



## Energy drink consumption among university students: Cross-cultural and gender differences between Croatia and India

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### KEYWORDS

energy drinks; students; gender differences; India; Croatia

### KEY CONTRIBUTION

First cross-national study comparing EDs use among Croatian and Indian university students (N = 690). Croatian students started to consume EDs earlier, consumed more often, and reported more side effects despite higher health risk awareness. Indian students showed stronger gender differences in activity, awareness, and motivations. 74% of Croatian students mixed EDs with alcohol, posing serious health risks. Results call for targeted education, stricter labelling, and harm-reduction policies.

### ABSTRACT

Energy drinks (EDs) have gained widespread popularity among young adults, yet their consumption carries potentially harmful health risks, including cardiovascular and neurological risks. This comparative study examines energy drink (EDs) consumption among 690 university students from Croatia (n=370) and India (n=323), focusing on cross-cultural and gender differences. Croatian students consumed EDs more frequently (95.1% of males vs. 87.1% in India) and started earlier (58.8% of Croatian males before age 15 vs. 23.9% Indian males). Mixing EDs with alcohol was far more common in Croatia (74% vs. 13%). Indian students showed stronger gender gaps: 87.1% of males vs. 67.9% of females had tried EDs, and males were significantly more informed (44% vs. 21%). Croatian females were more cautious, with 88.8% supporting a ban for minors, compared to 65.7% of Croatian males. Despite higher awareness, Croatian students reported more frequent side effects (e.g. rapid heartbeat in 32.8% of females). The findings emphasize the need for culturally and gender-sensitive health education and regulatory policies.



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## **Introduction**

In recent years, the consumption of energy drinks (EDs) has significantly increased among university students worldwide, becoming a common strategy to cope with academic stress, sleep deprivation, and demanding lifestyles (Pulla et al., 2024). EDs are marketed to enhance alertness, concentration, and physical performance, and are particularly popular during exam periods and prolonged study sessions. These beverages typically contain caffeine, sugar, taurine, and B-complex vitamins, which provide temporary stimulation, but may pose serious health risks when consumed excessively (Mihaiescu et al., 2024). Caffeine, the main active ingredient, is often ingested in amounts exceeding recommended daily intake, especially during high-stress periods, with students frequently reporting daily consumption above 150 mg, sometimes surpassing 300 mg (Pulla et al., 2024).

Overconsumption has been linked to insomnia, anxiety, tachycardia, and dependency. Sugar, while offering immediate energy, contributes to long-term health risks such as obesity, type 2 diabetes, and poor dental health. "Sugar-free" alternatives often contain artificial sweeteners like aspartame, which are under ongoing scientific scrutiny for their potential neurotoxic effects (Mihaiescu et al., 2024). University students represent a vulnerable and heavily targeted demographic in ED marketing. Studies in Jordan, Turkey, and Egypt have reported high consumption rates among students, often in the absence of adequate knowledge about associated health risks (Elsahoury et al., 2021; Borlu et al., 2019; Hafez et al., 2023). Social contexts such as parties or nightlife further contribute to risk, especially when EDs are mixed with alcohol, a combination that can mask intoxication and increase cardiovascular complications (Azarm et al., 2024; Reid and Gentius, 2018).

Richards and Smith (2016) and Van Batenburg-Eddes et al. (2014) both reported that frequent ED consumption is associated with increased mental health issues and impaired cognitive functioning, potentially affecting academic performance.

Despite the growing body of literature, most studies focus on single-country contexts. Several studies from Croatia and India have reported a high prevalence of EDs use among university students (Badaam and Masroor, 2013; Hossain et al., 2025; Jaisoorya et al., 2016; Kucurski et al., 2024; Laslo et al., 2022; Miškulin et al., 2018; Pavlović et al., 2023). However, labeling practices remain inconsistent and students are often unaware of recommended intake limits, highlighting the need for targeted education and clearer regulation (Ajibo et al., 2024; Pavlović et al., 2019). This study aims to fill the existing gap by comparing ED consumption behaviours among university students in Croatia and India, focusing on geographical, cultural, and gender-related differences.

## **Materials and methods**

The study was conducted during April and May of 2025 using an online questionnaire administered via Microsoft Forms (Microsoft Corporation, USA). The survey targeted students of Josip Juraj Strossmayer University of Osijek, Croatia and students of Cochin University of Science and Technology, India. Respondents were reached through social media and they were additionally motivated by the authors in a way that they were approached in student cafeterias and given access to the survey via a QR code. Participation in the study was anonymous and voluntary. All participants were fully informed about the voluntary nature of their involvement and were advised of their right to withdraw from the study at any time without consequence.

The study fulfilled all ethical guidelines and received the approval of the Ethics Committee at the Faculty of Tourism and Rural Development in Požega, Josip Juraj Strossmayer University in Osijek and Cochin

University of Science and Technology, India (classification code: 602-06/25-01/14, number 2177-1-20-01/11-25-3).

A total of 323 students from a Cochin University of Science and Technology participated in the survey (168 female and 155 male students). The university has approximately 8,000 students, representing about 4% of the student population. Additionally, 370 students from a Josip Juraj Strossmayer University of Osijek took part in the survey (268 female and 102 male students). This university has around 16,000 students, making the sample approximately 2.3% of the student population. Using a standard statistical formula for finite population sampling, which accounts for the desired confidence level (95%), margin of error ( $\pm 5\%$ ), and maximum variability ( $p = 0.5$ ), the recommended sample sizes are around 367 for the Indian university and 375 for the Croatian university.

The actual samples closely match these targets, indicating sufficient statistical power for analysis. Although the Indian sample is slightly below the ideal threshold, it still allows for reliable interpretation, especially given the balanced representation across study years and disciplines. Overall, the sample sizes are robust enough to support valid comparisons and generalizations within the scope of this research.

The survey consisted of a total of 30 questions divided into several groups.

