

Research Article

Patterns of Energy Drink Consumption among University Students in Lahore, Pakistan: A Cross-sectional Study

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ABSTRACT

This study aimed to determine the prevalence and associated factors of Energy Drinks (EDs) use among university students in Lahore, Pakistan. A cross-sectional study was conducted with 400 students (mean age: 20.6 years) who completed an anonymous questionnaire administered by the research team within their universities. Descriptive statistics revealed a high prevalence of EDs use, with 47.5% of participants reporting consumption. Chi-Square analysis showed significant associations between EDs use and several factors. Specifically, males were more likely to be EDs consumers than females ($p < 0.001$), and consumed them more frequently ($p = 0.008$). Additionally, ED use was significantly higher among students involved in sports or physical activities ($p = 0.042$) and among smokers compared to non-smokers ($p = 0.001$). In conclusion, this study highlights the high prevalence of EDs consumption among university students in Lahore and underscores the need for public health campaigns to raise awareness about the potential health risks associated with these beverages. However, self-reported data may have introduced bias, highlighting the need for further research.

INTRODUCTION

Energy Drinks (EDs), which are widely available non-alcoholic beverages containing high levels of caffeine, sugar, and stimulants like taurine and guarana, have surged in global popularity, particularly among young adults. This rise in consumption has generated significant public health concern due to their potential adverse effects on human well-being (Protano *et al.* 2023). A study revealed that ED use is more prevalent in males and adults, particularly. Adults mostly use EDs to seek pleasure and escape from burdens of life as their use cause excitement in them because of extra energy in them. It has been found that energy drinks are consumed mostly to compensate for lack of sleep, boosting energy, boosting focus during the study, driving for a longer period of time, consuming with alcohol to improve the flavor of drinks, or overcoming hangovers (Poulos & Pasch 2016).

The primary ingredient of concern in EDs is caffeine, which, when consumed in excessive amounts, can lead to a range of physiological and psychological issues. Caffeine intoxication has been linked to restlessness, anxiety, tachycardia, and insomnia, while chronic high doses can increase mean arterial blood pressure and contribute to insulin resistance (Borlu *et al.* 2019). Furthermore, studies have reported that the stimulating properties of EDs can have unfavorable effects, particularly on the cardiovascular and neurodegenerative systems. Fatalities have been linked to cardiac arrest following EDs consumption in some cases. Other reported health outcomes include palpitations, stomachaches, headaches, tremors and anxiety (Costa *et al.* 2016).

The etiology of these deleterious consequences is linked to the beverages' natural neuro-stimulant qualities, with caffeine being the most prominent component (Costantino

et al. 2023). The primary action of caffeine is in antagonism of adenosine receptors in the central nervous system which increases neuronal excitability and neurotransmitter release (dopamine, norepinephrine, and glutamate) in the body. Such a mechanism leads to an increase in alertness and less perception of fatigue, but high dose or chronic use can cause dis-regulation of sleep-wake cycle and impair autonomic balance. Also, caffeine activates the sympathetic nervous system, leading to acceleration of heart rate, blood pressure, and the circulation of catecholamines, which can cause cardiovascular stress in vulnerable people. The caffeine also affects metabolic and endocrine pathways, enhancing cortisol secretion and disrupting glucose homeostasis, which may worsen anxiety, gastrointestinal disturbances, and metabolic stress in case of high dosage or its activity in combination with other stimulants that are often found in energy drinks (Alimyar *et al.* 2024).

Beyond the direct health risks of their ingredients, the consumption of EDs is often associated with other health-damaging behaviors. Research has shown that EDs use can be linked to inadequate nutrition, higher Body Mass Index (BMI), and, most notably, a greater propensity for using tobacco, alcohol, illicit drugs, sweetened beverages and junk food (Galimov *et al.* 2019; Marinoni *et al.* 2022). Elevated BMI, coupled with poor nutrition, is already posing a significant long-term health impact. A recent study in Lahore illustrates that in the 15–34 age range, 10.9% citizens have diabetes while 33.8% are pre-diabetic (Tariq 2023). Another study states that EDs hinder the normal glucose levels 2 hours after their ingestion both in normal and pre-diabetic individuals (Hassan *et al.* 2025). The review article in Pak Heart J confirms a strong association between acute ED intoxication and various cardiovascular complications, including hypertension, cardiac arrhythmia, myocardial infarction, cardiomyopathy, and cardiac arrest (Zahoor *et al.* 2020). The European Cardiac Arrhythmia Society (ECAS) also warns that EDs may risk heart health, especially for children and those with a medical history of heart issues (Lévy *et al.* 2019). Even though adolescents' consumption of caffeine from other beverages has declined in the past years but caffeine intake from EDs has significantly increased in recent years (Ruiz & Scherr 2019).

