

Relationship between Frequency of Energy Drink Consumption and Insomnia, Depression, Alcohol Abuse, Socioeconomic Status, and Religion among Students in the Republic of Bashkortostan

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INTRODUCTION: Energy drinks (EDs) have recently been gaining popularity in Bashkortostan, as elsewhere in Russia, and are particularly prevalent among young people, whose health is critical to public health. Finding associations between the frequent consumption of EDs and mental health problems has become our main goal.

METHODS: An anonymous online questionnaire was designed to analyse the incidence and context of the consumption of EDs in relation to the demographics, socioeconomic status, Insomnia Severity Index, the Alcohol Abuse Risk Test, and the Zung Self-Rating Depression Scale. **RESULTS:** Among 813 participants, 20.8 ± 5.9 years old in average, 644 (79.2%) were women. Overall, 23% of participants had never tried

EDs, 42.4% reported sporadic use, 17% consume EDs several times a month, and 12.4% and 5.2% several times a week and day, respectively. A statistically significant association was observed between EDs drinking frequency and male gender, lower educational level, cigarette smoking, drug use, religiosity, and age. The relationship of insomnia severity and risk of alcohol abuse to the frequency of EDs intake was also statistically significant. **CONCLUSION:** The frequency of consumption of EDs was associated with male gender, atheism, a lower level of education and age, smoking and drug use, severe insomnia, and a high risk of alcohol abuse. These groups of people are more vulnerable to the adverse effects of EDs.

Keywords | Energy Drinks – Insomnia – Depression – Alcohol Consumption – Religion

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● 1 INTRODUCTION

Energy drinks (EDs) were introduced to the market at the beginning of the new millennium and have become an integral part of many people's lives. Several countries have restricted the sale and advertising of EDs in view of a high level of prevalence of ED use among children; thus in Norway, the sale of EDs is only allowed in pharmacies, in Sweden, the sale of EDs to children under 15 is prohibited, and Denmark has completely banned all EDs (Oddy & O'Sullivan, 2009; German Federal Institute for Risk Assessment, 2008). According to anonymous sociological studies conducted in US, Canada, Europe, China, Australia and New Zealand, between 30% and 50% of teenagers and young adults consume EDs, with 46% of the 5448 caffeine overdoses in the US in 2007 reported before the age of 19 (Seifert et al., 2011). In the study of Rahamathulla (2017) in Saudi Arabia, 81.3% of the respondents were identified as regular consumers of EDs. The prevalence of the consumption of EDs is rather difficult to estimate in Russia, considering the large number of regions with their own social and cultural peculiarities. For instance, in a study by Kosareva (2011) (N = 150) conducted in Ekaterinburg, the prevalence of the consumption of EDs among schoolchildren was 80%, among university students 56%, and among college students 38%; the main purposes of ED consumption were to increase work capacity, ward off drowsiness, and improve mood. A university-based survey in Novosibirsk showed that 74.4% of students consumed EDs (Krivyh & Zahlebina, 2019). A study of 76 adolescents from the Moscow Region revealed that 38% of the boys and 17.8% of the girls had consumed EDs (Skvorcova & Otvagina, 2011). In a larger study of high school and university students in various regions of the Russian Federation, (N = 813) 94% of the respondents had tried an ED at some point, while 10.6% had consumed EDs regularly; the researchers also found that the boys were more likely than the girls to report heavy work and sport as the reason for drinking an ED, and the girls were more likely than the boys to mix EDs with alcohol (Drozhzhina & Zastrozhin, 2013).

Today the ED market offers a wide range of drinks of various brands, differing in composition, volume, and the amount of caffeine and taurine, along with the following substances: L-carnitine, guarana, vitamins, mineral salts, and flavouring additives. Conventionally, all EDs can be divided into three groups according to the concentration of caffeine and taurine: drinks with a high content of these substances (caffeine – 135 mg, taurine – 600 mg), medium (caffeine – 30 mg, taurine – 200–240 mg) and low (caffeine – 20 mg, taurine – 100 mg).

