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Impact of COVID-19 pandemic on overall and exams-related energy drinks consumption among students of the University of Sarajevo, Bosnia and Herzegovina

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Key words: University students, energy drinks, academic activities, COVID-19 pandemic
Parole chiave: Studenti universitari, bevande energetiche, attività accademiche, pandemia di COVID-19

Abstract

Background. *A pilot study conducted in academic 2017/18 among undergraduates of the University of Sarajevo showed energy drinks to be most frequently consumed during academic activity, less frequently mixed with alcohol in leisure, and rarely in the sports activity. The aim of this study was to assess the impact of the COVID-19 pandemic on energy drinks consumption among undergraduates of the same University, with a focus on their consumption during exams.*
Study design. *A cross-sectional study was conducted by an online questionnaire.*
Methods. *The questionnaire, mainly based on the Consortium Nomisma-Areté questionnaire, was customized to compare energy drinks consumption before and during the COVID-19 pandemic, and distributed among students between July 26th, 2020 and April 3rd, 2021.*
Results. *Out of 1,045 students who chose to participate in the study (participation rate of 14.7%), 653 students, mostly women, attending the lower study years, reported energy drinks consumption. Both before and during pandemic, overall energy drinks consumption was most frequently reported as rare [281 (43.9%) before, 326 (51.2%) during the pandemic], and exams-related energy drinks consumption as once or twice a week [156 (43.8%) before, 130 (42.1%) during pandemic]. The pandemic increased the number of frequent consumers (consumption of 4–5 energy drinks per week) in both overall [35 (5.5%) before, 46*

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(7.2%) during pandemic] and exams-related energy drinks consumption [42 (11.8%) before, 48 (15.5%) during pandemic]. Study year (OR=0.842; 95% CI 0.77–0.921; p<0.001), being single and living alone [OR=0.512; 95% CI 0.296–0.883; p=0.016), or living with a partner and children [OR=0.377; 95% CI 0.168–0.847; p=0.018) were identified as negative independent predictors for exams-related energy drinks consumption, while being a regular smoker (OR=0.429; 95% CI 0.223–0.875; p=0.011) appeared its new negative independent predictor during pandemic.

Conclusions. *The pandemic seemed to decrease both the overall and exam-related energy drinks consumption among undergraduates of the University of Sarajevo with the exception of a portion of already frequent energy drinks consumers.*

Introduction

Due to aggressive primarily online marketing directed to a target population of young adults (1), the global market of energy drinks (EDs) is anticipated to grow at an annual rate of 7.5% in the period 2020–2027 (2). The most specific characteristic of an ED is its caffeine content, even though caffeine-free EDs exist. Depending on the brand, the caffeine content of a single ED ranges from 80 to 150 mg per 236 mL, compared to 34 mg of caffeine in a can of Coca-Cola (3, 4). EDs use is mostly driven by the intended performance-improving benefits of caffeine, including decreased drowsiness, sustained alertness, greater physical and mental fitness, and enhanced mood and focus (5-8). Our pilot study conducted in the academic year 2017/18 among undergraduates of the University of Sarajevo showed EDs to be most frequently consumed during academic activity, less frequently mixed with alcohol in leisure, and rarely in sports activity (9). Students are found to frequently consume EDs, especially during exam periods when they are stressed and require help with focus (10-12). A study conducted among the first-year students of the universities of Bosnia and Herzegovina (B&H) also showed increased consumption of coffee and EDs during the week before the exams to be correlated with exam stress level (13). Another study reported the total daily intake of caffeine during the exam period as above the daily limits of 400 mg allowed by the FDA (14).

Studies on the impact of the COVID-19 pandemic on EDs consumption showed different results. Public health measures during the pandemic have impacted the students' daily routine with restricted social activities, more time for sleeping and learning, as well as changed dietary habits including consumption of EDs (15-17). Other studies, including a recent systematic review from 2022, found decreased EDs consumption in the adult population during the pandemic compared to prepandemic time (16-18). Similar results were found among the group of both medical and non-medical Polish and Turkish students, where the portion of those who did not consume EDs increased during the pandemic by 5.6% and 8.8%, respectively (19). However, another study among undergraduates of medical sciences in Jordan reported an increase in EDs consumption and a decrease in physical activity (20).

