

Patterns, Awareness and Oral Health Implications of Energy Drink Consumption among University Students in Rural Sindh: A Cross-Sectional Study

Muhammad Bilal^{1*}, Ghazala Eidan¹, Muhammad Hassan¹, Kumail Ali¹, Abdul Qadir¹, Anusha Qureshi²

ABSTRACT

OBJECTIVE: To evaluate energy drink consumption patterns, awareness regarding their health effects, and their association with self-reported oral health problems among university students in rural Sindh, Pakistan.

METHODOLOGY: A cross-sectional observational study was conducted among university students in rural areas of Sindh. A convenience, non-probability sampling technique was used to collect data. Ethical approval was received from the Research Ethics Committee of LUMHS (LUMHS/REC/955). An online questionnaire was developed in Microsoft Forms and shared with the participants. Data were cleaned in Microsoft Excel and analyzed in SPSS Version 22. The study was conducted for a period of four months, from July to October 2025.

RESULTS: From a total of 304 responses, 182 (59.87%) were energy drink consumers. Out of 182 consumers, occasional consumers were 127 (58.2%), daily users were 24 (11%), 23 (10.5%) once a week, and 44 (20.5%) used them 2-3 times a week. 22.6% of beverage users reported dental caries/decay, 22.6% reported sensitivity, and 8% reported oral ulcers. The chi-square test statistically evidenced a significant association between energy drink consumption and the onset of oral issues, as well as worsening of oral problems. The chi-square test also showed a strong association between energy drink consumption and gender.

CONCLUSION: Energy drink consumption was prevalent among university students in rural Sindh and was associated with self-reported oral health problems, particularly dental caries and tooth sensitivity. Despite awareness regarding potential adverse effects, consumption remained common among participants.

KEYWORDS: Energy drinks, oral health, dental caries, tooth sensitivity, university students, Sindh, Pakistan

INTRODUCTION

Energy drink consumption has expanded rapidly over the past two decades and is now widely observed among university students worldwide¹. Red Bull was introduced first, followed by Sting in 2010. The market has since expanded to include both local and international brands, such as Monster and PowerHorse². Focused marketing, low prices, and easy accessibility have all played a role in increasing the consumption of energy drinks³.

Energy drinks help to combat fatigue, boost concentration, and help students push through long study nights⁴. The first energy drink containing vitamin B, caffeine, and taurine was introduced as an energy beverage⁵. Since then, these beverages have increased in popularity, especially among young individuals, as confirmed by a 2013 systematic review⁶.

Energy drinks not only affect systemic health but also affect oral health in many ways⁷. Caffeine, a

derivative of the tea plant, stimulates the sympathetic nervous system and reduces saliva flow⁸. The role of saliva is to buffer acids that demineralize enamel. In the absence of saliva, bacterial growth and proliferation increase, raising the risk of caries⁹. Reducing salivary flow therefore compromises oral health, increasing susceptibility to dental caries and other oral conditions¹⁰. The tolerable range for caffeine intake in adults is from roughly 100 to 400 mg/day⁹. However, when consuming multiple cans, the threshold will be crossed.

A single can of energy drink contains close to 27 g of sugar¹¹. When that sugar enters the oral cavity, bacteria, especially *Streptococcus mutans*, ferment sugars into lactic acid¹². This fermentation process decreases the pH below the threshold required for a stable enamel layer on teeth, increasing the chances of dissolution of teeth¹³. Greater surface exposure to these acids leads to greater erosion of dental tissues¹⁴. Additionally, a decreased pH in the oral cavity favors biofilm formation and plaque accumulation, which can lead to gingivitis¹⁵. In addition to sugars, acidic additives such as citric acid and carbonic acid contribute to enamel erosion, further weakening tooth structure¹⁶.

Despite these several oral health issues, very few

¹Institute of Dentistry, LUMHS, Jamshoro, Sindh, Pakistan

²Department of Oral Pathology, LUMHS, Jamshoro, Sindh, Pakistan

Correspondence: bilalkdigri@gmail.com

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studies have looked specifically at how these beverages affect rural university students in Pakistan. Most existing research comes from urban settings, athletes, or countries with very different cultures and socioeconomic context¹⁶. This study aimed to determine the prevalence of energy drink consumption among university students in rural Sindh, assess awareness regarding its potential oral health effects, and evaluate its association with self-reported oral health problems.