The medical community has repeatedly raised concerns about the potentially harmful effects of EDs. Among the possible adverse somatic and neurological effects are increased blood pressure, tachycardia, tremors, agitation, anxiety, gastrointestinal disturbances, and mood and behavioural disorders (Grasser et al., 2016; Gunja & Brown, 2012; Seifert et al., 2011). In adolescents and children, the adverse effects of EDs may be more pronounced as a result of the high concentration of substances in relation to their age: caffeine, sugar, taurine, and vitamins (Curran & Marczinski, 2017; Harris & Munsell, 2015). A 2016 literature review by Richards and Smith reported a

positive relationship between anxiety, depressive, and stress disorders and the frequency of consumption of EDs. The nature of this relationship is not yet fully understood, and there is no evidence of a causal relationship (Kendler et al., 2006; Visram et al., 2016). However, there is a confirmed suggestion that the relationship between the consumption of EDs and mental health problems depends on the caffeine concentration (McLellan & Lieberman, 2012). A 2014 comparative study of Canadian schoolchildren (N = 8210) revealed higher levels of depression among those who consumed EDs once a month or more frequently than other schoolchildren (Azagba et al., 2014). Hofmeister et al. (2010) also found that regular ED users have higher levels of depression than non-regular ones.

The consumption of EDs correlates positively with the presence of depression and of sensation-seeking, which in turn is associated with risks and consequences of substance use (Asadullin et al., 2018; Asadullin et al., 2016; Azagba et al., 2014). A US military study determined that service members who consumed three or more EDs per day were significantly more likely to experience sleep problems than those who consumed two or fewer; the authors point out that one to two EDs is considered equivalent to 200 mg of caffeine (Centers for Disease Control and Prevention, 2012). Studies have found a positive association between those who consume alcohol mixed with energy drinks (AMEDs) drinking more alcohol and engaging in more harmful behaviour than those who drink only alcohol (Brache & Stockwell, 2011; O'Brien et al., 2013). In contrast, other authors argue that AMED consumers drink significantly less alcohol and have fewer alcohol-related behaviour reports than those who drink only alcoholic beverages (De Haan et al., 2012; Johnson et al., 2016). There is also an association between the consumption of alcohol mixed with EDs and the use of tobacco, marijuana, prescription psychostimulants (Khan et al., 2016), and gambling (Vieno et al., 2018).

To date, not a single study has been conducted on the prevalence and consumption of EDs in the Republic of Bashkortostan. With its capital city being Ufa, Bashkortostan is a multi-ethnic republic, home to Bashkirs, Russians, Tatars, Ukrainians, Chuvashes, Maris, and many other nationalities. Two religions predominate in Bashkortostan: Sunni Islam and Orthodox Christianity. This cultural and ethnic diversity will provide unique data for this region.

Insomnia, alcohol abuse, and depression are relevant mental health problems and thus convenient to study. Studies on the consumption of EDs and the correlation with mental health disorders were of particular interest to our literature analysis. Therefore, the main aim of the study was to investigate the relationship between the consumption of EDs and insomnia, depression, and alcohol consumption. For this purpose, the degree of severity of these disorders was determined on the basis of special scales in the study and control groups, and then the results were compared.

● 2 METHODS

To collect data using Google Forms, we compiled an anonymous online questionnaire that included 51 questions, 14 of which were authored questions aimed at determining demographics and attitudes towards EDs. We contacted the student associations of universities and colleges in Ufa by email, asking them to distribute a link to our questionnaire via their media resources (Vkontakte, Facebook, Instagram). The institutions covered included Bashkir State Medical University, Ufa State Petroleum Technological University, Bashkir State Agrarian University, Bashkir State Pedagogical University, Ufa State Aviation Technical University, Bashkir State University, medical colleges, fuel and energy colleges, and trade and economic and aviation colleges. We chose this method of recruiting respondents because it allowed us to reach a large number of people quickly and widely, and our questionnaire consisted of self-administered questionnaires that did not require the presence of a specialist. The method used for the questionnaire distribution does not allow the percentage of respondents to be determined.

