

ENERGY DRINK CONSUMPTION AMONG ADOLESCENTS: PREVALENCE, KNOWLEDGE, ATTITUDES, CONSUMPTION PATTERNS, AND ASSOCIATION WITH ORAL HEALTH

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Abstract

Background/Aim: Energy drink consumption among adolescents has increased markedly worldwide, raising concerns about both general health effects and, more specifically, oral health, given the high acidity and sugar content of these products. This study aimed to assess the prevalence, knowledge, attitudes, and behavioral patterns associated with energy drink consumption among secondary and high school students, and to explore, on an exploratory basis, the relationship between regular consumption and dental health status (DMFT index), stratified by sex and area of residence. **Materials and Methods:** This observational, descriptive, cross-sectional study used a self-administered, anonymous questionnaire applied to 567 students aged 13–19 years (grades VII–XII), recruited through non-probability sampling. The questionnaire covered demographics, smoking behavior, and energy drink consumption (knowledge, frequency, quantity, motivations, side effects, and attitudes). A DMFT score was additionally recorded for regular consumers. Data were analyzed using descriptive statistics, cross-tabulation, independent-samples t-tests, and Pearson correlation ($p < 0.05$). **Results:** Regular energy drink consumption was reported by 13.4% of students (76/567), decreasing with age (16.9% at 13–14 years vs. 9.6% at 17–19 years). Knowledge of ingredients and effects was low (over 80% could not identify a substance), despite generally cautious attitudes (60.3% worried about health risks; 81.7% considered these drinks unsuitable for children). Among consumers, side effects and mixing with other beverages were frequently reported, yet 59% would not recommend the product to others. Taste and price were the main drivers of product choice. The DMFT analysis showed no significant association with sex ($p = 0.46$) or area of residence ($p = 0.18$). **Conclusions:** Adolescents in this sample combine low product-specific knowledge with reasonably intact risk awareness, sustaining consumption through sensory and commercial factors rather than perceived benefit. No significant associations were identified between DMFT and the investigated socio-demographic or behavioral variables. **Keywords:** energy drinks; adolescents; DMFT; oral health; questionnaire survey; cross-sectional study

Introduction

Oral diseases, and dental caries in particular, remain among the most prevalent non-communicable conditions worldwide, affecting close to 3.5 billion people and imposing a substantial economic and social burden (World Health Organization [WHO], 2022). Adolescence is a particularly vulnerable period for the onset and progression of caries, as newly erupted permanent teeth, dietary independence from parental supervision, and evolving oral hygiene habits combine to increase risk. The DMFT index (Decayed, Missing, Filled Teeth), recommended by the WHO for population-level surveillance, remains the standard epidemiological tool for quantifying caries experience and is widely used to compare oral health status across age groups, regions, and behavioral risk categories. Dietary sugar intake is consistently identified as the single most important modifiable risk factor for caries, with systematic evidence supporting a dose-dependent relationship between free sugar consumption and disease severity (Moynihan, Kelly, 2014).

In parallel, the consumption of energy drinks among children and adolescents has increased markedly over the past two decades. A large EU-wide survey commissioned by the European Food Safety Authority found that 68% of adolescents aged 10–18 years across 16 member states had consumed energy drinks, with national rates ranging from 48% to 82% (Zucconi et al., 2013), while

self-report surveys in the United States estimate that 30% to 50% of adolescents and young adults consume these products (Seifert et al., 2011). Energy drinks are formulated around high doses of caffeine, frequently combined with taurine, guarana, B vitamins, and substantial amounts of added sugar, and are marketed to young consumers with claims of improved alertness, concentration, and physical performance. Beyond their stimulant effects, this combination of ingredients has been linked to a range of adverse outcomes in the pediatric and adolescent population, including sleep disruption, anxiety, cardiovascular symptoms, and, in susceptible individuals, more serious events, prompting professional bodies to advise against their use in this age group (Seifert et al., 2011).