METHODOLOGY

This cross-sectional observational study recruited participants from universities across rural areas of Sindh province, Pakistan. This study was conducted in accordance with the ethical principles set out in the Declaration of Helsinki (2024 revision). Ethical approval was granted by the Research Ethics Committee of Liaquat University of Medical and Health Sciences (LUMHS), Jamshoro, reference number LUMHS/REC/-955, before any data were collected. All responses were recorded anonymously, and participant confidentiality was maintained throughout the study. As no comprehensive data were available regarding energy drink consumption among university students in rural Sindh, the sample size was estimated using a conservative prevalence of 50%, a 95% confidence level, and a 5% margin of error. This yielded a minimum required sample size of 384 participants, but the study included 304 complete responses obtained through a non-probabilistic convenience sampling during the study period. Although the sample achieved was below the calculated target, it exceeded the minimum sample sizes commonly reported in similar cross-sectional studies. It provided an adequate sample for examining consumption patterns, awareness levels, and associations among study variables. Bachelor's level students aged 18 to 30 enrolled in rural universities of Sindh were included in the study. In contrast, matriculation, intermediate, and postgraduate students, students aged below 18 or above 30 years, and those with systemic illness were excluded. To reduce information bias, data were collected via an online, structured questionnaire administered from July 2025 to October 2025. A pilot test was conducted with 40 students to assess clarity and understanding. Those 40 pilot responses were not included in the final dataset. The survey included information on demographics, energy drink consumption habits, oral hygiene habits, and self-reported health problems. The primary variable was energy drink consumption, and the outcome variables were self-reported oral health issues, including dental caries, sensitivity, and other conditions. Frequency of energy drink consumption was categorized into daily, weekly, occasional, and non-consumers for analysis. Questionnaires with incomplete responses were

excluded, and missing data were checked before analysis. All data were analyzed using SPSS version 22. Descriptive statistics, frequencies, and percentages were computed for all main variables. The chi-square test ($p < 0.05$) was used to assess the association between energy drink consumption and the onset or worsening of oral health conditions.

RESULTS

Final analysis consisted of 304 participants; 164 (53.9%) were male, and 140 (46.1%) were female. Energy drink use was reported by 182 (59.9%). Most of these consumers reported consuming energy drinks for over a year (77.36%). Fewer had used them for less than six months (17.45%), and only 5.19% reported using them for 6 to of months. (Table I) 127 (41.8%) of consumers reported using energy drinks occasionally. 44 (14.5%) who drank them two to three times a week, followed by 24 (7.9%) daily users, and once-a-week users were 23 (7.6%). The single biggest reason students gave for consuming energy drinks was taste and flavor, cited by 52.19%. 14.96% of participants selected staying awake as the main reason, then studying (10.20%), sports or fitness (8.39%), stress (5.10%), and peer influence (4.05%). These numbers are given in Table I.

Table I: Duration of energy drink use and reasons for consumption

Duration of use	Percentage
Less than 6 months	17.45
More than 1 year	77.36
More than 6 months	5.19
Reason for consumption	Percentage
Peer influence	4.05
Staying awake	14.96
Taste/flavor	52.19
Sports or fitness	8.39
Studying	10.20
Stress	5.10
Other	5.10

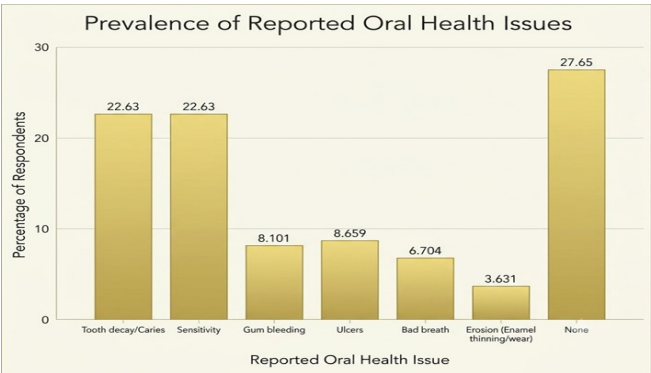


Figure 1: Oral Health Issues Reported

Table II: Brushing frequency and oral hygiene aids

Brushing frequency	Percentage
Once daily	49.6
Twice daily	44.4
Occasionally	2.3
More than twice	0.66
No response	2.30
Oral hygiene aid used	Percentage
Fluoridated toothpaste	75.59
Mouthwash	10.59
Dental floss	6.17
Miswak	3.23
None	4.4

When it came to self-reported oral problems, the two most common issues were tooth decay (caries) and dental sensitivity, each at 22.63%, as shown in **Figure 1**.

When asked about awareness, 78.95% of students believed that energy drinks are harmful to teeth or oral health; 8.88% disagreed, and 12.17% were unsure. Additionally, almost 84.84% of participants can reduce or stop energy drink use if they are informed about oral health concerns. However, 59.21% of students never read the label to check the content/ingredients of drinks, and only 40.79% did. (57.57%) reported to cut the energy drinks use if they get health warnings against the energy drinks consumption, followed by a dentist's advice (23.36%). Price (6.91%) and peer influence (4.28%) were reported in a small number. Full awareness data are in **Table III**.

Chi-square results analysis showed a statistically significant association between gender and energy drink consumption, with a higher proportion of males (68.3%) consuming energy drinks than females (50.0%) ($\chi^2(1) = 10.519$, $p = 0.001$). Additional chi-square analyses demonstrated statistically significant associations between energy drink consumption and self-reported oral health problems ($\chi^2(3, N = 304) = 59.27$, $p < .001$).