Caffeine content in EDs is harmful if consumed above safe limits. FDA limits caffeine to 400 mg/day for adults, depending on sensitivity and excretion rate among individuals (Food and Drug Administration (FDA) 2024). The European Cardiac Arrhythmia Society (ECAS) advise that children under 14 years old should avoid caffeine, while teenagers should limit intake to 2.5–3 mg/kg bw daily (Lévy *et al.* 2019b). However, caffeine content of all the energy drinks in the market has been found concerning. The study found energy drinks contain about 102.2 mg caffeine per serving, with 30.7 mg/100 mL (Keaver *et al.* 2017).

The global consumption patterns of EDs are a major concern. A study at Khyber Medical University, Kohat, Pakistan, found that 70.2% of MBBS students consume EDs. Of these consumers, 30.7% consume them at least once a day, while the remaining consume more than one per day (Zaman *et al.* 2023). Another study indicates that almost two-thirds of Pakistani athletes consume sports and energy drinks, with Sting being most common (Khan *et al.* 2022). Similarly high rates have been observed in other countries as well. It is estimated that >60% of the young university population in the United States consume EDs (García *et al.* 2025). A study in Eastern Croatia reported that 52.4 % of university students were found to be consuming EDs (Pavlovic *et al.* 2023). Despite the known risks, many consumers remain unaware of the potential adverse effects. It is also observed that consumers do not bother to read the label before purchasing anything. That is the reason they are not conscious of the adverse effects of EDs consumption (Chang *et al.* 2017). Also, the supermarkets often stock EDs alongside sports beverages, leading to confusion among customers. Sports drinks replenish electrolytes and water lost during exercise, while EDs use non-nutritive stimulants to boost performance, leading to dehydration (Mutabazi *et al.* 2019).

The regulatory landscape has now evolved. EDs were categorized as Natural Health Products before 2013 when they were reclassified to fall under the Food and Drug Act. This meant that they were subject to new rules on the amount of caffeine they contained, the requirement for cautionary labelling, and limitations on their ability to make health claims. In 2010, Health Canada's expert team on caffeinated energy drinks defined them as "drugs containing stimulants"

and deemed them a "safety concern" (Hammond *et al.* 2018). US Food and Drug Administration has linked EDs consumption to possible lethal consequences due to presence of more caffeine content in them (FDA 2024). Recently, the European Cardiac Arrhythmia Society has postulated some recommendations regarding EDs consumption to prevent diseases. Consumption of EDs before or during sports or mixing EDs with alcohol or other illegal medicines is strictly prohibited (Lévy *et al.* 2019).

While the global literature on EDs consumption is substantial, a critical gap remains in the regional context of Pakistan. To our knowledge, no previous study has comprehensively examined the consumption patterns and associated factors of EDs use among university students in Lahore. Given the growing global use of EDs and the related health hazards, understanding these relationships is crucial for developing effective prevention strategies.

Therefore, this study aims to determine the prevalence of EDs consumption among university students in Lahore, Pakistan, and to identify its association with lifestyle characteristics. The findings highlighted the need for developing and implementing appropriate public health interventions to mitigate the potential risks of EDs use.

METHODS

Design, location, and time

It was a cross-sectional study with a sample size of 400 individuals. Ethical approval for the study was obtained from the Institutional Review Committee for Biomedical Research, University of Veterinary and Animal Sciences Lahore, under approval number 69/IRC/BMR. The study was conducted on the university students of Lahore. Universities were selected randomly based on accessibility and sector category. Informed consent was taken from each participant and ethical approval was taken from the administration of all the institutions and after that data was collected.

Sampling

According to the target population of Lahore, we calculated the sample size of 400 using the formula $n = Z^2 p(1-p)/d^2$, where; level of confidence=95%, Margin of error=5%.

A multistage sampling approach was used, where 3 (2 public and 1 private university) out of 35 universities (13 public and 22 private universities) were selected. Within each selected university, students who were willing to participate were invited to complete the questionnaire. The survey comprised students from several public and private universities in Lahore. The sample was adjusted to reflect the majority population of university students in the city of Lahore.