The same properties that make energy drinks a public health concern generally, namely their high sugar content and pronounced acidity, place them among the beverages of greatest concern specifically for oral health. Most commercial energy drinks have a pH well below the critical threshold of 5.5 at which enamel begins to demineralize, and in vitro studies comparing multiple beverage categories have shown that energy drinks produce measurably greater enamel dissolution than sports drinks and most soft drinks, with visible surface softening occurring after only a few days of simulated regular exposure (Jain et al., 2012). Combined with their high free-sugar content, which independently drives the bacterial fermentation process underlying dental caries (Moynihan, Kelly, 2014), energy drinks are therefore understood to act through two parallel pathways — chemical erosion and microbial caries — both of which can contribute to a higher DMFT score in frequent consumers, particularly during the vulnerable adolescent years when enamel maturation is still incomplete.

Importantly, energy drink consumption in adolescents rarely occurs in isolation from other risk behaviors. In a large representative study of 15-year-old adolescents, current smokers were found to consume energy drinks at roughly twice the rate of non-smokers, and also presented with significantly more active caries lesions and poorer periodontal health, suggesting that these behaviors cluster together and may compound their individual effects on oral health (Petrauskienė et al., 2023). This convergence of behavioral and biological risk factors is precisely the rationale for the present study: by surveying energy drink consumption patterns, knowledge, and attitudes alongside a dental health indicator (DMFT) in the same adolescent sample, and examining these in relation to sex and area of residence, this report aims to lay the groundwork for a more integrated understanding of how a common adolescent lifestyle behavior may relate to oral health outcomes — a relationship that, to date, remains comparatively underexplored in the Romanian adolescent population. This study aims to assess the prevalence, knowledge, attitudes, and behavioral patterns associated with energy drink consumption among secondary and high school students, and to explore, on an exploratory basis, the relationship between regular energy drink consumption and dental health status (DMFT), stratified by sex and area of residence.

1. Materials and Methods

1.1 Study design

This is an observational, descriptive, cross-sectional study, based on a self-administered, anonymous questionnaire, designed to evaluate lifestyle behaviors — specifically smoking and energy drink consumption — among students enrolled in secondary and high school education. Data were collected at a single time point, without follow-up, which allows for the description of prevalence and associations but does not support causal inference.

1.2 Study population

The study sample consisted of 567 students, aged 13 to 19 years (mean age 15.4 years), enrolled in grades VII through XII, [city/county and school(s) to be specified by the author]. Data collection took place during [period to be specified by the author]. The sample included both sexes (57.8% male, 42.2% female) and both urban (87.8%) and rural (12.2%) areas of residence, distributed across six grade levels (VII–XII).

Sampling was non-probabilistic (convenience-based), determined by the availability and willingness of classes/schools to participate; as such, the sample is not necessarily representative of the general adolescent population, and results should be interpreted with this limitation in mind.

1.3 Inclusion and exclusion criteria

- Inclusion criteria: students enrolled in grades VII–XII at the participating school(s); age between 13 and 19 years; voluntary agreement to participate, with informed consent/assent obtained from students and, where applicable, parents or legal guardians, in accordance with the institution's ethical requirements for research involving minors.
- Exclusion criteria: refusal to participate; incompletely or inconsistently filled-in questionnaires; students outside the target age or grade range; questionnaires with missing key identifying variables (age, sex, grade).

Where individual questionnaire items were left unanswered despite overall inclusion of the respondent, the corresponding non-responses were treated as missing data for that item alone (see Section 1.5) rather than as grounds for excluding the respondent from the study.

Data collection instrument

Data were collected using a structured, self-administered paper questionnaire (“Questionnaire on Lifestyle”), organized into three sections:

- A demographic section, recording age, sex, area of residence (urban/rural), number of family members, and grade.
- A smoking-related section, covering smoking status, type of product used (conventional vs. electronic cigarettes), frequency and age of onset, access to cigarettes, smoking locations, parental smoking, motivations for starting and for quitting, perceived health risks, and prior quit attempts.
- An energy drink section, covering regular consumption status, knowledge of ingredients and perceived effects, frequency and quantity consumed, product preferences, motivations and contexts of use, perceived taste, reported side effects, and attitudes toward health risks, regulation, suitability for children, and performance impact.