The pandemic massively affected academic activities in terms of switching to online teaching and knowledge assessment. Besides social isolation, more stress during online exams was also found to cause increased consumption of caffeine-containing beverages, including EDs, among young people (20).

The high prevalence of EDs consumption among youth, primarily undergraduate students (5, 6), and its association with their risk behaviors and adverse health effects (5, 6, 21) make this topic of high public health interest. On the other hand, the

existing data on the impact of the COVID-19 pandemic on overall EDs consumption are conflicting, and the data on the impact of the COVID-19 pandemic on exams-related EDs consumption are scarce, we aimed to assess the impact of COVID-19 pandemic on overall EDs consumption among undergraduates of the University of Sarajevo, with a focus on the consumption during academic activities/exam periods.

Methods

Study design and setting

This cross-sectional, online questionnaire-based study using Google® Administration Survey App was conducted among undergraduates of the University of Sarajevo in B&H from the 26th of July 2020 to the 3rd of April 2021. The study was approved by the University Bioethical Committee (0101-8742/20).

Student representatives were asked to advertise and distribute the anonymous questionnaire to students of respective study years of all faculties of the University of Sarajevo via university e-mails and other social media platforms such as Facebook® student groups, WhatsApp® or Viber®. All students were informed about the study objectives, the anonymity and research purposes of the data given in the study, and instructions on how to fill out the questionnaire. It took approximately 5–7 minutes to complete the questionnaire. Students had no economic or any other interest in participating in the study.

The study questionnaire was divided into three sections, as follows:

Questionnaire and data collection

The questionnaire used in our previous pilot study, mainly based on an EFSA (European food safety agency) *Consortium Nomisma-Areté* questionnaire (21), was tailored to collect background information [age, gender (male, female or other), faculty, year of study, grade point average (GPA), living environment (urban or rural), characteristics of family units (single and living with parents, single and living alone, living with a partner and no children, living with the partner and children, other)], information on frequency, amount, brand, and reasons for overall and exam-period related EDs consumption practices before and during the pandemic, information on body weight before and during the pandemic, tobacco smoking and number of cigarettes consumed before and during the pandemic, and number of sleeping hours per night before and during the pandemic (Supplement 1). Students who consumed an ED at least once during the previous year were defined as consumers. Rare EDs consumption was defined as less frequent than once or twice a month. Consumers who consumed 4–5 EDs per week were defined as frequent consumers, while those who consumed EDs everyday as daily consumers. Tobacco users who smoked at least one cigarette per day were defined as regular smokers.

Data analysis

Collected data were statistically analyzed by the Statistical Package for the Social Sciences (SPSS) version 23.0. Using descriptive statistics, categorical variables were presented by case number (frequency) of cases and percentage (%). The distribution of numerical variables was analyzed by the Kolmogorov-Smirnov test. Numerical variables with normal distribution were represented by the arithmetic mean±standard deviation (SD), and those, whose distribution was not normal, by the median (25th; 75th quartile). The paired analysis (before *vs* during pandemic) of the association of dichotomous nominal categorical variables was done by the McNemar test, and of the difference in numerical variables by the Wilcoxon test. To identify independent

predictors/determinants of EDs consumption before and during the COVID-19 pandemic, binary logistic regression models were tested. The following variables were tested as covariates: gender, age, year of study, living environment, characteristic of family units, regular smoking before and during the pandemic, number of cigarettes before and during the pandemic, number of sleeping hours per night before and during the pandemic, body weight before and during the pandemic and GPA. To assess their independent predictive ability, all predictor variables that tested significant in univariate analysis were tested in one block by the Forced Entry method in multiple logistic regression analysis. All test results were considered statistically significant at the significance level of $p<0.05$ or at the 95% confidence level.