Data was collected in the month of January and February, 2025. The inclusion criteria for participants recruited in the study was students who were enrolled in any bachelors or postgraduate degree program in a university and have age of 18 and above. Students who were below 18 and had any medical condition were excluded from the study.

Data collection

After explaining the purpose of study and taking consent, self-administered questionnaires were distributed to participants. The questionnaire was divided into three segments. The first and second segments contained 11 questions regarding sociodemographic and socioeconomic factors. The third segment concerned participant's habits and EDs consumption comprised of 22 questions. The questionnaire was designed by revising some questions from a similar study conducted by Pavlovic *et al.* (2023) at the Josip University of Osijek in eastern Croatia. A questionnaire trial was conducted before the actual survey to ensure the clarity, ordering, consistency and acceptance of the questionnaire. The research team validated the questionnaire by pilot testing in which the questionnaire was administered to 20 participants. The participants included in pretesting were excluded from the main study. The research team then administered the validated questionnaire to the targeted sample.

Data analysis

IBM SPSS Statistics 23 was used to analyze the data. Descriptive statistics (frequencies, percentages, and means) were used to summarize participants' sociodemographic characteristics and patterns of EDs consumption. The Chi-square (χ^2) test was applied to study associations between categorical variables such as EDs consumption status (consumer/non-consumer) and sociodemographic characteristics including gender, field of study, university, level

of study, student status, playing sports, cigarette smoking, and coffee intake. When expected cell frequencies were less than five, Fisher's exact test was used instead. To determine relationships between the frequency of EDs consumption and other variables such as gender, playing sports, smoking, coffee intake, Spearman's correlation was applied. As variables were all nominals/categorical, Spearman's correlation was used instead of Pearson's correlation. All statistical tests were two-tailed, and a $p < 0.05$ was considered statistically significant.

RESULTS AND DISCUSSION

Out of 400 participants, 57.8% were females, while 42.3% were males. Participants were chosen from 3 universities in Lahore, out of which 72.5% were medical students. Almost 97.3% of the participants were undergraduates, while remaining were postgraduate students. 66% of the students were day scholars and 34% were hostel residents. The mean age of the participants was 20.6 years. For reference, the results for participants' profiles are shown in Table 1.

Study showed that 190 participants (47.5%) out of 400 reported EDs consumption (Figure 1a). Among 190 consumers, 109 (64.5%) were males, while only 81 (35.1%) were females, presented in Figure 1b. This prevalence is in line with findings from several international studies (Borlu *et al.* 2019), although it is somewhat higher than the 38.6% reported among Italian students (Majori *et al.* 2018) and lower than what has been observed in certain European and Middle Eastern populations (Chang *et al.* 2017). At the same time, other research such as the study in Lebanon found less than half of students had ever tried EDs (Ghozayel *et al.* 2020). These differences likely reflect cultural influences, patterns of marketing, and different regulatory environments. Nevertheless, consistently high consumption across regions is worrisome, particularly at this stage of life when long-term health behaviors are being formed.

Out of 190 participants who consume EDs, 30 (15.8%) were the most frequent consumers (4 or more times/week) while 32 (16.8%) of them called it a "sometime snack" (2–3 times/week). 53 (27.9%) were less frequent consumers (2–4 times/month) while 68 (35.8%) were those who consume EDs rarely (1 time/month).

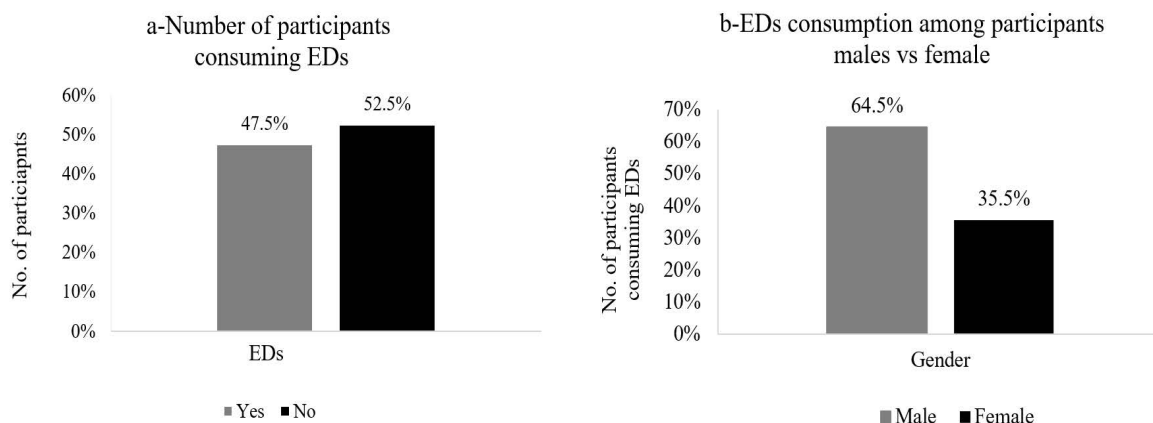
Table 1. Sociodemographic characteristics of the study participants