All regular energy drink consumers underwent a clinical oral examination, during which the DMFT (Decayed, Missing, Filled Teeth) index was recorded according to the World Health Organization (WHO) recommendations for epidemiological surveys.

Statistical analysis

Data were analyzed using SPSS26.0(IBM, USA). Categorical variables are described as absolute and relative frequencies (N, %); continuous variables are described as mean ± standard deviation, and where relevant, minimum-maximum range. Group comparisons for categorical outcomes (e.g., regular consumption by sex, area, age group) were assessed by cross-tabulation with column percentages. For the DMFT sub-analysis, group means were compared between sexes and between areas of residence using the independent-samples t-test (Welch's correction for unequal variances), and associations between DMFT and other numeric/ordinal variables were quantified using Pearson's correlation coefficient. A two-sided p-value below 0.05 was considered statistically significant.

Results

The questionnaire was applied to 567 students, aged 13 to 19 (mean 15.4 years), from grades VII–XII. The sample's structure on the main demographic variables is shown below.

Variable	Category	N	%
Sex	Male	328	57.8%
	Female	239	42.2%
Area of residence	Urban	498	87.8%
	Rural	69	12.2%
Grade	VII–VIII	238	42.0%
	IX–X	257	45.3%

Variable	Category	N	%
	XI–XII	72	12.7%

Frequency of regular consumption

Only 13.4% of students (76 of 567) report drinking energy drinks regularly. Prevalence decreases steadily with age and grade — from 16.9% at age 13–14 to 9.6% at age 17–19 — suggesting that interest in these products is higher in early adolescence. The difference between sexes is negligible (13.7% boys vs. 13.0% girls), while students from rural areas report slightly more frequent consumption (15.9% vs. 13.1% in urban areas).

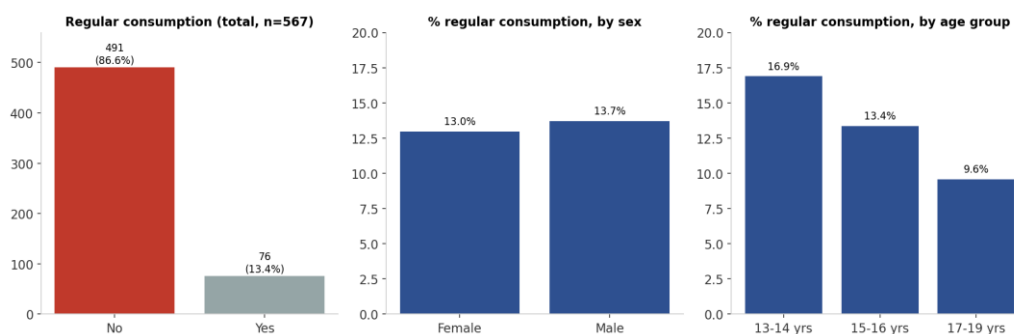


Fig. 1 — Prevalence of regular consumption, for the total sample, by sex and by age group

What students know about these products

The level of knowledge about the composition of energy drinks is low: 84.5% of respondents (479 of 567) answered “don’t know” when asked what substances these drinks contain. Among those who did name a substance, taurine (28) and caffeine (23) were mentioned most often, followed by sugar (16).

Regarding perceived effects, the most commonly associated effect is staying awake (“keeps me awake” — 40.2%), but a significant share (30%) doesn’t know what effects these drinks have, and 18.5% picked an option outside the standard list (“other”). Only a small percentage link these drinks to effects such as increased physical endurance (1.8%) or concentration (1.4%).