Results

The online questionnaire was distributed to an estimated 7100 students from the University of Sarajevo. Out of these, 1045 respondents, the median age 23 (21; 25), mainly women 779 (74.5%), participated in the study with an estimated participation rate of 14.7%.

Demographic characteristics of students not consuming and students consuming energy drinks (EDs) in overall and exams-related EDs consumption

Demographic characteristics of EDs non-consumers and EDs consumers in overall and exams-related EDs consumption are presented in Table 1. Of 1,045 respondents, 653 (62.4 %) were EDs consumers of whom mostly women, attending the earlier study years, and being single and living with their parents (Table 1). Out of all EDs consumers, most (472, 72.3%) reported usually drinking a can of 250 mL and preferred EDs with sugar (444, 68.0%). The most popular ED was Hell™, the first choice for 53% of EDs consumers ,followed by Red Bull™ (42.1%) and Fast Energy™ (32.7%). The most common reasons for EDs consumption were to stay awake (57.6%), because of the taste (55.8%), and because it improves their concentration while studying or working (39.3%).

Out of 653 EDs consumers, 415 (63.7%) consumed EDs during the exams period.

Impact of COVID-19 pandemic on overall and exams-related EDs consumption

The frequency of overall and exams-related EDs consumption per average month before and during the COVID-19 pandemic is presented in Table 2. Most of the EDs consumers consumed them only rarely per average month, with 281 (43.9%) respondents before and 326 (51.2%) during the pandemic. It was only that the portion of frequent EDs consumers, who consumed it 4–5 days per week, increased during (46, 7.2%) compared to before (35, 5.5%) pandemic. The most frequently consumed average volume of EDs per month was a can of approximately 250 mL both before (29.93%) and during the pandemic (32.73%), while consumption of more than 20 EDs per month was reported by only 1.9% of respondents before and 2.2% during the pandemic. In terms of consumption per sitting, most consumers, both before (46.8%) and during the pandemic (48.5%), also reported consumption of only one can of approximately 250 mL of ED per sitting. Of all EDs consumers, 417 (63.8%) consumed it during the exams period (midterms/finals). The most frequently reported reason for EDs consumption both before midterms/finals (195, 46.7%) and the night before the exam (154, 36.9%) was because they found it helping to concentrate during the exam. The frequency of EDs consumption during the exam period (midterms/finals) and the number of EDs consumed during the night before the exam, before and during

Table 1 - Demographic characteristics of non-consumers and consumers of energy drinks (EDs) in overall and exams-related EDs consumption. Data are presented as absolute numbers (and percentages) or as median (25^{th}; 75^{th} percentile)

Characteristics		Overall EDs consumption		Exams-related EDs consumption	
		EDs non-consumers, N=392	**EDs consumers, N=653**	**EDs non-consumers, N=628**	**EDs consumers, N=417**
Age (years)		23 (22; 25)	23 (21; 25)	23 (21; 25)	23 (21; 25)
Gender	females	318 (40.8%)	461 (59.2%)	477 (61.2%)	302 (38.8%)
	males	74 (27.9%)	192 (72.1%)	151 (56.7%)	115 (43.3%)
Year of study	1st year	64 (35.5%)	116 (64.5%)	110 (61.1%)	70 (38.9%)
	2nd year	76 (31.1%)	168 (68.9%)	129 (52.9%)	115 (47.1%)
	3rd year	90 (35.4%)	164 (64.6%)	144 (56.7.0%)	110 (42.3%)
	4th year	61 (39.1%)	95 (60.9%)	95 (60.9%)	61 (39.1%)
	5th year	63 (45.0%)	77 (55.0%)	100 (71.4%)	40 (28.6%)
	6th year	38 (58.5%)	33 (41.5%)	50 (70.4%)	21 (29.6%)
Grade point average		8.0 (7.6; 8.4)	7.9 (7.0; 8.3)	8.0 (7.5; 8.42)	7.8 (7.0; 8.2)
Living environment	urban	332 (37.9%)	544 (62.1%)	525 (59.9%)	351 (40.1%)
	rural	60 (35.5%)	109 (64.5%)	103 (60.9%)	66 (39.1%)
Characteristics of family units	Single and living with parents	320 (38.9%)	502 (61.1%)	499 (60.7%)	323 (39.3%)
	Single and living alone	25 (25.2%)	74 (74.8%)	55 (55.5%)	44 (34.5%)
	Living with a partner and no children	20 (38.5%)	32 (61.5%)	37 (71.1%)	15 (28.9%)
	Living with a partner and children	8 (57.1%)	6 (42.9%)	9 (64.3%)	5 (35.7%)
	Other	19 (32.8%)	39 (67.2%)	28 (48.3%)	30 (51.7%)