The first section addressed students' health behaviours, including physical activity and dietary awareness, and comprised 2 questions. The second group focused on students' perceptions of EDs and included 5 questions. The third section explored ED consumption patterns with 12 questions, while the final group consisted of 11 questions aimed at identifying patterns of energy drink use in combination with smoking and alcohol consumption. This structured approach allowed for a comprehensive assessment of students' behaviours and attitudes related to ED use and associated lifestyle factors. On average, participants required approximately eight minutes to complete the questionnaire.

#### *Data analysis*

Categorical data were summarized using absolute and relative frequencies. To assess differences in categorical variables between groups, the chi-square test was initially employed using R version 4.4.3 for Windows (R Foundation for Statistical Computing, Vienna, Austria). However, due to the presence of small expected frequencies (less than 5 or, in some cases, less than 1), the application of the chi-square test was inappropriate in some instances. Given the limitations of the chi-square test, Fisher's exact test with Monte Carlo simulation with 10000 permutations, was conducted in those cases, at a 95% confidence level using R version 4.4.3 for Windows (R Foundation for Statistical Computing, Vienna, Austria). For Monte Carlo simulation rows containing only zero values were excluded from the analysis prior to computation.

## Results and discussion

**Table 1** Differences in health behaviours and perceptions of energy drinks among students of Cochin University of Science and Technology, India and Josip Juraj Strossmayer University of Osijek, Croatia

| Characteristic/ Variable                                                                    | Response Category                                | India        |             | Croatia      |             | p-value<br>(gender,<br>India) | p-value<br>(gender,<br>Croatia) | p-value<br>(Country<br>Comparison) |
|---------------------------------------------------------------------------------------------|--------------------------------------------------|--------------|-------------|--------------|-------------|-------------------------------|---------------------------------|------------------------------------|
|                                                                                             |                                                  | F<br>(n,%)   | M<br>(n,%)  | F<br>(n,%)   | M<br>(n,%)  |                               |                                 |                                    |
| Do you engage in physical activity?                                                         | Every day                                        | 25,<br>14.9  | 57,<br>36.8 | 21,<br>7.8   | 15,<br>14.7 | <0.001                        | 0.044                           | <0.001                             |
|                                                                                             | Several times a week                             | 45,<br>26.8  | 31,<br>20.0 | 112,<br>41.8 | 55,<br>53.9 |                               |                                 |                                    |
|                                                                                             | Once a week                                      | 25,<br>14.9  | 19,<br>12.3 | 39,<br>14.6  | 10,<br>9.8  |                               |                                 |                                    |
|                                                                                             | Several times a month                            | 11,<br>6.6   | 13,<br>8.4  | 37,<br>13.8  | 11,<br>10.8 |                               |                                 |                                    |
|                                                                                             | Once a month                                     | 4,<br>2.4    | 4,<br>2.6   | 0,<br>0.0    | 0,<br>0.0   |                               |                                 |                                    |
|                                                                                             | Rarely                                           | 50,<br>29.8  | 24,<br>15.5 | 48,<br>17.9  | 11,<br>10.8 |                               |                                 |                                    |
|                                                                                             | Never                                            | 8,<br>4.8    | 7,<br>4.5   | 0,<br>0.0    | 0,<br>0.0   |                               |                                 |                                    |
| Do you watch carefully your dietary habits?                                                 | Yes                                              | 58,<br>34.5  | 79,<br>51.0 | 130,<br>48.5 | 56,<br>54.9 | 0.003                         | 0.272                           | 0.040                              |
|                                                                                             | No                                               | 110,<br>65.5 | 76,<br>49.0 | 138,<br>51.5 | 46,<br>45.1 |                               |                                 |                                    |
| Are you familiar with the ingredients of energy drinks?                                     | Yes                                              | 36,<br>21.4  | 68,<br>43.9 | 175,<br>65.3 | 74,<br>72.6 | <0.001                        | 0.184                           | <0.001                             |
|                                                                                             | No                                               | 104,<br>61.9 | 74,<br>47.7 | 93,<br>34.7  | 28,<br>27.5 |                               |                                 |                                    |
| What is your opinion on the potential harm of energy drinks to the body?                    | Yes, if consumed daily                           | 52,<br>31.0  | 60,<br>38.7 | 114,<br>42.5 | 38,<br>37.3 | 0.063                         | 0.621                           | <0.001                             |
|                                                                                             | Yes, if consumed on an empty stomach             | 13,<br>7.7   | 16,<br>10.3 | 4,<br>1.5    | 2,<br>2.0   |                               |                                 |                                    |
|                                                                                             | Yes, if consumed with alcohol                    | 4,<br>2.4    | 2,<br>1.3   | 21,<br>7.8   | 7,<br>6.9   |                               |                                 |                                    |
|                                                                                             | Yes, if consumed in large amounts                | 26,<br>15.5  | 26,<br>16.8 | 85,<br>31.7  | 37,<br>36.3 |                               |                                 |                                    |
|                                                                                             | Not harmful because it's legally sold            | 7,<br>4.2    | 13,<br>8.4  | 0,<br>0.0    | 0,<br>0.0   |                               |                                 |                                    |
|                                                                                             | Yes, if consumed by children                     | 8,<br>4.8    | 8,<br>5.2   | 3,<br>1.1    | 3,<br>2.9   |                               |                                 |                                    |
|                                                                                             | Yes, if consumed by people with heart conditions | 2,<br>1.2    | 5,<br>3.2   | 5,<br>1.9    | 4,<br>3.9   |                               |                                 |                                    |
|                                                                                             | Other (all above)                                | 25,<br>14.9  | 8,<br>5.2   | 22,<br>8.2   | 10,<br>9.8  |                               |                                 |                                    |
| Do you think energy drinks can cause addiction?                                             | Yes                                              | 92,<br>54.8  | 86,<br>55.5 | 219,<br>81.7 | 78,<br>76.5 | 0.238                         | 0.009                           | <0.001                             |
|                                                                                             | No                                               | 17,<br>10.1  | 24,<br>15.5 | 13,<br>4.9   | 14,<br>13.7 |                               |                                 |                                    |
|                                                                                             | Not sure                                         | 0,<br>0.0    | 0,<br>0.0   | 35,<br>13.1  | 9,<br>8.8   |                               |                                 |                                    |
| What are your main sources of information about energy drinks?                              | Media (TV, newspapers, internet)                 | 102,<br>60.7 | 96,<br>61.9 | 166,<br>61.9 | 75,<br>73.5 | 0.267                         | 0.401                           | <0.001                             |
|                                                                                             | Friends and family                               | 48,<br>28.6  | 49,<br>31.6 | 87,<br>32.5  | 42,<br>41.2 |                               |                                 |                                    |
|                                                                                             | Healthcare professionals                         | 16,<br>9.5   | 5,<br>3.2   | 49,<br>18.3  | 16,<br>15.7 |                               |                                 |                                    |
|                                                                                             | Educational institutions                         | 7,<br>4.2    | 7,<br>4.5   | 48,<br>17.9  | 13,<br>12.8 |                               |                                 |                                    |
|                                                                                             | Other                                            | 13,<br>11.3  | 18,<br>11.6 | 1,<br>0.4    | 0,<br>0.0   |                               |                                 |                                    |
| Do you support a legal ban on energy drink consumption for minors in the Republic of India? | Yes                                              | 101,<br>60.1 | 93,<br>60.0 | 238,<br>88.8 | 67,<br>65.7 | 0.562                         | <0.001                          | 0.002                              |
|                                                                                             | No                                               | 42,<br>25.0  | 33,<br>21.3 | 30,<br>11.2  | 35,<br>34.3 |                               |                                 |                                    |

