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Relationship between Behavioral-Related Variables and Dental Caries Prevalence Among University Students: A Cross-Sectional Study

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ABSTRACT

Background: Dental caries is a highly prevalent oral health problem among young adults. University students are particularly at risk due to lifestyle changes, irregular dietary patterns, and inadequate oral hygiene practices. This study assessed the association between behavioral factors and dental caries among university students.

Study Design: A Cross-sectional study.

Place and Duration of the Study: The study was conducted at University of Peshawar, over a period of six months from January 2024 to June 2024.

Materials and Methods: A total of 300 university students were selected through stratified random sampling. Data were collected using a structured self-administered questionnaire covering socio-demographic characteristics and oral health behaviors, including tooth brushing frequency, sugary snack intake, flossing, smoking/vaping, and dental visits. Clinical examinations were conducted to determine the presence of dental caries. Data were analyzed using descriptive statistics, Chi-square tests, and multivariable logistic regression. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs)were calculated, and $p < 0.05$ was considered statistically significant.

Results: The prevalence of dental caries was 62.0%. Brushing less than once daily significantly increased caries risk (AOR = 4.85; 95% CI: 1.90–12.40). High sugary snack consumption (≥4 times/day) was strongly associated with caries (AOR = 3.60; 95% CI: 1.75–7.42). Lack of dental visits within the past year (AOR = 2.75; 95% CI: 1.60–4.73), smoking/vaping (AOR = 2.05), and never flossing (AOR = 2.30) were also significant predictors.

Conclusion: Unhealthy oral behaviors were significantly associated with dental caries. Targeted preventive and behavioral interventions are recommended

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Key Words
Dental Caries, Oral Health Behavior, University Students, Oral Hygiene, Sugar Consumption, Cross-Sectional Studies

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INTRODUCTION

Dental caries remains one of the most common chronic non-communicable diseases worldwide and continues to pose a major public health challenge despite advances in preventive and restorative dentistry [1]. It affects individuals of all ages and has significant consequences for pain, infection, tooth loss, impaired function, and reduced quality of life [2]. The Global Burden of Disease Study consistently ranks untreated dental caries in permanent teeth among the most prevalent health conditions globally [3]. Although dental caries is largely preventable, its persistence highlights the importance of understanding modifiable risk factors, particularly behavioral determinants.

Dental caries is a multifactorial disease resulting from complex interactions between cariogenic bacteria in dental plaque, dietary fermentable carbohydrates, host factors such as saliva and enamel integrity, and time [4]. Frequent exposure to sugars leads to acid production by oral bacteria, resulting in demineralization of tooth enamel and subsequent cavity formation if preventive measures are inadequate [5]. Therefore, individual behaviors—especially oral hygiene practices and dietary habits—play a central role in either preventing or accelerating the caries process.Oral hygiene behaviors such as regular tooth brushing with fluoridated toothpaste are widely

recognized as effective preventive measures against dental caries. Brushing at least twice daily helps remove dental plaque and provides topical fluoride exposure, which enhances remineralization and inhibits bacterial activity [6]. However, studies conducted among young adults have reported inconsistent oral hygiene practices, with a significant proportion brushing less than the recommended frequency or failing to use dental floss regularly [7]. Inadequate plaque control can lead to prolonged bacterial activity and increased risk of enamel breakdown.

Dietary behavior is another critical factor associated with dental caries development. High consumption of sugar-rich foods and beverages, including soft drinks, confectioneries, and processed snacks, has been strongly linked to increased caries risk [8]. The frequency of sugar intake is particularly important, as repeated exposure throughout the day maintains an acidic oral environment conducive to tooth demineralization. University students are often exposed to irregular meal patterns, frequent snacking, and high intake of convenience foods due to academic demands and lifestyle changes. These patterns may significantly elevate their vulnerability to dental caries.In addition to oral hygiene and dietary practices, other lifestyle behaviors such as smoking and vaping have been implicated in poor oral health outcomes. Tobacco use may reduce salivary flow, impair immune responses, and alter the oral microbiome, thereby increasing susceptibility to dental diseases [9]. Although smoking has traditionally been associated with periodontal disease, emerging evidence suggests it may also contribute to increased caries risk through indirect mechanisms such as xerostomia and behavioral clustering of unhealthy habits.