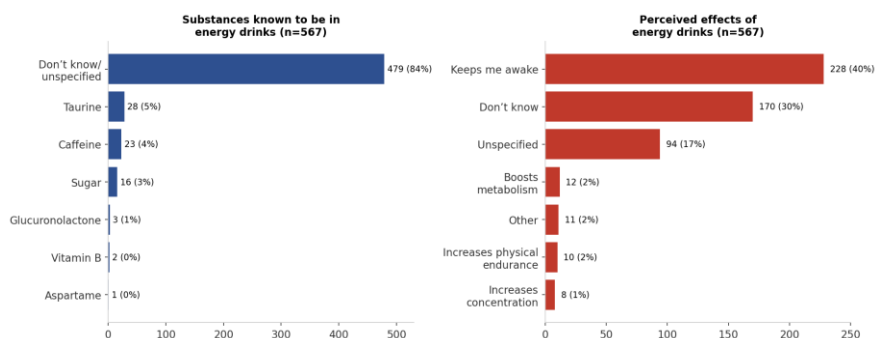


Fig. 2 — Substances known and perceived effects of energy drinks (full sample, n=567)

Attitudes and risk perception

Even though most students don’t consume regularly, a significant share holds a cautious attitude toward these products: 60.3% say they are worried about possible health risks, and 52.4% would support stricter regulation of caffeine content. Also, 81.7% consider energy drinks NOT suitable for children, and 53.8% don’t believe they have a positive impact on daily performance — although a quarter of the sample remains undecided (“don’t know”) on most of these questions, which confirms the low level of information observed above.

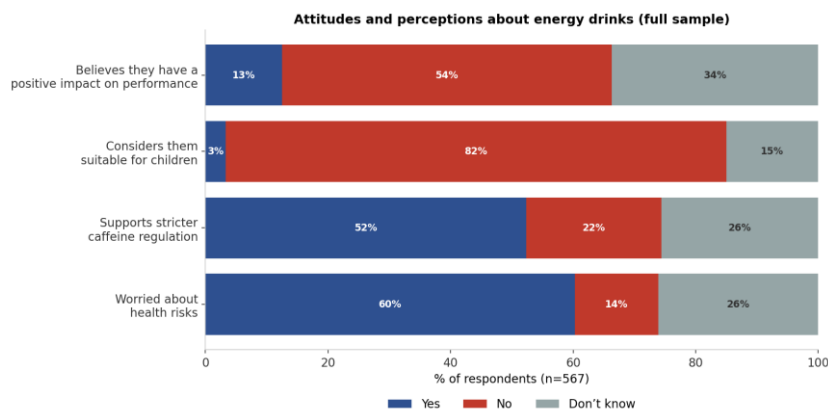


Fig. 3 — Attitudes regarding risks, regulation, and suitability for children (n=567)

Profile of regular consumers

Among the 76 students who consume energy drinks regularly, consumption patterns are heterogeneous. Of those who specified frequency, most drink them 1-2 times a week, and regarding quantity, most valid responses indicate 1-5 units per week. Note: many questions about consumption details (exact frequency, quantity, mixing with other drinks) were left unanswered by some consumers, so the percentages below are based on the number of valid responses, not the total of 76.

A point of concern: among those who answered the question about side effects, most (18 of 19 valid responses) confirm having experienced at least one adverse effect, the most frequently mentioned being headache, followed by insomnia and tremors. Likewise, nearly all who answered about mixing with other drinks (16 of 17) admit to mixing them with other products.

Despite their own consumption, consumers' attitude toward recommending these products to others is predominantly negative: 59% of consumers say they would not recommend at all that a friend start consuming energy drinks, and only 8% would do so with conviction.

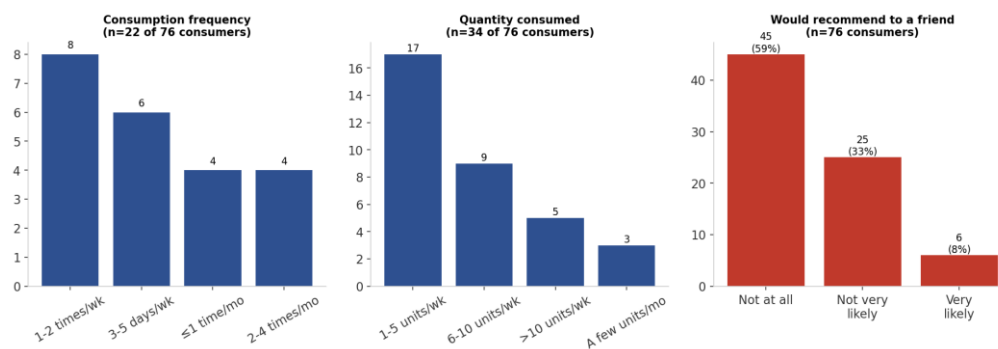


Fig. 4 — Frequency and quantity of consumption, and willingness to recommend the product (n=76 consumers)

Motivation for consumption

Among consumers who specified a reason, most say they choose these drinks for both taste and caffeine content alike, and the main activity for which they use them is sport, followed by simple enjoyment and studying.