F-female, M-male, p<0.05 indicates statistically significant difference

*Health behaviour among students (Table 1)*

The findings indicate statistically significant gender differences in physical activity levels among students, particularly within the Indian sample, where males reported considerably higher engagement in daily physical activity compared to females ( $p < 0.001$ ). A similar trend was observed among Croatian students, though the gender gap was less pronounced ( $p = 0.044$ ). Cross-country comparisons also revealed significant differences ( $p < 0.001$ ), with Croatian students more likely to report moderate physical activity (several times a week), while Indian students, particularly males, reported more frequent daily activity. Dietary awareness followed a similar pattern of variation. In the Indian sample, males demonstrated significantly greater attention to dietary habits than females ( $p = 0.003$ ), while in Croatia, no significant gender difference was observed. However, overall awareness was higher among Croatian students when compared to their Indian peers ( $p = 0.040$ ).

*Awareness and perception of energy drink ingredients (Table 1)*

Significant gender differences in knowledge about energy drink (ED) ingredients were found among Indian students, with males reporting higher awareness than females ( $p < 0.001$ ). This aligns only partially with previous studies conducted in India, where overall awareness levels were somewhat higher (Sangle and Alex, 2022; Hossain et al., 2025). In contrast, Croatian students demonstrated higher overall familiarity with ED ingredients, with no significant gender disparity ( $p = 0.184$ ). The cross-country comparison revealed a statistically significant difference ( $p < 0.001$ ), suggesting regional variation in exposure to health-related information, possibly influenced by differences in regulation, marketing practices, or public health education. These findings align with students' reported main sources of information about EDs. While no statistically significant gender differences were observed at either university, a highly significant difference emerged between the two institutions ( $p < 0.001$ ). In both India and Croatia, the majority of students identified media (TV, newspapers, internet) as their primary information source, followed by friends and family. However, Croatian students more frequently cited healthcare professionals and educational institutions as sources, contrasting with the Indian sample where these sources were less prominent. Gupta et al. (2019) emphasized the need for clear guidelines on ED consumption in India, recommending that caffeinated drinks should be avoided by children and adolescents, and advocating for widespread dissemination of these guidelines through school-based programs. However, the present study suggests that such strategies have not yet effectively translated into improved awareness or behavior among Indian students.

Significant differences between the two universities were observed in students' perceptions of the potential harm of EDs ( $p < 0.001$ ). Most students at both institutions acknowledged that daily or excessive consumption can be harmful. However, a small but notable proportion of Indian students considered EDs not harmful due to their legal status, a perception not found among Croatian students. These differences likely reflect varying levels of awareness and the impact of regional public health messages and regulations. A significantly higher proportion of Croatian students believed that EDs can cause addiction compared to Indian students ( $p < 0.001$ ). Within Croatia, gender differences were also statistically significant ( $p = 0.009$ ), with more females endorsing this view than males. In contrast, no significant gender difference was found among Indian students. Gender differences were significant in Croatia regarding support for a legal ban on ED consumption among minors, with 88% of female and 65% of male students in favour ( $p < 0.001$ ). In India, no significant gender differences were found, and around 60% of respondents supported the ban. These results suggest that Croatian students, especially females, may be better informed through public health and educational efforts and are more aware of the potential risks associated with ED consumption.

**Table 2** Differences in energy drink consumption and attitudes among students of Cochin University of Science and Technology, India and Josip Juraj Strossmayer University of Osijek, Croatia