Dental service utilization is another important determinant of oral health status. Regular dental check-ups facilitate early detection and management of carious lesions, application of preventive measures such as fluoride varnish and sealants, and reinforcement of oral health education [10]. However, many young adults seek dental care only when symptomatic, which often results in delayed treatment and progression of disease. Barriers such as cost, limited awareness, fear of dental procedures, and lack of perceived need may reduce preventive dental attendance among university students. University students represent a unique and transitional population group. The shift from adolescence to adulthood is often accompanied by increased independence, changes in dietary habits, exposure to stress, and reduced parental supervision of health behaviors. Living arrangements—such as residing in dormitories or shared housing—may further influence eating habits and oral hygiene routines. Moreover, socioeconomic background and parental education may shape students' health literacy and access to dental care services. These combined factors make university students a critical group for oral health research and intervention.

The objective of this study was to determine the prevalence of dental caries among university students of University of Peshawar and to assess the association between behavioral-related factorsincluding tooth brushing frequency, use of fluoridated toothpaste, flossing habits, sugary snack consumption, soft drink intake, smoking/vaping, and dental attendanceand dental caries using a cross-sectional study design.

MATERIALS AND METHODS

Study Design and Setting

This cross-sectional analytical study was conducted among undergraduate students at University of Peshawar. The university comprises multiple faculties, including Health Sciences, Engineering Business, Social Sciences, and Natural Sciences. Data were collected over a Six -month period from January to June 2024. This design enabled the assessment of the prevalence of dental caries and its association with behavioral-related variables among university students.

Sample Size and Sampling Technique

The required sample size was calculated using the single population proportion formula assuming an expected dental caries prevalence of 60%based on previous studies among university students, with a 95% confidence level and 5% margin of error. The calculated minimum sample size was 369 participants. Considering logistical feasibility and an anticipated response rate, a final sample size of 300 students was included in the study. Stratified random sampling was used to ensure proportional representation from different faculties and academic years.

Inclusion Criteria

- University students enrolled during the study period
- Students of either gender who were willing to participate
- Students who provided informed consent
- Students available for clinical oral examination and questionnaire completion

Exclusion Criteria

- Students with systemic conditions affecting oral health
- Students undergoing orthodontic treatment or extensive dental treatment at the time of data collection
- Students with incomplete questionnaire responses or clinical records
- Students unwilling to participate in the study

Data Collection Procedure

Ethical approval for the study was obtained from the Institutional Research Ethics Committee University of Peshawar, Pakistan, prior to the commencement of data collection (Letter No: 2611/IREC dated: 02/11/2023; Permission to conduct the study was also obtained from the relevant university authorities. Participation was voluntary, and written informed consent was obtained from all participants before their inclusion in the study. Confidentiality and anonymity were strictly maintained by assigning unique identification codes instead of personal identifiers. Participants who were diagnosed with dental caries during the clinical examination were advised to seek appropriate dental consultation and treatment.

Data were collected using a structured, self-administered questionnaire and a clinical oral examination. The questionnaire was developed based on previously validated oral health surveys and consisted of two main sections: socio-demographic characteristics and behavioral-related variables. Socio-demographic information included age, sex, year of study, residence type, monthly income/allowance, and parental education level.

Behavioral variables included tooth brushing frequency, use of fluoridated toothpaste, dental floss usage, sugary snack consumption, soft drink intake, smoking/vaping status, and dental visits within the past year. The questionnaire was pre-tested among 30 students (not included in the final analysis) to ensure clarity and reliability Content validity of the questionnaire was evaluated by three experts in dental public health and epidemiology. A pilot study involving 30 students was conducted to assess clarity, relevance, and feasibility of the items. The reliability of behavioral variables was assessed using Cronbach's alpha coefficient ($\alpha = 0.82$), indicating good internal consistency.