Table 2 - Frequency of overall and exams-related energy drinks (EDs) consumption per average month before and during the COVID-19 pandemic

Overall EDs consumption			Exams-related EDs consumption		
Frequency of EDs consumption	Before pandemic N=640*	During pandemic N=636	Frequency of EDs consumption	Before pandemic N=356	During pandemic N=309
every day	20 (3.1%)	18 (2.8%)	every day	33 (9.3%)	33 (10.7%)
4–5 days per week	35 (5.5%)	46 (7.2%)	4–5 days per week	42 (11.8%)	48 (15.5%)
2–3 days per week	145 (22.6%)	130 (20.4%)	2–3 days per week	125 (35.1%)	98 (31.7%)
once or twice a month	159 (24.8%)	116 (18.2%)	once or twice a week	156 (43.8%)	130 (42.1%)
rarely	281 (43.9%)	326 (51.2%)	-	-	-

*4 persons didn't answer this question

the COVID-19 pandemic, are presented in Table 2 and Table 3. Frequent EDs consumption during midterms/finals, both daily consumption and consumption 4–5 days a week as well as the number of ED consumers who consume more than one can of ED the night before the exam increased during the pandemic. The transition from live to online exams made a change in the pattern of EDs consumption among 205 (50.7%) students, of whom 150 (37.1%) consumed more EDs for live compared to online exams and only 55 (13.6%) students consumed more EDs for online compared to live exams. The rest of the 200 students (49.4%) reported consuming an equal amount of EDs for both live and online exams. Still, most students consumed more EDs for live exams compared to online exams. Most EDs consumers who consume it before the exam (151, 54.7%), complain of the same nervousness as when they do not drink ED.

A paired analysis of smoking habits, sleeping duration, and body weight before and during the COVID-19 pandemic, in overall and exams-related EDs consumers

Paired analysis for both overall and exams-related ED consumption found that among both EDs non-consumers and consumers, the pandemic did not affect the portions of regular smokers as well as the number of cigarettes consumed per day by smokers. However, the number of sleeping hours, as well as body weight, in both EDs non-consumers and consumers, increased during the pandemic (Table 4). Paired analysis for both overall ED consumption and exams-related ED consumption found that among both EDs non-consumers and EDs consumers, the pandemic did not affect the portions of regular smokers as well as the number of cigarettes consumed per day by smokers. However, the number of sleeping hours as well as body weight in both EDs consumers and EDs non-consumers increased during the pandemic (Table 4).

Table 3 - The number of EDs consumed during the night before the exam - before and during the COVID-19 pandemic

	Exams-related EDs consumption	
	Before pandemic	During pandemic
Number of EDs consumed the night before the exam	N=282	N=250
1 ED	186 (65.9%)	162 (64.8%)
2 ED	74 (26.2%)	68 (27.2%)
3 and more EDs	22 (7.8%)	20 (8.0%)

Table 4 - A paired analysis of smoking habits, sleeping duration, and body weight before vs during the COVID-19 pandemic in overall and exams-related EDs consumption. Data are presented as absolute numbers (and percentages) or as median (25^{th}; 75^{th} percentile)