| Characteristic/ Variable                                                         | Response Category        | India        |              | Croatia      |             | p-value<br>(gender<br>India) | p-value<br>(gender<br>Croatia) | p-value<br>(Country<br>Comparison) |
|----------------------------------------------------------------------------------|--------------------------|--------------|--------------|--------------|-------------|------------------------------|--------------------------------|------------------------------------|
|                                                                                  |                          | F<br>(n,%)   | M<br>(n,%)   | F<br>(n,%)   | M<br>(n,%)  |                              |                                |                                    |
| Have you ever consumed an energy drink?                                          | Yes                      | 114,<br>67.9 | 135,<br>87.1 | 240,<br>89.6 | 97,<br>95.1 | <0.001                       | 0.094                          | <0.001                             |
|                                                                                  | No                       | 54,<br>32.1  | 20,<br>12.9  | 28,<br>10.5  | 5,<br>4.9   |                              |                                |                                    |
| If you have consumed an energy drink, how old were you when you first tried one? | Under 10 years old       | 15,<br>8.9   | 5,<br>3.2    | 5,<br>1.9    | 12,<br>11.8 | 0.042                        | <0.001                         | <0.001                             |
|                                                                                  | 10-15 years              | 16,<br>9.5   | 32,<br>20.7  | 104,<br>38.8 | 60,<br>58.8 |                              |                                |                                    |
|                                                                                  | 15-20 years              | 52,<br>31.0  | 60,<br>38.7  | 125,<br>46.6 | 22,<br>21.6 |                              |                                |                                    |
|                                                                                  | 20-25 years              | 21,<br>12.5  | 26,<br>16.8  | 8,<br>3.0    | 3,<br>2.9   |                              |                                |                                    |
|                                                                                  | after 25 years           | 10,<br>6.0   | 12,<br>7.7   | 1,<br>0.4    | 0,<br>0.0   |                              |                                |                                    |
|                                                                                  |                          |              |              |              |             |                              |                                |                                    |
| If you have consumed or still consume energy drinks, what are your reasons?      | Refreshment              | 53,<br>31.6  | 67,<br>43.2  | 86,<br>32.1  | 44,<br>43.1 | <0.001                       | <0.001                         | <0.001                             |
|                                                                                  | Sports                   | 13,<br>7.7   | 32,<br>20.7  | 5,<br>1.9    | 23,<br>22.6 |                              |                                |                                    |
|                                                                                  | To prevent fatigue       | 10,<br>6.0   | 18,<br>11.6  | 109,<br>40.7 | 42,<br>41.2 |                              |                                |                                    |
|                                                                                  | Curiosity                | 31,<br>18.5  | 17,<br>11.0  | 70,<br>26.1  | 22,<br>21.6 |                              |                                |                                    |
|                                                                                  | For better concentration | 5,<br>3.0    | 13,<br>8.4   | 45,<br>16.8  | 22,<br>21.6 |                              |                                |                                    |
|                                                                                  | For extra energy         | 13,<br>7.7   | 31,<br>20.0  | 103,<br>38.4 | 36,<br>35.3 |                              |                                |                                    |
|                                                                                  | Other                    | 23,<br>13.7  | 9,<br>5.8    | 0,<br>0.0    | 1,<br>1.0   |                              |                                |                                    |
|                                                                                  |                          |              |              |              |             |                              |                                |                                    |
| Rate the taste of energy drinks from 1 to 5                                      | 1 = Don't like it at all | 42,<br>25.0  | 23,<br>14.8  | 30,<br>11.2  | 7,<br>6.9   | 0.007                        | 0.030                          | <0.001                             |
|                                                                                  | 2                        | 20,<br>11.9  | 22,<br>14.2  | 27,<br>10.1  | 5,<br>4.9   |                              |                                |                                    |
|                                                                                  | 3                        | 34,<br>20.2  | 53,<br>34.2  | 6,<br>25.0   | 18,<br>17.7 |                              |                                |                                    |
|                                                                                  | 4                        | 24,<br>14.3  | 27,<br>17.4  | 76,<br>28.4  | 41,<br>40.2 |                              |                                |                                    |
|                                                                                  | 5 = Really like it       | 5,<br>3.0    | 15,<br>9.7   | 50,<br>18.7  | 27,<br>26.5 |                              |                                |                                    |
|                                                                                  |                          |              |              |              |             |                              |                                |                                    |
| How often do you consume energy drinks?                                          | Every day                | 2,<br>1.2    | 3,<br>1.9    | 5,<br>1.9    | 5,<br>4.9   | <0.001                       | 0.002                          | 0.014                              |
|                                                                                  | Every week               | 7,<br>4.2    | 32,<br>20.7  | 34,<br>12.7  | 25,<br>24.5 |                              |                                |                                    |
|                                                                                  | Once a month             | 21,<br>12.5  | 25,<br>16.1  | 48,<br>17.9  | 25,<br>24.5 |                              |                                |                                    |
|                                                                                  | A few times per year     | 53,<br>31.6  | 60,<br>38.7  | 102,<br>38.1 | 30,<br>29.4 |                              |                                |                                    |
|                                                                                  | never                    | 84,<br>50.0  | 35,<br>22.6  | 79,<br>29.5  | 17,<br>16.7 |                              |                                |                                    |

