasionally	137	10.61 ± 9.68	3.01 ± 2.72
Weekly	62	18.42 ± 6.11	4.65 ± 2.40
Daily	54	23.39 ± 9.91	5.50 ± 2.54
Total	253	15.25 ± 10.43	3.94 ± 2.80

3.2 GN-SBQ dependence categories

According to GN-SBQ scores, moderate behavioral dependence was the most common category (42.3%), followed by mild dependence (33.6%), strong dependence (19.4%), and very strong dependence (4.7%).

Table 4: Distribution of behavioural smoking dependence according to GN-SBQ scores

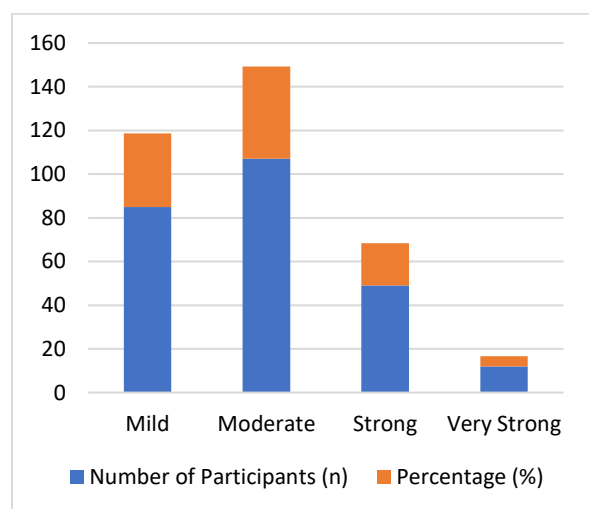
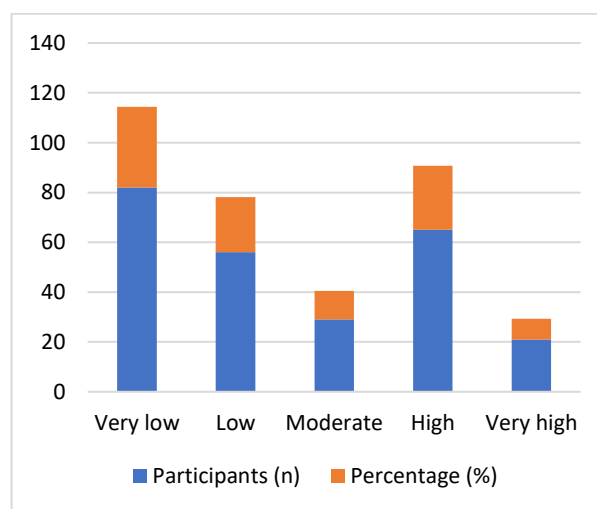
GN-SBQ category	Score	Frequency	Percentage
Mild	<12	85	33.6%
Moderate	12–22	107	42.3%
Strong	23–33	49	19.4%
Very strong	>33	12	4.7%
Total		253	100%

3.3 FTND dependence categories

The FTND results showed that 32.4% of participants had very low nicotine dependence, while 22.1% had low, 11.5% moderate, 25.7% high, and 8.3% very high dependence.

Table 5: Distribution of nicotine dependence according to FTND scores

FTND category	Score	<i>n</i>	%
Very low	0–2	82	32.4
Low	3–4	56	22.1
Moderate	5	29	11.5
High	6–7	65	25.7
Very high	8–10	21	8.3
Total		253	100

**Figure 1: GN-SBQ dependence categories****Figure 2: FTND nicotine dependence categories**

3.4 Correlation between GN-SBQ and FTND scores

The scatter plot demonstrates a positive relationship between GN-SBQ and FTND scores among the 253 college students. As the GN-SBQ score increases, the FTND score generally tends to increase, indicating that participants with higher behavioral smoking dependence also tended to have higher nicotine dependence. The Spearman correlation coefficient was $\rho = 0.507$, with $p < 0.001$, showing that the correlation was statistically significant. Overall, the findings suggest a moderate positive association between behavioral smoking dependence and nicotine dependence in the study population.