The product most frequently mentioned explicitly is Red Bull, followed by Monster; however, most valid responses fell under "another brand," indicating a fragmented market with no clearly dominant brand in this sample.

DMFT in relation to sex and area of residence

Among the 76 regular consumers, the mean DMFT score is 2.16 (SD 1.53; range 0-7). Comparing by sex, the mean value is 2.27 for boys versus 2.00 for girls — a statistically non-significant difference (t-test, p=0.46). By area of residence, the mean is 2.25 in urban areas versus 1.64 in rural areas (p=0.18, also non-significant).

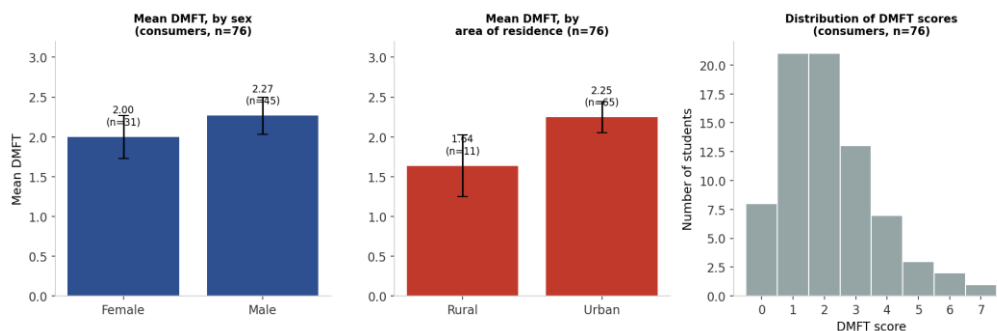


Fig. 6 — Mean DMFT by sex and area of residence, and distribution of scores (consumers, n=76)

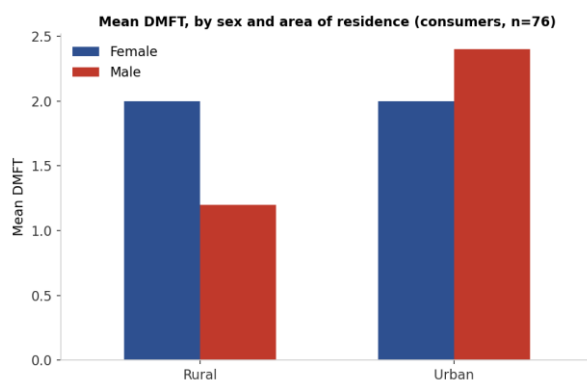


Fig. 7 — Mean DMFT, broken down jointly by sex and area of residence (n=76)

No relevant relationship was observed between DMFT score and the other questionnaire responses: consumption frequency (b4), quantity consumed (b5, $r=0.08$), or reported side effects (b7) do not differentiate students by DMFT .

DMFT correlations with questionnaire variables

We computed the Pearson correlation coefficient between DMFT and all relevant numeric/ordinal variables available for the 76 consumers: age, number of family members, grade, sex, area of residence, as well as responses on consumption frequency and quantity, mixing with other drinks, side effects, willingness to recommend, perceived taste, concern about risks, and perceived impact on performance.

The largest correlation observed ($r=-0.20$, with the number of family members) does not reach statistical significance ($p=0.089$). The DMFT index was not significantly associated with socio-demographic characteristics or with behaviors and perceptions related to energy drink consumption. However, these findings should be interpreted with caution, as some variables were analyzed in very small subgroups (e.g., $n = 17-34$), reducing the statistical power and potentially limiting the ability to detect true associations.