Study participants' characteristics	n=400 n (%)
Sex	
Male	169 (42.3)
Female	231 (57.8)
Subject area	
Medical	290 (72.5)
Non-Medical	110 (27.5)
University	
Public	236 (59.0)
Private	164 (41.0)
Level of study	
BS	389 (97.3)
MPhil	10 (2.4)
PhD	1 (0.3)
Student status	
Day Scholar	264 (66.0)
Hostel residents	136 (34.0)
Session	
Morning	261 (65.3)
Evening	139 (34.8)
Fee status	
Fully Funded	72 (18.0)
Partially Funded	79 (19.8)
Self-Finance	249 (62.3)
Source of income	
Parents	324 (81.0)
Scholarship	37 (9.3)
Work	32 (8.0)
Other	7 (1.8)

BS: Bachelor of Science; Mphil: Master of Philosophy; PhD: Doctor of Philosophy.

Out of 400 participants, 52.5% were non-consumers. Among 47.5% of consumers, some of the most common reasons for EDs consumption are presented in Figure 2. A 52 participants (27.4%) mentioned they consume EDs as they help them stay awake during work hours. 33 (17.4%) participants stated that EDs act as their stimulant in performing any difficult task, which mirrors findings from other countries where students turn to EDs as a study performance enhancer (Borlu *et al.* 2019). Some studies, however, also highlight taste, physical endurance, or sports as important motivators (Majori *et al.* 2018). A recent meta-

Energy drink consumption among university students



ED: Energy Drink

Figure 1. (a) shows the number of participants who consume EDs and who don't (b) shows the number of male and female participants out of total 190 participants who consume EDs

analysis confirmed that alertness, fatigue relief, and focus are the most common drivers (Nadeem *et al.* 2021). It is possible that high academic demands and poor sleep habits push students toward EDs as a quick solution.

Of all the participants who take energy drinks, 128 (67.4%) stated that flavor is the main reason for purchasing a particular energy drink brand and 23 participants (12.1%) stated that price is the determining factor for their choice.

It was also discovered that 105 (55.3%) consumers read labels while purchasing EDs while 85 (44.7%) consumers stated that they do not read labels. This differs from studies in Taiwan, where many students were unaware of the potential harms and did not check labels (Chang *et al.* 2017). Since EDs are marketed aggressively, the lack of consistent label awareness may increase risk of overconsumption. Out of 105 consumers

who read labels, 38 (36.2%) participants were interested in the energy value on the labels, 21 participants (20%) stated that caffeine attracts them most, while 12 (11.4%) participants stated that they were interested in sugars. While looking into the choice of sugars, 145 (76.3%) consumers preferred sweetened EDs over unsweetened energy drinks and thus are likely to be facing more health complications. Excessive sugar consumption, particularly from EDs, is associated with several adverse health outcomes. High sugar intake contributes to obesity, insulin resistance, and type 2 diabetes by disrupting normal glucose metabolism. Findings in the Journal of statistics indicate that the prevalence of diabetes and prediabetes in Lahore is increasing with age, peaking in individuals aged 35–54, where nearly half of the population is affected (Tariq 2023b). Frequent use of sugary beverages among