Overall energy drinks consumption					
EDs non-consumers, N=392		Regular smoking during pandemics			
		No	Yes	Test statistics[a]	p
Regular smoking before pandemics	No	327 (98.5%)	5 (1.5%)	303888	0.774
	Yes	7 (11.7%)	53 (88.3%)		
		Before pandemics	During pandemics	Test statistics[b]	p
Nr of cigarettes/day, N=63		10 (7; 20)	10 (5; 17)	-0.209	0.834
Nr of sleeping hours/day		7 (6; 8)	8 (6; 8)	-7.776	<0.001
Body weight		67 (57; 77)	65 (56; 80)	-2.745	0.006
		Regular smoking during pandemics			
EDs consumers, N=653		No	Yes	Test statistics[a]	p
Regular smoking before pandemics	No	465 (96.9%)	15 (3.1%)	508036	1.000
	Yes	15 (8.7%)	158 (91.3%)		
		Before pandemics	During pandemics	Test statistics[b]	p
Nr of cigarettes/day, N=172		10 (5.25; 20)	10 (5; 20)	-0.817	0.414
Nr of sleeping hours/day N=653		7 (6; 8)	8 (7; 9)	-10.558	<0.001
Body weight N=653		68.5 (60; 79)	69 (60; 80)	-6.330	<0.001
Exams-relates energy drinks consumption					
		Regular smoking during pandemics			
EDs non-consumers, N=627		No	Yes	Test statistics[a]	p
Regular smoking before pandemics	No	506 (98.4%)	8 (1.6%)	484692	0.286
	Yes	14 (12.4%)	99 (87.6%)		
		Before pandemics	During pandemics	Test statistics[b]	p
Nr of cigarettes/day N=113		10 (7; 20)	10 (5; 20)	-0.030	0.974
Nr of sleeping hours/day		7 (6; 8)	8 (7; 8)	-10.021	<0.001
Body weight		67 (60; 78)	65 (58; 80.5)	-4.745	<0.001
		Regular smoking during pandemics			
EDs consumers, N=415		No	Yes	Test statistics[a]	p
Regular smoking before pandemics	No	284 (95.9%)	12 (4.1%)	324007	0.503
	Yes	8 (6.7%)	111 (93.3%)		
		Before pandemics	During pandemics	Test statistics[b]	p
Nr of cigarettes/day		10 (5; 20)	10 (5; 17.5)	-0.957	0.339
Nr of sleeping hours/day, N=121		7 (6; 8)	8 (7; 9)	-0.461	<0.001
Body weight		68 (60; 78.5)	70 (59.5; 79.5)	-4.771	<0.001

a: McNemar test; b: Wilcoxon test

Table 5 - Independent predictors for EDs consumption during exam periods, including before and during the COVID-19 pandemic identified by multiple binary logistic regression analysis

Independent predictors for exams-related EDs consumption							
Independent predictors	Odds ratio			95% Confidence Interval		p value	
Year of study	0.842			0.77–0.921		<0.001	
Single and living alone (yes *vs* no)	0.512			0.296–0.883		0.016	
Living with partner and children (yes *vs* no)	0.377			0.168–0.847		0.018	
Before COVID-19 pandemic				**During COVID-19 pandemic**			
Independent predictors	Odds ratio	95% Confidence Interval	p value	Independent predictors	Odds ratio	95% Confidence Interval	p value
Sleeping hours	0.888	0.802–0.983	0.022	Regular smoking (yes *vs* no)	0.429	0.223–0.875	0.011
Body mass index	1.010	1.000–1.019	0.039				

The model was considered as statistically significant for χ^2=54.802; p<0.001; this explained 7.0% (Nagelkerke R2) of the variance and the correctly classified 63.4% of cases.

Independent predictors for exams-related EDs consumption

Independent predictors for exams-related EDs consumption were identified by binary logistic regression models (Table 5). Students from more advanced study years, single and living alone, or living with a partner and children, were less likely to consume EDs during exams. The number of sleeping hours was identified as a negative, and body weight as a positive independent predictor of exams-related EDs consumption before the pandemic, while being a regular smoker appeared its negative independent predictor during the pandemic.