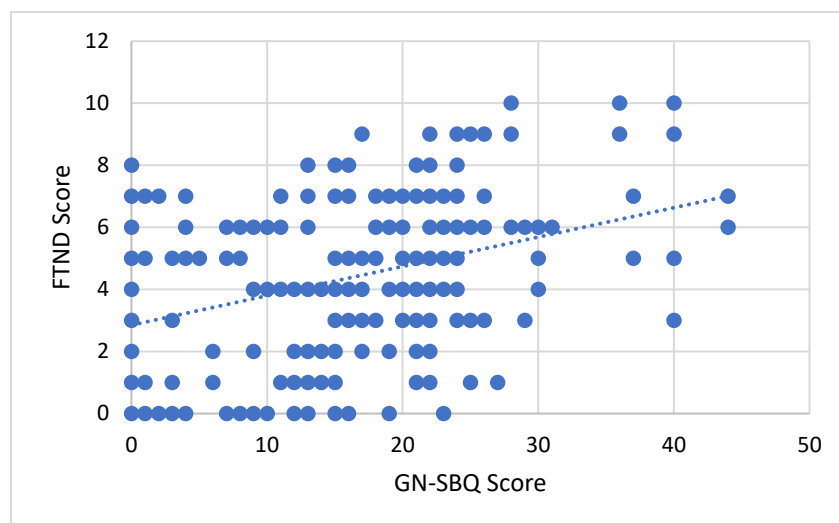


Figure 3: Correlation between GN-SBQ and FTND scores

3.5 Association analysis using chi-square tests

To examine the association between behavioral smoking dependence and nicotine dependence, a cross-tabulation was performed between GN-SBQ behavioral-dependence categories and FTND nicotine-dependence categories. Pearson's chi-square test indicated a statistically significant association between GN-SBQ and FTND categories ($\chi^2 = 70.95$, $df = 12$, $p < 0.001$). However, several expected cell frequencies were below 5; therefore, the Pearson chi-square result should be interpreted with caution.

Table 6: Association between GN-SBQ behavioural dependence and FTND nicotine dependence

GN-SBQ category	Very low	Low	Moderate	High	Very high	Total
Mild	50	13	7	14	1	85
Moderate	29	30	15	24	9	107
Strong	3	11	4	24	7	49
Very strong	0	2	3	3	4	12
Total	82	56	29	65	21	253

Note: Pearson's chi-square test was used. Several expected cell frequencies were below 5; therefore, the chi-square result should be interpreted with caution.

A statistically significant association was also observed between smoking frequency and FTND nicotine-dependence category ($\chi^2 = 37.62$, $df = 8$, $p < 0.001$). This indicates that the distribution of nicotine-dependence categories differed according to smoking frequency among the participants.

Similarly, smoking frequency was significantly associated with GN-SBQ behavioral-dependence category ($\chi^2 = 95.76$, $df = 6$, $p < 0.001$). This indicates that the distribution of behavioral smoking-dependence categories varied according to smoking frequency.

3.6 Association between smoking frequency and nicotine dependence

Smoking frequency was compared with nicotine dependence to determine whether the level of cigarette use was associated with FTND scores among the study participants. The participants were classified into three smoking-frequency groups: occasional, weekly, and daily smokers. Nicotine dependence was assessed using the Fagerström Test for Nicotine Dependence (FTND) and classified as very low, low, moderate, high, and very high dependence.

Among the 253 participants, 137 (54.2%) were occasional smokers, 62 (24.5%) were weekly smokers, and 54 (21.3%) were daily smokers. Daily smokers showed a greater proportion of participants with higher nicotine-dependence levels compared with occasional and weekly smokers.