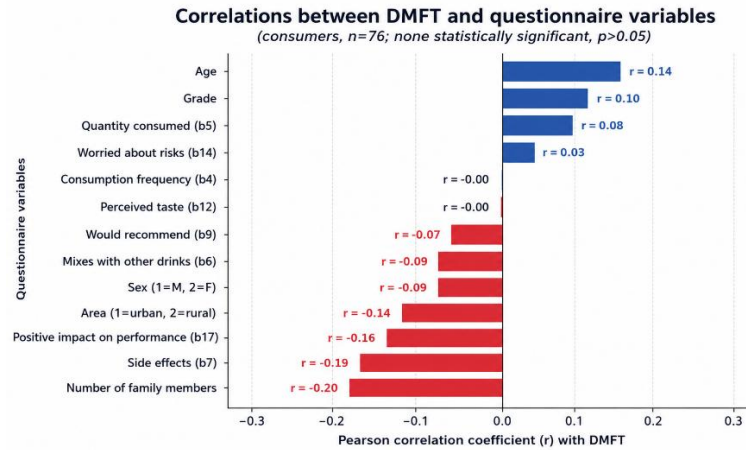


Fig. 8 — Pearson correlations between DMFT and questionnaire variables (n=76 consumers)

Table 2. DMFT correlations with questionnaire variables (consumers, n=76)

Variable	N	r (Pearson)	p
Number of family members	76	-0.196	0.089
Side effects (b7)	19	-0.187	0.443
Positive impact on performance (b17)	76	-0.157	0.176
Age	76	0.144	0.213
Area (1=urban, 2=rural)	76	-0.141	0.225
Grade	76	0.098	0.399
Sex (1=male, 2=female)	76	-0.086	0.460
Mixes with other drinks (b6)	17	-0.086	0.744
Quantity consumed (b5)	34	0.079	0.659
Would recommend to a friend (b9)	76	-0.070	0.549
Worried about risks (b14)	76	0.031	0.792
Perceived taste (b12)	76	-0.002	0.988
Consumption frequency (b4)	22	0.000	1.000

What influences the choice of an energy drink

For the entire surveyed population, among the explicitly stated factors, taste is the most important selection criterion, followed by price, caffeine content, and brand. Advertising and peer opinion play a minor stated role. It should be noted that most respondents (over 70%) did not indicate a factor from the standard list, which limits how representative this ranking is.

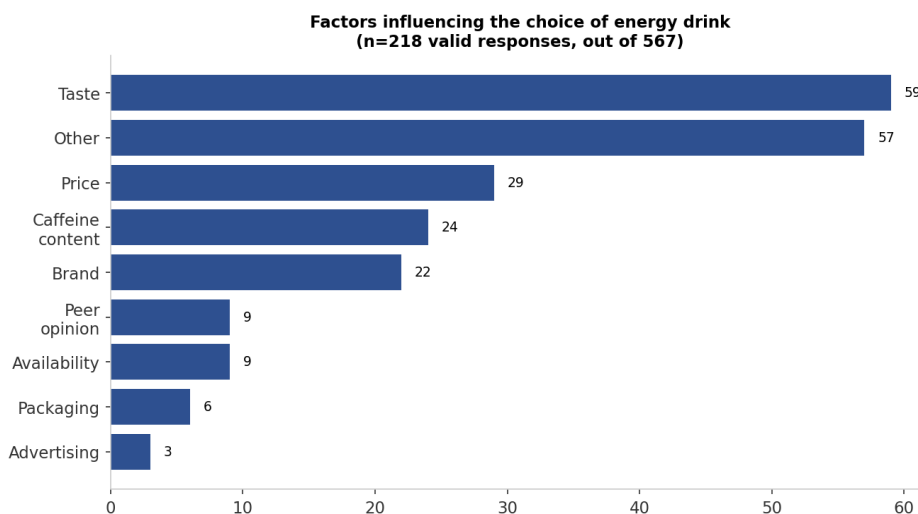


Fig. 5 — Factors influencing the choice of an energy drink (valid responses, n=218 of 567)

Discussion

The overall prevalence of regular energy drink consumption found in this sample (13.4%) is considerably lower than the 68% reported for European adolescents in the EFSA-commissioned survey (Zucconi et al., 2013) and below the 30–50% range typically cited for North American samples (Seifert et al., 2011), though it is broadly comparable to the 20.6% regular-consumption rate reported among Slovak adolescents using a similarly strict definition of “regular” use (Holubcikoveet al., 2017). This variability across studies likely reflects genuine differences in national consumption culture and product availability, differing operational definitions of “regular” consumption, and possible under-reporting of a behavior that a majority of respondents in this sample already view unfavorably.