Clinical oral examinations were conducted by a trained and calibrated dental professional under adequate lighting conditions using sterile mouth mirrors and explorers. Dental caries was assessed using the Decayed, Missing, and Filled Teeth (DMFT) index recommended by the World Health Organization (WHO). Each participant was examined under adequate lighting using sterile mouth mirrors and explorers. Teeth showing cavitated lesions were recorded as decayed according to WHO oral health survey guidelines.The dependent variable in this study was dental caries status, categorized as "present" or "absent." The independent variables included behavioral-related factors such as brushing frequency, flossing habits, sugary snack consumption, soft drink intake, smoking/vaping status, and dental attendance. Socio-demographic variables were considered potential confounders and were controlled for in multivariable analysis.

Data Analysis

Data were coded and entered into the Statistical Package for the Social Sciences (SPSS) version 25 for analysis. Descriptive statistics were computed to summarize socio-demographic characteristics and behavioral variables. Frequencies and percentages were used for categorical variables.The prevalence of dental caries was calculated as the proportion of students diagnosed with caries during clinical examination. The association between independent variables and dental caries was assessed using the chi-square test. Variables with a p-value less than 0.05 in bivariate analysis were included in a multivariable logistic regression model to identify independent predictors of dental caries. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were calculated, and statistical significance was set at $p < 0.05$.Model fitness was evaluated using the Hosmer–Lemeshow goodness-of-fit test, and the explanatory power of the model was assessed using the Nagelkerke R^2 statistic.

RESULTS

Table 1 presents the socio-demographic characteristics of the 300 university students included in the study. The majority of participants were aged 21–23 years (46%), followed by 18–20 years (34%), indicating that most respondents were in early adulthood. Females constituted a slightly higher proportion (54%) compared to males (46%). Students were relatively evenly distributed across academic years, with the largest group in Year 3 (28%). In terms of residence, 40% lived in on-campus hostels, while 37% resided in off-campus shared housing, suggesting a substantial proportion were living independently. Most students reported middle (44%) or low (42%) monthly income

levels. Regarding parental education, 43% of mothers had college or university education. Nearly half of the students (47%) rated their oral health as good or very good, although 15% perceived it as poor. Overall, the sample reflects a diverse university population with varied socio-demographic backgrounds.

Table 1: Demographic Characteristics of Participants (n = 300)

Variable	Category	n	%
Age group (years)	18–20	102	34.0
	21–23	138	46.0
	24–26	45	15.0
	≥27	15	5.0
Sex	Female	162	54.0
	Male	138	46.0
Year of study	Year 1	72	24.0
	Year 2	78	26.0
	Year 3	84	28.0
	Year 4+	66	22.0
Faculty/discipline	Health/Medicine	81	27.0
	Engineering/IT	69	23.0
	Business/Economics	63	21.0
	Social Sciences/ Humanities	57	19.0
	Natural Sciences	30	10.0
Residence type	On-campus hostel	120	40.0
	Off-campus shared housing	111	37.0
	Living with family	69	23.0
Monthly personal income/allowance	Low	126	42.0
	Middle	132	44.0
	High	42	14.0
Mother's education	Primary or less	57	19.0
	Secondary	114	38.0
	College/University	129	43.0
Self-rated oral health	Good/Very good	141	47.0
	Fair	114	38.0
	Poor/Very poor	45	15.0

Table 2 describes the oral health behaviors of the participants. Slightly more than half of the students (52%) reported brushing their teeth at least twice daily, while 14% brushed less than once per day, indicating suboptimal oral hygiene among a notable minority. The majority (76%) reported using fluoridated toothpaste; however, only 20% flossed daily, and 44% never used dental floss, highlighting inadequate interdental cleaning practices. Frequent sugar consumption was common, with 47% consuming sugary snacks two to three times daily and 20% consuming them four or more times per day. Similarly, 28% reported consuming soft drinks four or more times per week. Dental attendance was relatively low, as 61% had not visited a dentist within the past year. Additionally, 27% of students reported smoking or vaping. These findings suggest that a considerable proportion of students engage in behaviors that may increase their risk of developing dental caries.