| Characteristic/ Variable                                                                     | Response Category   | India        |              | Croatia      |             | p-value<br>(gender<br>India) | p-value<br>(gender<br>Croatia) | p-value<br>(Country<br>Comparison) |
|----------------------------------------------------------------------------------------------|---------------------|--------------|--------------|--------------|-------------|------------------------------|--------------------------------|------------------------------------|
|                                                                                              |                     | F<br>(n,%)   | M<br>(n,%)   | F<br>(n,%)   | M<br>(n,%)  |                              |                                |                                    |
| When you consume an energy drink, what is the volume consumed in one day?                    | 250 ml              | 99,<br>58.9  | 119,<br>76.8 | 155,<br>57.8 | 47,<br>46.1 | 0.810                        | 0.002                          | <0.001                             |
|                                                                                              | 251 - 500 ml        | 6,<br>3.6    | 10,<br>6.5   | 38,<br>14.2  | 29,<br>28.4 |                              |                                |                                    |
|                                                                                              | 501 ml - 1 l        | 2,<br>1.2    | 2,<br>1.3    | 3,<br>1.1    | 4,<br>3.9   |                              |                                |                                    |
|                                                                                              |                     |              |              |              |             |                              |                                |                                    |
| What time of day do you usually consume energy drinks?                                       | Morning/Before noon | 8,<br>4.8    | 15,<br>9.7   | 13,<br>4.9   | 9,<br>8.8   | 0.561                        | 0.160                          | 0.056                              |
|                                                                                              | Midday/Afternoon    | 51,<br>30.4  | 62,<br>40.0  | 119,<br>44.4 | 57,<br>55.9 |                              |                                |                                    |
|                                                                                              | Evening/Night       | 43,<br>25.6  | 48,<br>31.0  | 72,<br>26.9  | 22,<br>21.6 |                              |                                |                                    |
|                                                                                              |                     |              |              |              |             |                              |                                |                                    |
| Have you experienced side effects when consuming energy drinks?                              | Yes                 | 23,<br>13.7  | 26,<br>16.8  | 81,<br>30.2  | 26,<br>25.5 | 0.909                        | 0.263                          | <0.001                             |
|                                                                                              | No                  | 100,<br>59.5 | 109,<br>70.3 | 157,<br>58.6 | 68,<br>66.7 |                              |                                |                                    |
| What side effects did you experience?                                                        | Depression          | 3,<br>1.8    | 4,<br>2.6    | 1,<br>0.4    | 2,<br>2.0   | 0.270                        | 0.003                          | <0.001                             |
|                                                                                              | Anxiety             | 9,<br>5.4    | 10,<br>6.5   | 30,<br>11.2  | 6,<br>5.9   |                              |                                |                                    |
|                                                                                              | Rapid heartbeat     | 6,<br>3.6    | 11,<br>7.1   | 88,<br>32.8  | 30,<br>29.4 |                              |                                |                                    |
|                                                                                              | Sweating            | 11,<br>6.6   | 15,<br>9.7   | 15,<br>5.6   | 10,<br>9.8  |                              |                                |                                    |
|                                                                                              | Headache            | 13,<br>7.7   | 8,<br>5.2    | 14,<br>5.2   | 0,<br>0.0   |                              |                                |                                    |
|                                                                                              | High blood pressure | 5,<br>3.0    | 15,<br>9.7   | 10,<br>3.7   | 11,<br>10.8 |                              |                                |                                    |
|                                                                                              | Dehydration         | 17,<br>10.1  | 13,<br>8.4   | 13,<br>4.9   | 5,<br>4.9   |                              |                                |                                    |
|                                                                                              | Other               | 31,<br>18.5  | 28,<br>18.1  | 1,<br>0.4    | 1,<br>1.0   |                              |                                |                                    |
|                                                                                              |                     |              |              |              |             |                              |                                |                                    |
|                                                                                              |                     |              |              |              |             |                              |                                |                                    |
| Do you think consuming energy drinks affects your academic performance?                      | Positively          | 13,<br>7.7   | 23,<br>14.8  | 19,<br>7.1   | 22,<br>21.6 | 0.005                        | 0.002                          | <0.001                             |
|                                                                                              | Negatively          | 14,<br>8.3   | 17,<br>11.0  | 6,<br>2.2    | 2,<br>2.0   |                              |                                |                                    |
|                                                                                              | No effect           | 34,<br>20.2  | 50,<br>32.3  | 167,<br>62.3 | 62,<br>60.8 |                              |                                |                                    |
|                                                                                              | Not sure            | 75,<br>44.6  | 46,<br>29.7  | 47,<br>17.5  | 11,<br>10.8 |                              |                                |                                    |
| What other methods do you use to increase energy or concentration?                           | Coffee or tea       | 74,<br>44.1  | 68,<br>43.9  | 178,<br>66.4 | 60,<br>58.8 | 0.203                        | 0.561                          | <0.001                             |
|                                                                                              | Dietary supplements | 19,<br>11.3  | 25,<br>16.1  | 26,<br>9.7   | 13,<br>12.8 |                              |                                |                                    |
|                                                                                              | Exercise            | 47,<br>28.0  | 63,<br>40.7  | 74,<br>27.6  | 33,<br>32.4 |                              |                                |                                    |
|                                                                                              | Short rest or sleep | 78,<br>46.4  | 64,<br>41.3  | 170,<br>63.4 | 68,<br>66.7 |                              |                                |                                    |
|                                                                                              | Other               | 13,<br>7.7   | 8,<br>5.2    | 0,<br>0.0    | 0,<br>0.0   |                              |                                |                                    |
|                                                                                              |                     |              |              |              |             |                              |                                |                                    |
| If you consume energy drinks while studying, how many do you drink throughout the day/night? | 1-2                 | 2,<br>1.2    | 8,<br>5.2    | 45,<br>16.8  | 19,<br>18.6 | 0.334                        | 0.867                          | <0.001                             |
|                                                                                              | 3-4                 | 1,<br>0.6    | 2,<br>1.3    | 8,<br>3.0    | 3,<br>2.9   |                              |                                |                                    |
|                                                                                              | 5 or more           | 1,<br>0.6    | 1,<br>0.7    | 1,<br>0.4    | 1,<br>1.0   |                              |                                |                                    |
|                                                                                              | I don't know        | 110,<br>65.5 | 123,<br>79.4 | 0,<br>0.0    | 0,<br>0.0   |                              |                                |                                    |

F-female, M-male, p&lt;0.05 indicates statistically significant difference

*Energy drink consumption patterns (Table 2)*

Consumption of EDs was significantly more prevalent among Indian male students (87.1%) compared to females (67.9%,  $p < 0.001$ ). These figures align with previous findings by Sangle and Alex (2022), who reported that 76% of Indian university students have consumed EDs, and Hossain et al. (2025), who found a 62% consumption rate among Indian medical students. In contrast, Croatian students reported very high consumption rates across both genders, exceeding 95%, with no significant gender difference ( $p = 0.094$ ).

Age at first ED consumption differed significantly between countries ( $p < 0.001$ ), as well as between genders in both India ( $p = 0.042$ ) and Croatia ( $p < 0.001$ ). Early initiation before the age of 15 emerged as a concerning trend, especially in Croatia, where a substantial proportion of male students reported trying EDs even before the age of 10. Although Indian students generally started consuming EDs slightly later, a notable share of both male and female respondents also reported use before age 15.