The clear downward gradient with age (from 16.9% at 13–14 years to 9.6% at 17–19 years) is nonetheless consistent with prior evidence that energy drink experimentation often begins early in adolescence and is shaped more by curiosity and peer context than by sustained, purposeful use (Visram, Cheetham, Riby, Crossley, & Lake, 2016).

The low level of knowledge observed here — with the large majority of students unable to name a single ingredient and nearly a third unable to identify any effect — mirrors the central finding of Visram et al. (2016), who reported that awareness of the possible negative effects of energy drinks was consistently low among children and young people across the studies they reviewed. This pattern is compounded by the fact that, in the same review, taste and energy-seeking were identified as the main drivers of consumption, while branding and marketing exerted a stronger influence on choice than any functional or health-related consideration. Our findings reproduce this pattern closely: taste and price dominate the stated reasons for choosing a specific product, while caffeine content and brand come next, and health-related factors are essentially absent from the list of stated motivations. Taken together, these results suggest that consumption decisions in this age group are driven largely by sensory and commercial factors rather than by an informed weighing of risks and benefits.

Among regular consumers, the high rate of self-reported side effects (headache, insomnia, tremors) and the near-universal habit of mixing energy drinks with other beverages are consistent with the broader adverse-effect profile described for this age group, where even moderate but frequent intake has been associated with sleep disruption, nervousness, and gastrointestinal symptoms (Seifert et al., 2011). At the same time, the finding that most consumers themselves would not recommend energy drinks to a friend is a notable and somewhat counterintuitive result: it suggests a form of cognitive dissonance in which personal use continues despite an internalized recognition of risk, rather than a genuine belief in the products' benefits. This pattern echoes the broader risk-perception findings from the full sample, where a majority expressed concern about health risks and considered energy drinks unsuitable for children, yet a meaningful minority continues to consume them regularly — underlining that awareness alone, without accompanying behavior change support, may be insufficient to alter consumption patterns in this age group.

The DMFT index was not significantly associated with socio-demographic characteristics or with behaviors and perceptions related to energy drink consumption. In vitro studies have demonstrated that energy drinks produce measurably greater enamel dissolution than most other beverage categories, owing to their low pH and buffering capacity (Jain et al., 2012), while the high free-sugar content typical of these products is independently associated with a dose-dependent increase in dental caries risk (Moynihan & Kelly, 2014).

A near-significant negative correlation was observed between the DMFT index and the number of family members ($r = -0.20$, $p = 0.089$), suggesting a tendency toward lower caries experience among participants from larger families, although this association did not reach statistical significance. Similar findings have been reported in pediatric populations, where family size has been identified as a complex factor influencing oral health, with some studies describing lower caries prevalence despite less favorable oral hygiene practices in larger households (Park et al., 2023). Although no statistically significant associations were found between DMFT and the reported patterns of energy drink consumption in the present study, a tendency toward higher DMFT values among more frequent and higher-quantity consumers cannot be excluded. Further studies with larger sample sizes are warranted to clarify the relationship between energy drink consumption behaviors and dental caries experience.

Finally, the co-occurrence of risk behaviors documented in the broader literature is directly relevant to how this dataset should ultimately be interpreted. In a large sample of 15-year-old adolescents, current smokers consumed energy drinks at roughly twice the rate of non-smokers and also presented with significantly more active caries lesions and poorer periodontal status, suggesting that smoking and energy drink consumption cluster together and may have a compounded, rather than simply additive, impact on oral health (Petrauskienė et al., 2023).