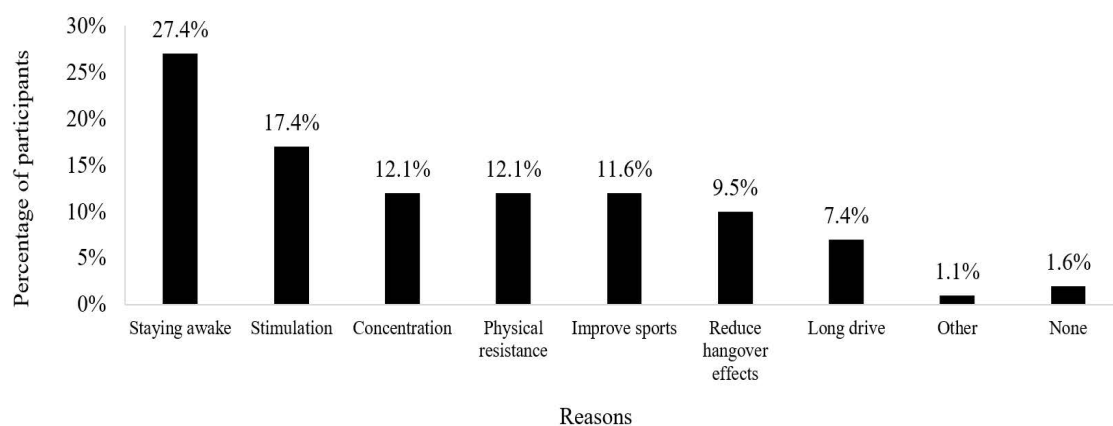


Figure 2. Reasons for energy drink consumption among students

young adults, especially males, poses a growing public health concern, highlighting the need for awareness campaigns and policies promoting reduced sugar intake and healthier alternatives (Gupta & Pushkala 2022).

Participants were also asked about the adverse health impacts of EDs. 86 participants (45.3%) never experienced any side effects, 21 (11.1%) experienced sudden drop and rise in energy, 19 (10%) experienced increased heart rate as the adverse effect while 18 (9.5%) experienced headaches as the adverse effect of EDs on their health. These results were consistent to other studies (Alaif *et al.* 2021; Nadeem *et al.* 2021; Hammond *et al.* 2018; Tóth *et al.* 2020). Also, there were studies that reported insomnia (Hardy *et al.* 2021; Nadeem *et al.* 2021), palpitations (Vujcic *et al.* 2023), excitation (Fields *et al.* 2015; Nordt *et al.* 2017), and headache as prevailing symptoms. A research meta-analysis showed insomnia as the main symptom faced by EDs consumers including both children and adults (Nadeem *et al.* 2021).

The relationship between EDs consumption and other sociodemographic characteristics and behaviors is shown in Table 2 below. Results show that the prevalence of EDs was more in males (64.5%) as compared to females (35.1%). These results were confirmed using chi-square ($p < 0.001$). Also, it was found that men were also the most frequent consumers (four times or more/month) ($p < 0.05$). This pattern has been reported in many countries (Tóth *et al.* 2020). Still, some studies around the world suggest a more mixed picture, with some reporting higher female use, like a study about EDs consumption among college students in Zambia (Mutabazi *et al.* 2019) and others showing little gender difference (Fields *et al.* 2015). These inconsistencies probably reflect social and cultural norms around gender, as well as differences in marketing strategies.

When the participants were analyzed according to their field of study using the chi-square, it was observed that the field of study has a non-significant association with the prevalence of EDs consumption ($p = 0.82$). Likewise, an insignificant relation was observed between the field of study and the frequency of energy drink consumption ($p = 0.269$). Observing the sports habits of participants, EDs consumption was significantly associated with sports ($p < 0.05$). It is consistent with prior studies showing that athletes often use EDs to enhance performance

(Tóth *et al.* 2020). Also, EDs consumption was significantly associated with smoking and coffee consumption ($p < 0.01$ and $p < 0.05$ respectively). Smoking and coffee use associated with higher EDs consumption, echoing with findings from other settings (Chang *et al.* 2017). However, it was found that there is no significant association between smoking and sports participation ($p = 0.131$) and a significant association between coffee consumption and sports ($p < 0.05$). In particular, male smokers were more likely to be EDs consumers, suggesting clustering of addictive behaviors (Casuccio *et al.* 2015). These overlapping risk patterns deserve more attention in future research. While moderate caffeine can act as an ergogenic aid, frequent and high-dose use may contribute to cardiovascular risks (Munteanu *et al.* 2018).

From Table 3 it can be seen that males are significantly more inclined to consume a higher quantity of EDs at one time compared to females ($p < 0.001$). It reflects the marketing of EDs with masculine themes such as strength, endurance, and power. Males are more likely to associate these beverages with enhanced physical and mental performance, aligning with risk-taking and competitive traits (Mehta 2025). Excessive consumption among males can increase the risk of cardiovascular issues, sleep disturbances, and dependency on caffeine or sugary beverages (Moussa *et al.* 2025). Such marketing strategies need to be regulated to discourage overconsumption.