Despite Croatian students showing greater awareness of the health risks associated with EDs, their patterns of earlier and more widespread consumption raise significant public health concerns. Early exposure increases the potential for long-term health effects, highlighting the need for targeted preventive measures in both countries.

Motivations for ED consumption differed significantly between genders in both countries, in India ( $p < 0.001$ ), male students more often cited sports performance and the need for extra energy, while females more frequently mentioned refreshment and curiosity. Similar patterns were observed in Croatia ( $p < 0.001$ ), where males more commonly associated ED use with sports, while both genders frequently reported using them to combat fatigue.

These findings are supported by previous studies. Badaam and Masroor (2013) reported that approximately 30% of football players use energy drinks for recovery after training or competition. Similarly, Pavlović et al. (2023) found that Croatian students involved in sports consume EDs more frequently than those not engaged in athletic activities. The overall difference between the two university populations was statistically significant ( $p < 0.001$ ). Croatian students more frequently reported functional reasons for ED consumption, such as boosting energy and improving concentration, while these motivations were less commonly mentioned by Indian students.

Students rated the taste of energy drinks from 1 (dislike) to 5 (like). In Croatia, most females chose 4, while most males selected 5. More females strongly disliked the taste compared to males, with a significant gender difference. In India, females mostly rated taste as 1, and males preferred 3. Taste ratings also differed significantly between the two universities ( $p < 0.001$ ).

*Consumption frequency and volume (Table 2)*

Regular consumption was more common among Indian males, with 20.7% consuming energy drinks weekly compared to only 4.2% of females ( $p < 0.001$ ). Croatian males also reported higher weekly use (24.5%) than their female counterparts (12.7%,  $p = 0.002$ ). Bokan et al. (2012) reported that around 7% of both female and male students from Novi Sad, Serbia, a region very close to the Osijek, consumed EDs three to five times per week, while males tended to consume EDs every weekend with alcohol much more frequent than females (7.3 vs. 2.6 %). In terms of volume, males in both countries tended to consume larger quantities per day, with statistically significant differences observed between genders in Croatia ( $p = 0.002$ ) and between universities ( $p < 0.001$ ). Pavlović et al. (2023) also confirmed that male students more frequently consume EDs six or more times per month than female students.

Regarding timing, most students reported consuming energy drinks in the afternoon or evening, with no significant gender- or university-based differences.

A significantly higher proportion of Croatian students reported experiencing side effects from energy drink consumption compared to Indian students ( $p < 0.001$ ), with no significant gender differences within either group. This likely reflects the higher frequency of consumption among Croatian students. Indian students most commonly reported dehydration, sweating, and headaches, while Croatian students more frequently experienced heart palpitations, anxiety, and high blood pressure. These results are consistent with findings by Kucurski et al. (2024), who reported similar side effects in 32.3% of students. The physiological effects of caffeine, such as increased heart rate and blood pressure, explained by Bedi and Gupta (2018), further support these observations. Overall, the significant differences between the two universities ( $p < 0.001$ ) highlight important health concerns related to energy drink use.

Alternative methods to enhance concentration and energy, such as consuming coffee or tea, engaging in physical activity, and taking short rests, were widely reported at both universities. However, a greater proportion of Croatian students (around 60 %) than Indian students (around 40%) reported coffee or tea consumption and short rest as methods to increase energy, resulting in significant difference between universities ( $p < 0.001$ ).

More Croatian male students believed that energy drinks positively affect academic performance compared to females, while female students tend to be more uncertain about such effects. A similar gender pattern was observed among Indian students, although overall uncertainty regarding the impact of energy drinks is notably higher in this group. These differences contributed to a statistically significant variation between the two universities ( $p < 0.001$ ). Especially high caffeine intake among Croatian students during examination periods was also reported by Laslo et al. (2022) with a poor positive correlation between the amount of caffeine intake and academic success connected with caffeine consumption. Consistent positive effects of one commercial type of energy drink on cognitive functions (immediate memory, attention, and verbal fluency), improved performance in mental stress test and improved reaction time were confirmed by Cavka et al. (2015).

In response to the question regarding the number of energy drinks consumed per day while studying, a very large proportion of Indian students reported that they were unsure. In contrast, the most common response among Croatian students was 1–2 energy drinks per day. This is similar to finding of Pavlović et al. (2023) where 64.9% of respondents answered that they drink one can of EDs on a single occasion. No statistically significant gender-based differences were observed within either university; however, the difference between the two universities was statistically significant ( $p < 0.001$ ).

#### *Smoking, alcohol and energy drinks use (Table 3)*

Smoking prevalence differed significantly between the two universities. Indian male students reported higher smoking rates compared to Indian females ( $p = 0.005$ ), while in Croatia, smoking rates were substantially higher overall with no significant gender difference ( $p = 0.18$ ). The comparison between the two universities showed a highly significant difference ( $p < 0.001$ ), indicating much higher smoking prevalence among Croatian students regardless of gender. Those results are different to those reported by Bjelica et al. (2016) where there was substantial gender-difference in smoking (35% and 16% for Croatian male and female students).

Alcohol consumption was common in both student populations but was significantly more prevalent among Croatian students ( $p < 0.001$ ). In India, consumption rates showed no significant gender difference, with approximately 30% of females and 40% of males reporting alcohol use. Croatian students exhibited much higher rates, with over 97% of both genders having consumed alcohol.