Pearson's chi-square test showed a statistically significant association between smoking frequency and FTND nicotine-dependence category ($\chi^2 = 37.62$, $df = 8$, $p < 0.001$), indicating that the distribution of nicotine-dependence categories differed according to smoking frequency.

Table 7: Association between smoking frequency and FTND nicotine dependence

Smoking frequency	Very low	Low	Moderate	High	Very high	Total
Occasional	65	24	16	26	6	137
Weekly	11	19	7	19	6	62
Daily	6	13	6	20	9	54
Total	82	56	29	65	21	253

4. Discussion

The present study examined the relationship between behavioral smoking dependence and nicotine dependence among college students using the GN-SBQ and FTND. Rather than representing identical aspects of smoking, these instruments address complementary dimensions of dependence. The GN-SBQ focuses on behavioral characteristics associated with smoking, whereas the FTND evaluates indicators of nicotine dependence. The significant relationship observed between the two measures therefore suggests that behavioral patterns associated with smoking may occur alongside greater nicotine dependence in this population. This interpretation is consistent with the original development of the GN-SBQ and FTND as instruments addressing different aspects of tobacco dependence (5, 9). The positive association between the two dependence measures is also consistent with previous research examining relationships among different smoking-dependence scales. Studies evaluating the reliability and validity of the GN-SBQ have supported its use for assessing behavioral dependence, while research comparing dependence measures has shown that different instruments may be related without being interchangeable (6, 11). The findings therefore support the usefulness of examining behavioral and nicotine-related dependence together rather than assuming that cigarette consumption or a single dependence score fully represents the smoking experience.

One possible explanation for the observed relationship is the development of repetitive smoking routines. As smoking becomes repeated, nicotine exposure may become linked with particular situations, activities, social settings, or established habits. Behavioral cues may consequently become associated with smoking, while repeated nicotine exposure may simultaneously contribute to physical dependence. Research examining psychological factors among university students and studies investigating smoking-dependence motives provide support for considering both psychological and behavioral dimensions when understanding tobacco dependence (12, 20). However, because the present study was cross-sectional, the direction of the relationship between these dimensions cannot be established.

The association between smoking frequency and the two dependence measures provides additional context. More frequent smoking was accompanied by higher average GN-SBQ and FTND scores in the present sample. This pattern may be consistent with greater opportunities for nicotine exposure and reinforcement of smoking routines among more frequent smokers. Nevertheless, smoking frequency should not be treated as synonymous with dependence. An individual who smokes occasionally may still experience substantial behavioral or nicotine

dependence, while frequent smoking may also be influenced by social or situational circumstances. Previous research among college students has similarly documented variation in tobacco use and dependence, supporting the importance of examining smoking patterns rather than relying on frequency alone (1, 2).

The findings can also be considered in relation to the broader student smoking literature. Research among university students has reported tobacco use across different academic groups and geographical settings, while studies among dental and health-science students have specifically examined nicotine dependence in student populations (14, 15). Differences between populations may reflect variations in social environment, tobacco accessibility, academic background, cultural context, and types of tobacco products used. Consequently, dependence patterns identified in one student population should not automatically be assumed to apply to all college students. Psychological and contextual factors may also influence smoking behavior among students. Previous research has examined the relationship between anxiety and nicotine dependence among university students, while research conducted during the COVID-19 pandemic examined changes in smoking behavior among university populations (12, 13). Such factors may influence initiation, maintenance, or escalation of tobacco use, but they were not directly assessed in the present study. Therefore, they should be regarded as possible contextual factors rather than direct explanations for the associations observed in this dataset.