Discussion and conclusion

Although the COVID-19 pandemic seemed not to affect the portion of EDs consumers and decreased the frequency of both overall and exam-related EDs consumption, the portion of frequent consumers increased regardless of the period of consumption, overall or during exams. The most common reasons for overall EDs consumption were to stay awake, because of the taste, and because it improves their concentration while studying or working, and for exams-related EDs consumption because they find it easier to concentrate during the exam. Students from more advanced study years, single and living alone, or living with a partner and children were less likely to consume EDs during exams. The number of sleeping hours as negative, and body weight as positive independent predictor before pandemic lost significance during the pandemic period, while being a regular smoker appeared as a new negative independent predictor of exams-related EDs consumption during pandemic.

This study confirmed our previous findings (9) that overall and exams-related EDs consumptions are popular, with more than 60% of undergraduates in our country being EDs consumers, but, both before and during pandemic periods, EDs were still most often consumed in small amounts or rarely. EDs consumers were mostly drinking a can of 250 mL, and most rarely, i.e. less than once or twice a month (43.9% before and 51.2% during pandemic), with the least common everyday consumption. In contrast, other prepandemic studies reported lower portions of ED consumers but with more common frequent/everyday consumption, i.e. 50% in Austria, 44.5% in Slovakia of whom one-half consume it regularly (8), 30% of adults (only 14% in Cyprus), mainly young adults from 18 to 29 years, of whom 13% consume it daily according to the EFSA study (21), and 15.8% of EDs consumers among university students in Italy consume EDs 3–4 times a week (22).

Unlike our study, in other studies the favorable impact of the pandemic on EDs consumption was expressed through the decrease in portion of EDs consumers (16, 19). A previous polish study found EDs consumption to be unchanged for most of the participants (93.4%), whereas 5% of the participants decreased their consumption (18). Moreover, a cross-sectional study among Romanian medical dentistry students confirmed only a small portion of EDs consumers (13.86%) during pandemic and, unlike in our study, older students were more likely to consume more EDs (23). The possible explanation for decreased EDs consumption during the pandemic might be the closing of nightclubs and the lower need for an "energy boost" during the lockdown (17).

In our study, only the number of frequent consumers (consumption of 4–5 EDs per week) increased during pandemic, from 5.5% consumers before to 7.2% during it. This was also found in a study conducted among Polish adults, where the frequency of EDs consumption was decreased after/during the lockdown period compared to prepandemic period, with the exception of

a slight increase from 0.3 to 0.6% in the portion of daily consumers (16).

Also, in our study, in both study periods, EDs were most frequently consumed during exams – deemed as primary academic activities. Like in overall EDs consumption, it was the portion of frequent consumers as well as the portion of daily consumers (everyday consumption) that increased during pandemic in exams-related EDs consumption. In addition, the number of ED consumers who consumed more than one can of ED the night before the exam also slightly increased during the pandemic.

In our study, higher EDs consumption for online compared to live exams was found in 13.6% of students. Another study showed online exams to be more stressful in one-third of students from faculties of medical sciences, mainly due to the mode of questions navigation and technical problems (20). They also suggested that the online exam experience negatively impacted students' diets with increased consumption of caffeine and high EDs, high sugar food, and fast food as well as a reduction in eating healthy food (20).

We speculate that the two groups of both frequent and daily consumers, albeit still relatively small, enlarged, as those consumers may have attempted to temper the pandemic-related stress (17) including the burden associated with the new, online way of exam performance. This might have led students who already were in the habit of consuming EDs to begin consuming them even more frequently. As the portions of those who consume 3 and more cans of EDs the night before the exam before (7.8%) as well during the pandemic (8.0%) were low, and as most popular brands have each 80 mg of caffeine per 250 mL, consumption still may not exceed the 400 mg of caffeine/day, the content allowed by the FDA (14) – serving to alleviate the severity of implications of our findings. Moreover, most (49.4%) of the EDs consumers reported the same EDs consumption regardless of the type of the exam (online *vs* live), while fewer consumed more EDs for live compared to online exams.