**Table 3** Patterns and perceptions of smoking, alcohol and energy drink use among students of Cochin University of Science and Technology, India and Josip Juraj Strossmayer University of Osijek, Croatia

| Characteristic/ Variable                                                                                                                             | Response Category          | India        |              | Croatia      |             | p-value<br>(gender<br>India) | p-value<br>(gender<br>Croatia) | p-value<br>(Country<br>Comparison) |
|------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|--------------|--------------|--------------|-------------|------------------------------|--------------------------------|------------------------------------|
|                                                                                                                                                      |                            | F<br>(n,%)   | M<br>(n,%)   | F<br>(n,%)   | M<br>(n,%)  |                              |                                |                                    |
| Are you a smoker?                                                                                                                                    | Yes                        | 7,<br>4.2    | 20,<br>12.9  | 107,<br>39.9 | 33,<br>32.4 | <b>0.005</b>                 | 0.180                          | <b>&lt;0.001</b>                   |
|                                                                                                                                                      | No                         | 161,<br>95.8 | 135,<br>87.1 | 161,<br>60.1 | 69,<br>67.7 |                              |                                |                                    |
| Have you ever consumed alcohol?                                                                                                                      | Yes                        | 51,<br>30.4  | 62,<br>40.0  | 262,<br>97.8 | 99,<br>97.1 | 0.087                        | 0.711                          | <b>&lt;0.001</b>                   |
|                                                                                                                                                      | No                         | 96,<br>57.1  | 77,<br>49.7  | 6,<br>2.2    | 3,<br>2.9   |                              |                                |                                    |
| Did you try alcohol before the age of 18?                                                                                                            | Yes                        | 17,<br>10.1  | 23,<br>14.8  | 251,<br>93.7 | 96,<br>94.1 | 0.242                        | 0.929                          | <b>&lt;0.001</b>                   |
|                                                                                                                                                      | No                         | 127,<br>75.6 | 115,<br>74.2 | 15,<br>5.6   | 6,<br>5.9   |                              |                                |                                    |
| Have you consumed alcohol in combination with energy drinks?                                                                                         | Yes                        | 22,<br>13.1  | 19,<br>12.3  | 199,<br>74.3 | 79,<br>77.5 | 0.665                        | 0.677                          | <b>&lt;0.001</b>                   |
|                                                                                                                                                      | No                         | 120,<br>71.4 | 120,<br>77.4 | 65,<br>24.3  | 23,<br>22.6 |                              |                                |                                    |
| If you combine alcohol and energy drinks, when do you consume them?                                                                                  | Every weekend              | 1,<br>0.6    | 8,<br>5.2    | 5,<br>1.9    | 6,<br>5.9   | 0.583                        | 0.388                          | <b>&lt;0.001</b>                   |
|                                                                                                                                                      | On special occasions       | 12,<br>7.1   | 21,<br>13.6  | 10,<br>3.7   | 7,<br>6.9   |                              |                                |                                    |
|                                                                                                                                                      | On night outs with friends | 9,<br>5.4    | 14,<br>9.0   | 109,<br>40.7 | 48,<br>47.1 |                              |                                |                                    |
|                                                                                                                                                      | At parties                 | 10,<br>6.0   | 14,<br>9.0   | 68,<br>25.4  | 36,<br>35.3 |                              |                                |                                    |
|                                                                                                                                                      | Other                      | 21,<br>12.5  | 37,<br>23.9  | 2,<br>0.8    | 0,<br>0.0   |                              |                                |                                    |
| Have you had bad experiences consuming alcohol with energy drinks?                                                                                   | Yes                        | 18,<br>10.7  | 18,<br>11.6  | 41,<br>15.3  | 28,<br>27.5 | 0.707                        | <b>0.020</b>                   | 0.250                              |
|                                                                                                                                                      | No                         | 74,<br>44.1  | 85,<br>54.8  | 173,<br>64.6 | 61,<br>59.8 |                              |                                |                                    |
| Are you aware that mixing energy drinks with alcohol can be harmful to your health?                                                                  | Yes                        | 76,<br>45.2  | 72,<br>46.5  | 244,<br>91.0 | 95,<br>93.1 | 0.654                        | 0.516                          | <b>&lt;0.001</b>                   |
|                                                                                                                                                      | No                         | 45,<br>26.8  | 48,<br>31.0  | 24,<br>9.0   | 7,<br>6.9   |                              |                                |                                    |
| When drinking alcohol with energy drinks, do you notice you can consume more alcohol than if drinking alcohol alone?                                 | Yes                        | 5,<br>3.0    | 11,<br>7.1   | 75,<br>28.0  | 33,<br>32.4 | <b>0.021</b>                 | 0.938                          | <b>&lt;0.001</b>                   |
|                                                                                                                                                      | No                         | 17,<br>10.1  | 8,<br>5.2    | 45,<br>16.8  | 18,<br>17.7 |                              |                                |                                    |
|                                                                                                                                                      | Not sure                   | 0,<br>0.0    | 0,<br>0.0    | 85,<br>31.7  | 34,<br>33.3 |                              |                                |                                    |
| Do you drink energy drinks with alcohol in the same glass or separately?                                                                             | Together                   | 21,<br>12.5  | 18,<br>11.6  | 185,<br>69.0 | 70,<br>68.6 | 1.000                        | 0.730                          | 1.000                              |
|                                                                                                                                                      | Separately                 | 1,<br>0.6    | 1,<br>0.7    | 10,<br>3.7   | 3,<br>2.9   |                              |                                |                                    |
| Do you mix energy drinks with any other beverage that is not alcohol?                                                                                | Yes                        | 2,<br>1.2    | 0,<br>0.0    | 11,<br>4.1   | 4,<br>3.9   | 0.209                        | 0.944                          | <b>0.005</b>                       |
|                                                                                                                                                      | No                         | 112,<br>66.7 | 135,<br>87.1 | 208,<br>77.6 | 79,<br>77.5 |                              |                                |                                    |
| How many drinks containing a combination of alcohol (e.g., 30 mL vodka) and energy drink (e.g., 200 mL) do you usually consume during one night out? | 1-2                        | 1,<br>0.6    | 6,<br>3.9    | 27,<br>10.1  | 6,<br>5.9   | <b>0.021</b>                 | <b>0.002</b>                   | <b>&lt;0.001</b>                   |
|                                                                                                                                                      | 3-4                        | 0,<br>0.0    | 0,<br>0.0    | 24,<br>9.0   | 4,<br>3.9   |                              |                                |                                    |
|                                                                                                                                                      | 5 or more                  | 0,<br>0.0    | 1,<br>0.7    | 16,<br>6.0   | 17,<br>16.7 |                              |                                |                                    |
|                                                                                                                                                      | I don't know               | 21,<br>12.5  | 12,<br>7.7   | 5,<br>1.9    | 6,<br>5.9   |                              |                                |                                    |