Several limitations should be considered when interpreting the findings of the present study. First, participating classes and schools were selected based on convenience and willingness to participate rather than through a random or stratified sampling procedure. Consequently, the study sample may not be fully representative of the general adolescent population, and the prevalence estimates and observed associations should therefore be generalized with caution. In addition, information regarding energy drink consumption, smoking, and related behaviors was collected through anonymous self-reported questionnaires, making the data susceptible to recall bias and social desirability bias, particularly for behaviors that adolescents may perceive as undesirable or socially discouraged.

Although the overall sample included 567 adolescents, only 76 participants reported regular energy drink consumption. As a result, analyses restricted to consumers—particularly those examining consumption frequency, quantity, or reported side effects—had limited statistical power, and findings derived from the smallest subgroups should be interpreted with caution. In addition, several questionnaire items included broad response categories such as "other" or "unspecified," limiting the level of detail that could be obtained for certain variables. Finally, because the study was conducted within a specific geographical region and school population, the findings may not be directly generalizable to adolescents from other regions or educational settings, particularly given the rapidly evolving patterns of energy drink marketing, availability, and consumption.

Conclusion

This study found a relatively low overall prevalence of regular energy drink consumption (13.4%), with the highest exposure among the youngest adolescents (13–14 years), consistent with early experimentation rather than sustained use. Knowledge about the composition and effects of these products was strikingly limited, even though general attitudes were fairly cautious — most students viewed energy drinks as risky and unsuitable for children. Among regular consumers, side effects and mixing with other beverages were common, yet most would not recommend the products to others, suggesting consumption persists despite an internalized sense of risk rather than genuine conviction in their benefits. Product choice was driven mainly by taste and price rather than health-related considerations. The DMFT analysis revealed no significant association with sex or area of residence among regular energy drink consumers. Likewise, no significant correlations were identified between DMFT and the investigated consumption behaviors or perceptions, although larger studies are needed to further clarify these relationships.

References

1. Holubciková, J., Kolarcik, P., Madarasova Geckova, A., Reijneveld, S. A., & van Dijk, J. P. (2017). Regular energy drink consumption is associated with the risk of health and behavioural problems in adolescents. *European Journal of Pediatrics*, 176(5), 599–605.
2. Jain, P., Hall-May, E., Golabek, K., & Agustin, M. Z. (2012). A comparison of sports and energy drinks — physiochemical properties and enamel dissolution. *General Dentistry*, 60(3), 190–197.
3. Moynihan, P. J., & Kelly, S. A. (2014). Effect on caries of restricting sugars intake: Systematic review to inform WHO guidelines. *Journal of Dental Research*, 93(1), 8–18.

4. Park, A. H., Kulchar, R. J., Susarla, S. M., Turton, B., & Sokal-Gutierrez, K. (2023). Fewer children in families associated with lower odds of early childhood caries: A sample from three countries. *International Journal of Environmental Research and Public Health*, 20(3), 2195.
5. Petrauskienė, S., Žemaitienė, M., Bendoraitienė, E. A., Saldūnaitė-Mikučionienė, K., Vasiliauskienė, I., Zūbienė, J., Andruškevičienė, V., & Slabšinskienė, E. (2023). A cross-sectional study of oral health status and behavioral risk indicators among non-smoking and currently smoking Lithuanian adolescents. *International Journal of Environmental Research and Public Health*, 20(16), 6609.
6. Seifert, S. M., Schaechter, J. L., Hershorin, E. R., & Lipshultz, S. E. (2011). Health effects of energy drinks on children, adolescents, and young adults. *Pediatrics*, 127(3), 511–528.
7. Visram, S., Cheetham, M., Riby, D. M., Crossley, S. J., & Lake, A. A. (2016). Consumption of energy drinks by children and young people: A rapid review examining evidence of physical effects and consumer attitudes. *BMJ Open*, 6(10), e010380.
8. World Health Organization. (2022). *Global oral health status report: Towards universal health coverage for oral health by 2030*. Geneva: WHO.
9. Zucconi, S., Volpato, C., Adinolfi, F., Gandini, E., Gentile, E., Loi, A., & Fioriti, L. (2013). Gathering consumption data on specific consumer groups of energy drinks. *EFSA Supporting Publications*, 10(3), EN-394.