As the consumption of EDs is socially acceptable, the awareness of their adverse health effects is low. Moreover, students tend to underestimate the caffeine content in products other than coffee and non-energy drinks such as tea, chocolate, soft drinks, and OTC drugs (14). So, in a study conducted among a small group of university students in Lebanon, high average daily caffeine consumption during exams was alarmingly above the Food and Drug Administration (FDA)-approved daily doses of 400 mg/day in 46.6% of participants, and products other than coffee and EDs contributed to at least 61% of their daily caffeine consumption (14). Unfortunately, the concomitant consumption of other food/beverages containing caffeine was not explored in our study.

Adverse effects usually appear when caffeine intake exceeds 3 mg/kg/day, acute clinical toxicity occurs with daily doses of 1 g, while a dose of 5 g can be fatal (24). The most common adverse effects are increased arterial blood pressure, anxiety, nervousness, poor sleep, confusion, gastritis, and palpitations. Serious adverse effects, including central nervous, cardiovascular, renal, and gastrointestinal problems, usually appear within a few hours after consuming EDs (4), and mostly in chronic caffeine consumers (6, 14, 25).

However, most ED consumers before the exam in our study (151, 54.7%) complained of the same nervousness as when they do not drink ED. Also, although another study found online exams to be associated with a reduction in sleeping hours with more consumption of insomnia medications (20), our results suggest that the pandemic increased the number of sleeping hours among both EDs consumers and nonconsumers. This is also consistent with the results of our previous study on the sleep quality of young West

Balkan adults during the third wave of COVID-19 pandemic, when being a student was a negative independent predictor for both insomnia symptoms and poor sleep quality (26). This may be explained by the increase in frequent exams-related EDs consumption and the number of EDs consumed the night before exams to increase students' alertness and concentration during the pandemic. In addition, in our study, sleeping hours as a negative, and body weight as a positive independent predictor before pandemic lost significance during the pandemic period. This change could be explained by the pandemic-related changes in daily routine as our paired analysis found that the pandemic increased sleeping duration as well as body weight in all respondents.

Although scientific evidence in university students shows a positive association between ED consumption and risk-taking behaviors, such as mixing EDs with alcohol and smoking tobacco and cannabis (5, 6), as well as the positive association between online exams and increased smoking (20), no change in smoking habits were identified by our paired analysis, and moreover, being a regular smoker appeared the negative independent predictor for exams-related EDs consumption during pandemic.

Studies performed among students attending online universities in the USA showed that only individuals who consumed >10 ED/month reported side effects of headaches and speeding. It is assumed that they had become habituated to caffeine since they drank EDs despite experiencing side effects (11). Other authors also showed that, as the habituation level increases, the impact of EDs on hemodynamic parameters tends to decrease (27).

Although most students consume coffee for better concentration, one study showed caffeine boosts the explicit memory of young college students only in the morning and not in the afternoon (28). Also, our result that the use of EDs was associated with a lower GPA confirmed earlier finding of the counterproductive effect of caffeine on academic performance, especially if caffeine consumption was associated with alcohol and smoking (14, 29). This can be explained not only by EDs effect but also by the level of motivation to learn.

Strengths and limitations. This is the first study that has investigated the impact of the COVID-19 pandemic on the overall and exams-related consumption of EDs among undergraduates of the University of Sarajevo. However, it had several limitations. First, the response rate to the questionnaire is deemed as relatively low (14.7%), potentially related to the fact that the questionnaire was distributed to students' Facebook groups at the time when students were preparing for exams, which could have impacted the study participation rate. Also, the questionnaire was not distributed to students of eight faculties, presenting a limitation to our potential inference that findings from our sample are indicative of the entire population of undergraduate students. Second, self-reported questionnaires could lead to biases, including recall bias as students were asked about their consumption habits over the past year, which is a long recall duration. Finally, the cross-sectional design of the study does not allow causality testing and it is not clear whether tested covariates lead to EDs consumption or vice versa.