Table 2: Behavioral-related characteristics of participants (n = 300)

Variable	Category	n	%
Tooth brushing frequency	≥2 times/day	156	52.0
	Once/day	102	34.0
	<Once/day	42	14.0
Use of fluoridated toothpaste	Yes	228	76.0
	No/Not sure	72	24.0
Dental floss use	Daily	60	20.0
	Occasionally	108	36.0
	Never	132	44.0
Sugary snack consumption	≤1 time/day	99	33.0
	2–3 times/day	141	47.0
	≥4 times/day	60	20.0
Soft drink consumption	Rarely/Never	87	29.0
	1–3 times/week	129	43.0
	≥4 times/week	84	28.0
Dental visit in past year	Yes	117	39.0
	No	183	61.0
Smoking/Vaping status	Non-user	219	73.0
	Current user	81	27.0

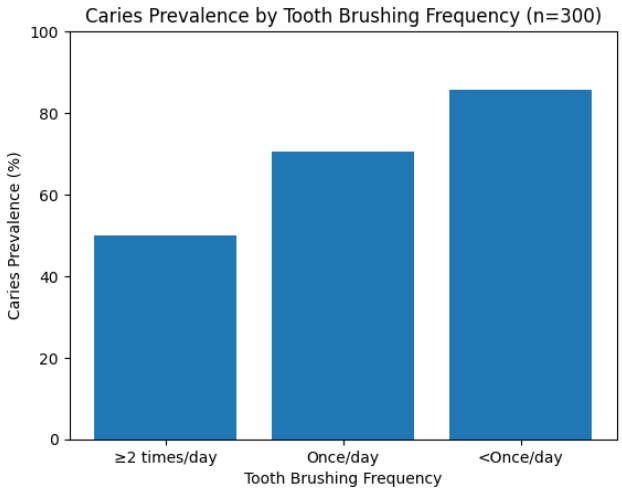

Figure 1: Illustrates the Overall Prevalence of Dental Caries among the Study Participants. A total of 62% of Students were Diagnosed with Dental Caries during the Clinical Examination, while 38% were Caries-Free

Table 3 shows the bivariate association between selected behavioral factors and dental caries prevalence. The overall prevalence of dental caries was 62%. A statistically significant association was observed between tooth brushing frequency and caries ($p = 0.002$), with students brushing less than once daily showing the highest prevalence (85.7%). Sugary snack consumption was strongly associated with caries ($p < 0.001$), as prevalence increased progressively with higher intake frequency. Students who had not visited a dentist in the past year had significantly higher caries prevalence (72.1%) compared to those who had attended (46.2%) ($p = 0.001$). Smoking/vaping was also significantly associated with caries ($p = 0.021$),

with users demonstrating higher prevalence (77.8%) compared to non-users (56.2%). These findings indicate that poor oral hygiene practices, high sugar intake, lack of preventive dental visits, and tobacco use are significantly related to dental caries at the bivariate level.

Table 3: Association between Selected Behavioral Variables and Dental Caries Prevalence (n = 300)

Variable	Category	Caries Present n (%)	Caries Absent n (%)	p-value*
Tooth brushing frequency	≥2 times/day (n=156)	78 (50.0)	78 (50.0)	0.002
	Once/day (n=102)	72 (70.6)	30 (29.4)	
	<Once/day (n=42)	36 (85.7)	6 (14.3)	
Sugary snack consumption	≤1/day (n=99)	45 (45.5)	54 (54.5)	<0.001
	2–3/day (n=141)	96 (68.1)	45 (31.9)	
	≥4/day (n=60)	45 (75.0)	15 (25.0)	
Dental visit (past year)	Yes (n=117)	54 (46.2)	63 (53.8)	0.001
	No (n=183)	132 (72.1)	51 (27.9)	
Smoking/Vaping	Non-user (n=219)	123 (56.2)	96 (43.8)	0.021
	Current user (n=81)	63 (77.8)	18 (22.2)	

Table 4 presents the multivariable logistic regression analysis identifying independent predictors of dental caries after controlling for potential confounders. Students who brushed less than once daily were nearly five times more likely to have dental caries compared to those brushing twice daily or more (AOR = 4.85, p = 0.001), indicating a strong independent association. High sugary snack consumption (≥4 times/day) significantly increased the odds of caries (AOR = 3.60, p < 0.001), confirming its role as a major risk factor. Not visiting a dentist within the past year was also independently associated with higher caries risk (AOR = 2.75, p < 0.001). Smoking/vaping (AOR = 2.05, p = 0.020) and never flossing (AOR = 2.30, p = 0.012) remained significant predictors. In contrast, sex and residence type were not statistically significant after adjustment. Overall, the regression model indicates that behavioral factors, rather than demographic characteristics, are the primary determinants of dental caries among the study population.