To confirm the relation between frequency of EDs consumption and other socio-demographic factors, we performed Spearman correlation. The study revealed that there was a weak positive correlation between the monthly frequency of EDs consumption and playing sports ($r = 0.137$; $p < 0.01$). Also, smoking was positively correlated to frequency of EDs consumption ($r = 0.215$; $p < 0.001$), while no association was found between coffee intake and monthly frequency of EDs consumption ($r = 0.099$; $p < 0.05$).

Before leading to the conclusion, it is claimed that this study is not without limitations. The sample was limited to three universities in Lahore and may not represent all students in the city or the country. Data were self-reported, so under- or over-reporting cannot be ruled out. We believe that if these limitations were taken into consideration, there would be a higher prevalence of EDs consumption. Even so, this study provides

Table 2. Consumption of EDs according to the sociodemographic characteristics and habits of participants

Participants' sociodemographic characteristics and habits	Do not drink	Drink	Overall	<i>p</i>
	n (%)			
Sex				0.000*
Male	60 (35.5)	109 (64.5)	169 (100.0)	
Female	150 (64.9)	81 (35.1)	231 (100.0)	
Subject area				0.82
Medical	160 (55.2)	130 (44.8)	290 (100.0)	
Non-Medical	50 (45.5)	60 (54.5)	110 (100.0)	
University				0.000*
Public	133 (56.3)	103 (43.6)	236 (100.0)	
Private	77 (47.0)	87 (53.0)	164 (100.0)	
Level of study				0.564
BS	203 (52.2)	186 (47.8)	389 (100.0)	
MPhil	6 (60.0)	4 (40.0)	10 (100.0)	
PhD	1 (100.0)	0 (0.0)	1 (100.0)	
Student status				0.767
Day Scholar	140 (53.0)	124 (47.0)	264 (100.0)	
Hostel residents	70 (51.5)	66 (48.5)	136 (100.0)	
Playing sports				0.042*
No	112 (57.7)	82 (42.3)	194 (100.0)	
Yes	98 (47.6)	108 (52.4)	206 (100.0)	
Cigarette smoking				0.001*
No	200 (55.2)	162 (44.8)	362 (100.0)	
Yes	10 (26.3)	28 (73.7)	38 (100.0)	
Coffee intake				0.040*
No	110 (57.9)	80 (42.1)	190 (100.0)	
Yes	100 (47.6)	110 (52.4)	210 (100.0)	

*Chi-Square Test, $p < 0.05$ were considered statistically significant; EDs: Energy Drinks

Table 3. The amount of consumed EDs on one occasion according to gender

Sex	Do not drink	Drink				Overall	<i>p</i>
		Less than 0.25 L	0.25–0.5 L	More than 0.5 L	Do not know		
Male	60 (35.5)	40 (23.7)	40 (23.7)	15 (8.9)	14 (8.3)	169 (100.0)	0.000*
Female	152 (65.8)	37 (16)	23 (10)	9 (3.9)	10 (4.3)	231 (100.0)	
Overall	212 (53.0)	77 (19.3)	63 (15.8)	24 (6.0)	24 (6.0)	400 (100.0)	

*Chi-square test, $p < 0.05$ were considered statistically significant; EDs: Energy Drinks

the first snapshot of EDs consumption among university students in Lahore and highlights key patterns and associations, so it can serve as a domain for further studies in the future on a larger scale. Our study can be used not only as a reference source for other researchers but also for policy-making. Larger studies across multiple regions of Pakistan will be necessary

to better understand this behavior and its health implications.

CONCLUSION

Cardiometabolic risk factors such as overweight, obesity, diabetes and hypertension are highly prevalent in Pakistan. One of the

underlying causes for these risk factors is consumption of energy drinks. There is a high prevalence of energy drink consumption among university students in Lahore, particularly among males, physically active individuals, and those who engage in other risk-related behaviors such as smoking. The reported adverse effects highlight potential health concerns associated with regular consumption. By offering insight into consumption patterns in Pakistan, this study highlights the need for greater awareness of these products, encourages responsible use, and points to the importance of further research to guide health education and policy efforts.

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DECLARATION OF CONFLICT OF INTEREST

The authors have no conflict of interest.

DECLARATION OF GENERATIVE AI IN SCIENTIFIC WRITING

No generative AI tools were used in the content creation, writing of the manuscript, data analysis, or interpretation of the results. Proofreading services were used only to enhance the manuscript's language and grammatical quality.

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