Another important issue is the diversity of tobacco and nicotine products used by young adults. Waterpipe tobacco use has been examined among university students, with research identifying associated behavioral and social risk factors (17). Studies have also examined cigarette, waterpipe, and other tobacco-product use among university students (4). More recently, electronic-cigarette dependence has become an additional area of investigation, with studies evaluating dependence measures and nicotine-salt-based electronic-cigarette use among young adults (18, 19). Although the present study focused on smoking behavior assessed through the questionnaire used, future research could incorporate different forms of nicotine exposure to provide a more comprehensive assessment of dependence. The findings also have relevance for understanding cessation among college students. A substantial proportion of participants reported previous attempts to quit smoking. Previous research among college students has examined tobacco use together with cessation attempts and behavioral characteristics associated with quitting (16). Research on university students has also examined nicotine dependence among students who were not interested in smoking cessation, suggesting that dependence and willingness to quit may not always correspond (22). These observations indicate that cessation interventions may need to consider both the degree of nicotine dependence and the behavioral patterns that maintain smoking.

The behavioral dimension is particularly relevant when considering cessation. If smoking is associated with established routines, social situations, or psychological cues, simply reducing nicotine exposure may not address all factors contributing to continued smoking. Research investigating smoking-dependence motives among university students has highlighted the importance of understanding why students smoke, while intervention research has explored approaches combining psychological support with pharmacological treatment (21, 24). The present findings therefore provide a rationale for considering multidimensional assessment when studying smoking cessation in student populations. The Indian context is also important when interpreting the findings. Previous research among college students in India has documented tobacco use and nicotine dependence, demonstrating the relevance of tobacco dependence within student populations (1, 2). Research among adults in urbanized settings has also examined tobacco use and dependence, providing additional evidence that tobacco dependence occurs across different populations (23). However, the present study involved a specific sample of

college students recruited through an online questionnaire, and its findings should therefore be interpreted as describing the surveyed population rather than representing all college students in India.

The significant association between smoking frequency and GN-SBQ categories suggests that behavioral dependence may become more prominent with increasing frequency of tobacco use. The corresponding association between smoking frequency and FTND categories similarly indicates that smoking frequency is related to nicotine-dependence classification. However, these findings should not be interpreted as evidence that frequency directly causes dependence. The cross-sectional nature of the study means that temporal relationships cannot be established, and other factors may contribute to both smoking frequency and dependence.

The association between GN-SBQ and FTND categories should also be interpreted cautiously because some expected frequencies in the contingency table were below 5. Although the Pearson chi-square test indicated a statistically significant association, low expected counts can affect the reliability of the conventional chi-square approximation. The Spearman correlation between the continuous GN-SBQ and FTND scores provides a complementary analysis because it evaluates the relationship between the underlying scores rather than depending entirely on categorized data.

5. Limitations

This study was limited by its cross-sectional design, online self-reported data, and WhatsApp-based recruitment, which may introduce selection and reporting bias. The sample of 253 college students may not represent all college students. Other factors such as psychological, social, and socioeconomic influences were not comprehensively assessed. Additionally, some chi-square analyses had low expected cell frequencies and should therefore be interpreted cautiously.

6. Conclusion

The present study demonstrates a significant relationship between smoking behavior and nicotine dependence among college students. The mean GN-SBQ score was 15.25 ± 10.43 , while the mean FTND score was 3.94 ± 2.80 , indicating varying levels of behavioral and nicotine dependence among the participants. A significant positive correlation was observed between GN-SBQ and FTND scores ($\rho = 0.507$, $p < 0.001$), and significant associations were found between smoking frequency and both GN-SBQ and FTND categories. Daily smokers generally showed higher dependence scores than occasional and weekly smokers. These findings highlight the importance of assessing both behavioral and nicotine dependence when evaluating smoking among college students. Early identification of dependence and appropriate smoking-cessation education and support may help reduce continued tobacco use in this population.

Acknowledgements

The authors would like to express their sincere gratitude to Ms. Suparna Deepak, Coordinator, Department of Biotechnology, for her valuable guidance, continuous support, and encouragement throughout the course of this research work. Her constructive suggestions and academic assistance were instrumental in the successful completion of this study. The authors also extend their heartfelt thanks to all the participants who voluntarily contributed their responses to the study and made this research possible.

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