Table III: Awareness-related responses

	Yes (Percentage)	No (Percentage)	Not Sure (Percentage)
Do you believe energy drinks cause dental issues?	78.95	8.88	12.17
Would you reduce intake if informed of the risks?	84.84	15.16	
Do you read energy drink labels?	41	59	
What would influence you to reduce/quit?	Percentage		
None	07.24		
Dentist's advice	23.36		

Health warnings	57.57
I don't use much anyway	00.33
Peer influence	04.28
Personal preference	00.33
Price	06.91

DISCUSSION

The present study investigated energy consumption patterns, awareness regarding their health effects, and their association with self-reported oral health problems among university students in rural Sindh, Pakistan. Energy drink consumption was highly prevalent, with approximately 60% of participants reporting current use. Consumption was significantly more common among males than females and was associated with self-reported oral health problems. Despite high awareness of the potential harmful effects of energy drinks on oral health, consumption remains common among participants.

In our study, 59.9% of participants reported consuming energy drinks, attributing that these beverages are frequently used among university students in rural Sindh. This prevalence is comparable to that reported in studies from Pakistan and other countries, which have similarly documented widespread energy drink use amongst young adults and university populations¹.

In our cohort, the most reported reasons for energy drink consumption were taste and flavor, accounting for 52.19% of responses. This finding suggests that the use of energy drinks among these students may not be driven solely by functional purposes such as improving academic performance or maintaining alertness¹⁷. Nevertheless, a considerable proportion of participants reported consuming energy drinks to stay awake (14.96%) or to assist with studying (10.22%), indicating that perceived stimulant effects also influence consumption patterns. These findings are consistent with previous studies among university students, which have shown that energy drinks are consumed not only for their sensory appeal but also for their perceived ability to reduce fatigue and enhance concentration during academic activities¹⁸.

A significant association was observed between energy drink consumption and self-reported oral health problems, with tooth decay/caries and tooth sensitivity being among the most frequently reported conditions. Although the cross-sectional design of this study does not allow causal inferences, the observed association is supported by biological mechanisms. Energy drinks typically have high concentrations of fermentable carbohydrates and acidic additives. This results in low pH values that may contribute to enamel demineralization and increase susceptibility to the development of dental caries and dentinal hypersensitivity¹⁹.

Experimental and in vitro studies have demonstrated that repeated exposure to commercially available

energy drinks can markedly reduce the micro-hardness of enamel and increase erosive wear of dental hard tissues, providing support for the potential link between habitual consumption and adverse oral health outcomes²⁰.

Moreover, the present study found that awareness of potential oral health risks did not necessarily translate into reduced energy drink consumption. Although 78.95% of participants recognized that energy drinks may be harmful to oral health, consumption remained consistent, with 59.9% reporting current use. This discrepancy reflects the well-recognized gap between health knowledge and health-related behavior¹⁷. Factors such as taste preferences, habitual consumption, perceived functional benefits, peer influence, and the widespread availability of these beverages may outweigh awareness of potential health risks²¹. Similar patterns have been observed in studies of energy drink use and other dietary behaviors among young adults, in which awareness of adverse health effects does not consistently lead to healthier choices²¹.

Moreover, in this study, male participants were significantly more likely to consume energy drinks than female participants (68.3% vs 50.0%, $p = 0.001$). This finding is consistent with previous studies reporting a higher prevalence of energy drink consumption among males⁷. Several factors may contribute to this gender difference, including greater participation in sports and fitness activities, higher overall caffeine consumption, sensation-seeking and risk-taking behaviors, and marketing strategies that often target young men²¹. However, the sociocultural and behavioral factors contributing to these gender-specific patterns of consumption remain poorly understood and warrant further investigation.

An encouraging finding in this study was that many participants expressed a willingness to reduce energy drink consumption if they were provided with better information about the potential impact on oral health. In particular, health warnings (57.57%) and recommendations from dentists (23.36%) were identified as the strongest reasons to induce behavioural change.

This study has several strengths, including the assessment of both energy drink consumption patterns and oral health awareness among university students from rural Sindh, a population for which published data remain scarce. Nevertheless, several limitations should also be acknowledged. First, the cross-sectional design impedes the establishment of temporal or causal relationships between energy drink consumption and oral health outcomes. Second, oral health conditions were self-reported rather than clinically verified. This may have introduced reporting and recall bias. Furthermore, the use of convenience sampling and an online questionnaire may have introduced selection bias and limited the generalizability of the findings. Future research should employ probability-based sampling strategies,

incorporate standardized clinical oral examinations, and utilize longitudinal study designs to examine better the relationship between energy drink consumption and oral health outcomes.

CONCLUSION

Energy drink consumption was common among university students in rural Sindh, particularly among males. A considerable proportion of participants reported oral health problems, including dental caries and tooth sensitivity, which were more frequent among energy drink consumers. Although awareness regarding the potential harmful effects of energy drinks was generally high, consumption remained prevalent, indicating a gap between awareness and behavior.

RECOMMENDATIONS

We recommend integrating the energy drinks association into oral health education within existing dental health programs, and that dentists regularly counsel patients on the potentially harmful effects of energy drink consumption on oral health. Future research should include clinical examination alongside self-report data and consider longitudinal designs that can track actual enamel changes over time.

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AUTHOR CONTRIBUTION

Bilal M: Data collection
Eidan G: Acquisition of data
Hassan M: Data analysis
Ali K: Drafting
Qadir A: Final approval
Qureshi A: Concept of study

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