To drive more evidence-based recommendations, further studies, including interventional, multi-centric, and long-term ones should involve multiple institutional, clinical, educational, and community stakeholders. Meanwhile, next to health promotion, any contact with a young person should be used as an opportunity to raise awareness of the possible adverse health effects and risky behaviors related to EDs and to inform them about other stress-reduction techniques that could replace exams-related EDs consumption. Also, remote mock online

exams are recommended to reduce students' potential stress (20).

In conclusion, the COVID-19 pandemic seemed to decrease the overall and exam-related EDs consumption among undergraduates of the University of Sarajevo with the exception of an increased portion of already frequent EDs consumers. This increase is worrying and therefore of additional public health relevance as it, especially when used concomitantly with other caffeine-containing food/beverages, may exceed the FDA-approved daily amount. Also, this point to a lack of accessible and healthy tools and resources for managing exam-related performance anxiety, regardless of the online or live form of the exam, the same tools which would mitigate the potential abuse of high caffeine content drinks, including, but not limited to, EDs.

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Riassunto

Impatto della pandemia di COVID-19 sul consumo complessivo - ed in occasione degli esami profitto - di bevande energetiche tra gli studenti dell'Università di Sarajevo, Bosnia-Erzegovina

Premessa. Uno studio pilota condotto nell'Anno Accademico 2017/18 tra studenti dell'Università di Sarajevo ha mostrato che le bevande energetiche vengono consumate più frequentemente durante l'attività accademica, meno frequentemente, mescolate con l'alcol, nel tempo libero e raramente nell'attività sportiva. Scopo del presente studio è stato di valutare l'impatto della pandemia di COVID-19 sul consumo di bevande energetiche tra gli studenti della suddetta Università, con particolare attenzione al loro consumo durante gli esami.

Disegno dello studio. Uno studio trasversale è stato condotto mediante un questionario online.

Metodi. Il questionario, basato principalmente sul questionario del Consorzio Nomisma-Areté, è stato personalizzato per confrontare il consumo di bevande energetiche prima e durante la pandemia di COVID-19, e distribuito tra gli studenti tra il 26 luglio 2020 ed il 3 aprile 2021.

Risultati. 1.045 studenti hanno deciso di partecipare allo studio (tasso di partecipazione del 14,7%). La maggioranza (653 o 62,5%), rappresentata prevalentemente da donne che frequentano i primi anni di studio, ha dichiarato di consumare bevande energetiche. Sia prima che durante la pandemia, il consumo onnicomprensivo di bevande energetiche è stato segnalato più frequentemente come raro: 281 soggetti (o 43,9%) prima, e 326 soggetti (o 51,2%) durante la pandemia, mentre il consumo di bevande energetiche in associazione agli esami è risultato di una o due volte alla settimana (156 soggetti od il 43,8% prima, 130 soggetti od il 42,1% durante la pandemia). La pandemia ha aumentato invece il numero di consumatori assidui (consumo di 4-5 bevande energetiche a settimana), sia complessivamente (35 soggetti o il 5,5% prima, 46 o il 7,2% durante la pandemia) che in associazione con gli esami (42 soggetti o l'11,8% prima, 48 o il 15,5% durante la pandemia). L'anno di iscrizione (OR=0,842; 95% CI 0,77–0,921; p<0,001), essere single e vivere da solo (OR=0,512; IC 95% 0,296–0,883; p=0.016), vivere con un partner e avere figli (OR=0.377; IC 95% 0,168–0,847; p=0,018) sono stati identificati come predittori indipendenti negativi per il consumo di bevande energetiche correlato agli esami, mentre essere un fumatore regolare (OR=0,429; 95% CI 0,223–0,875; p=0,011) è apparso il nuovo predittore indipendente negativo durante la pandemia.

Conclusioni. La pandemia sembra aver ridotto il consumo di bevande energetiche sia onnicomprensivo che associato agli esami tra gli studenti dell'Università di Sarajevo, ad eccezione di coloro che erano già consumatori frequenti di bevande energetiche.

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