F-female, M-male, p&lt;0.05 indicates statistically significant difference

Verenkar and Vaz (2018) reported slightly higher alcohol use among female medical students in Goa compared to males, highlighting cultural acceptance of alcohol within the Catholic community, which aligns with the predominantly Catholic Croatian sample in our study. Jaisoorya et al. (2016) noted Kerala's relatively liberal drinking norms and early initiation of alcohol use, yet consumption remains lower than that observed among Croatian students. Bjelica et al. (2016) explored cultural and religious influences on substance use among Catholic Croats and Muslim Bosniaks in Bosnia and Herzegovina, showing that despite expected religious boundaries, alcohol use varied: higher among Bosniak girls than Croatian girls, but the opposite trend was observed for boys.

No significant gender difference was observed in alcohol initiation among Indian students. However, Nadkarni et al. (2022) reported that alcohol initiation before age 12 was present only among males, with most starting after 18. Croatian students showed much earlier initiation, with over 93% having tried alcohol before age 18, without gender differences. The difference between universities was highly significant ( $p < 0.001$ ), indicating an earlier onset in Croatia. Numerous studies conducted in the Republic of Croatia have confirmed early alcohol consumption among adolescents, with only a small proportion experiencing difficulties when attempting to purchase alcohol in stores or bars before the legal age of 18. All these findings highlight the need for a clear national strategy focused not only on educating young people but also of service industry workers regarding alcohol consumption and its associated risks (Mišević et al., 2020; Šarić Posavec et al., 2023; Vrkić Boban and Saraga, 2025; Tripković et al., 2014).

Approximately 74% of Croatian students had combined alcohol with energy drinks, compared to only 11% of Indian students. On the other hand, Sangle and Alex (2022) revealed that only 1.9% of Indian students consumed such combination, and Kucurski et al. (2024) revealed that 18.5% of students in Bosnia and Herzegovina combined EDs and alcohol. Gender differences were not significant in either sample, but the inter-university difference was highly significant ( $p < 0.001$ ), showing that combining alcohol with EDs is far more common in Croatia. In India, the most frequent contexts were "special occasions", "parties" and "night outs" with generally low percentages overall. In Croatia, however, combining alcohol and EDs was common during night outs with friends and parties, again reflecting a more frequent and socially normalized practice. The university-level difference remained significant ( $p < 0.001$ ).

Indian students reported relatively low incidence of negative experiences (approximately 11% for both genders), while Croatian male students reported significantly more adverse effects than females (27.45% vs. 15.30%;  $p = 0.020$ ). Nonetheless, the inter-university difference ( $p = 0.250$ ) suggests that this contrast may not be uniformly strong across both samples.

Both Indian and Croatian students exhibited relatively high levels of awareness of potential harm of mixing EDs with alcohol, with over 90% of Croatian students acknowledging potential health risks. No significant gender-based differences were found, but the university-level difference was significant ( $p < 0.001$ ), pointing to greater health awareness in the Croatian cohort although Croatian students drink significantly larger amounts of EDs and alcohol.

Indian students showed a significant gender difference in perceiving that mixing alcohol with energy drinks allows greater alcohol consumption ( $p = 0.021$ ), while no such gender difference was observed in Croatia. A highly significant difference between the two universities ( $p < 0.001$ ) reflects a stronger perceived effect among Croatian students.

Both populations showed similar patterns of mixing EDs and alcohol, with the majority mixing both substances in the same glass, and very few students in either country reported mixing EDs with non-alcoholic beverages.

In India, consumption of combined energy drink and alcohol beverages was generally low, with only a small percentage of students reporting intake of 1 – 2 drinks ( $p = 0.021$ ), and almost no reports of higher quantities. In contrast, Croatian students, particularly males, reported significantly higher consumption levels, with a notable gender difference ( $p = 0.002$ ). The inter-university difference was also highly significant ( $p < 0.001$ ), reflecting considerably more frequent and higher-quantity drinking episodes in the Croatian sample. These findings highlight distinct consumption patterns between the two populations.

The approach of this study provides valuable insights into the influence of cultural, social, and regional factors on consumption patterns. Including both male and female students from different universities enhances the representativeness and generalizability of the findings within the studied populations. Additionally, the comprehensive data collection covering frequency, motivations, taste perception, side effects, smoking, alcohol use, and mixing of energy drinks with alcohol allows for a multidimensional understanding of consumption behaviours. However, reliance on self-reported data may introduce recall or social desirability bias, potentially leading to under- or overestimation of behaviours. Furthermore, the sample is limited to university students from specific regions, restricting the generalizability of results to broader populations or other demographic groups.

## Conclusion

The comparative analysis revealed complex interactions between cultural norms, gender roles, and health awareness in shaping energy drink consumption patterns among students in India and Croatia. While Croatian students demonstrated higher levels of knowledge about EDs, this awareness did not consistently translate into safer behaviour, indicating a potential gap between knowledge and practice. Indian students, on the other hand, exhibited more moderate consumption, but also showed notable gender disparities in physical activity, dietary awareness, and EDs-related perceptions. Future research should explore the psychological and social drivers behind energy drink consumption, particularly the influence of academic stress and digital marketing. It would also be valuable to replicate this study in other cultural contexts to develop a broader international perspective and to assess whether targeted health communication campaigns, especially those delivered via educational institutions, can shift both attitudes and behaviours. Collaborative projects between universities, public health agencies, and student organisations could serve as practical platforms for testing and implementing such initiatives.

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