Table 4: Multivariable Logistic Regression Analysis of Factors Associated with Dental Caries (n = 300)

Variable	Category (Reference)	Adjusted OR (AOR)	95% CI	p-value
Tooth brushing frequency	≥2 times/day (Ref)	1.00	–	–
	Once/day	2.10	1.20 – 3.65	0.009
	<Once/day	4.85	1.90 – 12.40	0.001
Sugary snack consumption	≤1 time/day (Ref)	1.00	–	–
	2–3 times/day	2.45	1.40 – 4.28	0.002
	≥4 times/day	3.60	1.75 – 7.42	<0.001
Dental visit in past year	Yes (Ref)	1.00	–	–
	No	2.75	1.60 – 4.73	<0.001
Smoking/Vaping status	Non-user (Ref)	1.00	–	–
	Current user	2.05	1.12 – 3.74	0.020
Flossing habit	Daily (Ref)	1.00	–	–
	Occasionally	1.65	0.85 – 3.18	0.140
	Never	2.30	1.20 – 4.41	0.012
Sex	Female (Ref)	1.00	–	–
	Male	1.35	0.82 – 2.23	0.240
Residence type	Living with family (Ref)	1.00	–	–
	On-campus hostel	1.70	0.95 – 3.02	0.074
	Off-campus shared housing	1.55	0.85 – 2.83	0.150

DISCUSSION

The present study assessed the prevalence of dental caries and its association with behavioral-related factors among university students of University of Peshawar. The overall prevalence of dental caries was 62.0%, indicating that dental caries remains a significant oral health concern in this population.

Similar prevalence rates have been reported in previous studies among university and young adult populations, where caries prevalence ranged between 50% and 70% [11, 12]. These findings reinforce the continuing burden of dental caries among young adults despite advancements in preventive dentistry.Studies conducted in Pakistan have also reported a high prevalence of dental caries among university students, largely attributed to inadequate oral hygiene practices and frequent consumption of sugary foods and beverages. These findings are consistent with the present study and further highlight the need for oral health promotion strategies within university settings.

Tooth brushing frequency demonstrated a strong and statistically significant association with dental caries. Students who brushed less than once daily were substantially more likely to have caries compared to those brushing twice or more per day. This finding is consistent with prior research showing that inadequate brushing frequency increases plaque accumulation and enhances the risk of enamel demineralization [13]. Regular brushing with fluoridated toothpaste has been widely recognized as one of the most effective preventive strategies against dental caries due to its role in mechanical plaque removal and fluoride-mediated remineralization [14]. Therefore, poor adherence to recommended brushing practices may explain the higher caries prevalence observed in this subgroup.Sugary snack consumption was another significant predictor of dental caries in this study. Students who consumed sugary snacks four or more times per day had markedly increased odds of caries compared to those with lower intake. This finding aligns with extensive epidemiological evidence demonstrating that frequent sugar exposure is a key determinant of caries development [15]. The frequency of sugar intake is particularly important, as repeated acid production following carbohydrate fermentation prolongs enamel demineralization [16]. University students often adopt irregular eating patterns and increased snacking behaviors due to academic pressures and lifestyle transitions, which may contribute to elevated caries risk [17].Similar findings have been reported in recent studies among university populations in different regions, where inadequate brushing practices and frequent consumption of sugary snacks were identified as major predictors of dental caries. These studies emphasize that behavioral factors remain key determinants of oral health outcomes among young adults and highlight the need for targeted preventive interventions in academic institutions.

Dental attendance behavior also emerged as a significant factor. Students who had not visited a dentist within the past year were nearly three times more likely to have dental caries. Regular dental visits facilitate early detection, preventive interventions, and reinforcement of oral health education, thereby reducing disease progression [18]. Previous studies have reported that young adults often seek dental care only when symptomatic, leading to delayed diagnosis and treatment of carious lesions [19]. Barriers such as financial constraints, limited awareness, and dental anxiety may influence preventive dental attendance among university students.Smoking and vaping were significantly associated with dental caries in the adjusted model. Students who reported tobacco use had approximately twice the likelihood of caries compared to non-users. Although tobacco use is more frequently linked to periodontal disease, emerging evidence suggests that smoking may indirectly contribute to caries development by reducing salivary flow, altering oral microbiota composition, and promoting unhealthy lifestyle behaviors [20]. With the increasing prevalence of vaping among young adults, further research is necessary to clarify its long-term effects on oral health.

Flossing habits showed a moderate association with dental caries, particularly among students who never used dental floss. Interdental plaque accumulation may predispose individuals to proximal caries, especially when combined with poor brushing and high sugar intake [21]. However, in the present study, occasional flossing was not significantly associated with caries after adjustment, suggesting that brushing frequency and dietary habits may exert a stronger independent effect.Socio-demographic variables such as sex and residence type were not independently associated with dental caries after multivariable adjustment. This finding suggests that modifiable behavioral factors may play a more dominant role than demographic characteristics in influencing caries risk among university students. Similar observations have been reported in previous studies emphasizing the importance of behavioral determinants over purely demographic predictors [12, 17].

The findings of this study have important public health implications. Since most identified risk factors are modifiable, targeted oral health promotion interventions within university settings could substantially reduce disease burden. Educational programs emphasizing twice-daily brushing with fluoridated toothpaste, reduced sugar intake, tobacco

cessation, and regular dental attendance are strongly recommended. University health services may serve as strategic platforms for implementing preventive initiatives and routine screening programs. Nevertheless, certain limitations should be acknowledged. The cross-sectional design precludes establishing causal relationships between behavioral factors and dental caries [19-23]. Self-reported behavioral data may be subject to recall bias or social desirability bias [23]. Additionally, the study was conducted within a single institution, which may limit generalizability. Future longitudinal and multi-center studies are recommended to further explore behavioral patterns and their long-term impact on oral health outcomes.

In conclusion, this study confirms that dental caries remains highly prevalent among university students of University of Peshawar and is significantly associated with modifiable behavioral factors, particularly inadequate tooth brushing, frequent sugar consumption, irregular dental visits, smoking/vaping, and poor flossing habits. These findings highlight the need for comprehensive preventive strategies targeting behavioral modification to improve oral health among young adults.

This study has several limitations that should be considered. First, the cross-sectional design limits the ability to establish causal relationships between behavioral factors and dental caries. Second, some behavioral variables were self-reported and may therefore be subject to recall bias or social desirability bias. Third, the study was conducted in a single university, which may limit generalizability of the findings to other populations. Despite these limitations, the study provides useful insights into behavioral determinants of dental caries among university students of University of Peshawar.

CONCLUSION

This study demonstrated that dental caries remains highly prevalent among university students of University of Peshawar, affecting more than half of the study population. The findings highlight a significant association between dental caries and modifiable behavioral factors, particularly inadequate tooth brushing frequency, frequent sugary snack consumption, irregular dental attendance, smoking/vaping, and poor flossing habits. Students who practiced suboptimal oral hygiene and engaged in high-risk dietary and lifestyle behaviors were significantly more likely to experience dental caries.The results emphasize the critical role of preventive behaviors in reducing caries risk among young adults. Since university years represent a transitional period characterized by increased independence and lifestyle changes, this stage provides an important opportunity for establishing lifelong healthy oral practices. Targeted oral health promotion programs within university settings, including education on proper brushing techniques, reduction of sugar intake, tobacco cessation, and encouragement of regular dental check-ups, are strongly recommended. Although the cross-sectional design limits causal inference, the study provides valuable insight into behavioral determinants of dental caries in a university population. Future longitudinal studies are recommended to further explore causal relationships and evaluate the effectiveness of preventive interventions. Strengthening behavioral-focused preventive strategies may substantially reduce the burden of dental caries among university students and improve overall oral health outcomes.

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AUTHORS CONTRIBUTION

Concept & Design of Study: Dr. Muhammad Naeem
Drafting: Dr. Muhammad Yousaf
Data Analysis: Dr. Raham Zaman
Critical Review: Dr. Muhammad Naeem
Final Approval of Version: Dr. Muhammad Naeem
All authors have reviewed and approved the final manuscript.

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