The main block of the questionnaire consisted of authored questions and three tests: the Insomnia Severity Index (ISI), Alcohol Abuse Risk Test (AUDIT), and Zung Self-Rating Depression Scale (SDS). The authors' questions included a consent form and demographic data such as gender, age, level of education, main occupation, and religion (*Annex 1*). Educational attainment was determined by the number of years of schooling completed by the respondent and the number of college or university courses completed or in progress. In Russia, the level of education corresponding to four grades is defined as "primary", nine grades as "incomplete secondary", and eleven grades as "general secondary". College graduation corresponds to the "secondary specialised" level of education, while graduation from a university or institute corresponds to the "tertiary" level. We also asked about the number of EDs the participants consumed at certain intervals and their motivation for taking EDs, and whether the respondents paid attention to the composition of the drink and its caloric content and caffeine and taurine concentration (*Annex 2*). Finally, questions were asked about smoking and substance use.

The ISI is a brief questionnaire defining a patient's perception of their insomnia. It aims to determine the subjective symptoms and consequences of insomnia, as well as the degree of anxiety or distress caused by these difficulties. The questionnaire consists of seven questions. Each question is evaluated from 0 to 4 points, and therefore the sum of scores can range from 0 to 28 points. The higher the score, the more severe the insomnia (Morin, 1993). The ISI is a reliable and valid tool for quantifying the perceived severity of insomnia (Bastien et al., 2001). AUDIT is a ten-item questionnaire that covers areas such as alcohol consumption, drunken behaviour, and alcohol problems. Each question is scored from 0 to 4 points, with a maximum score of 40. AUDIT is a simple method for the early identification of possible harmful effects of alcohol consumption developed by the World Health Organisation to predict problematic alcohol use in various clinical settings (Allen et al., 1997; Saunders et al., 1993). The SDS assesses the level of depression in patients and

determines the degree of depressive disorder. The scale consists of 20 questions and is divided in half, with ten positively worded and ten negatively worded questions. Each question is scored from 1 to 4 points (Zung, 1965). The scales described above are valid and are widely used in world practice (Savard, Savard, Simard, & Ivers, 2004; Thurber, Snow, & Honts, 2002; Young & Mayson, 2010).

● 3 RESULTS

A total of 813 people responded to all the questionnaire questions, of whom 644 (79.2%) were women. The respondents' ages ranged from 11 to 57 years, with an average age of 20.8 ± 5.9 years. The majority of those surveyed were college and university students – 608 respondents (74.8%); 68 (8.4%) indicated that they work in their profession; 21 (2.6%) work outside their profession; nine (1.1%) have their own business; 43 (5.3%) do not work now; 66 (8.1%) indicated that they are school students. When asked about smoking, 634 (78%) of the respondents indicated that they do not smoke, and 51 (6.3%) indicated that they use drugs. *Figure 1* presents data on the main spheres of activity of the respondents. The responses to the questions about religion were distributed as follows: 142 participants (17.5%) responded that they practise Islam, 167 (20.5%) responded that they practise Christianity, 224 respondents (27.6%) chose "atheism", 62 respondents (7.6%) wrote their own response, and 218 people (26.8%) did not want to answer this question.

With regard to the consumption of EDs, 187 respondents (23%) reported never having tried them, 345 (42.4%) indicated occasional consumption, 138 (17%) consume EDs several times a month, 101 (12.4%) several times a week, and 42 respondents (5.2%) stated that they drink EDs several times a day (*Figure 2*). The participants were also asked multiple-choice questions about their reasons for consuming EDs and preferred ingredients, and these results are summarised in *Figure 3* and *Figure 4*. Overall, 524 respondents (83.7%) did not consider the drink's calorie content when purchasing, 14 (2.2%) preferred high-calorie drinks, and 88 (14.1%) chose low-calorie drinks. The caffeine and taurine preferences were also explored: 64 respondents (10.2%) prefer EDs with high levels of caffeine and taurine, 91 (14.5%) medium levels of these substances, 15 (2.4%) low levels, and 456 respondents (72.8%) pay no attention to the caffeine and taurine content in the EDs they buy.

The multiple linear regression method was applied to assess the influence of the co-factors that were studied on the frequency of consumption of EDs. The frequency of consumption of EDs was ranked from 0 to 4: 0 – the respondent does not consume EDs, 1 – they record sporadic consumption, 2 – they drink several times a month, 3 – several times a week, 4 – several times a day. In model selection, the model including the following predictors was the most significant: the respondent's gender, level of education, smoking, and drug use. The model that was constructed explains 22% of the variance ($R^2 = 0.22$). The expected predictors were assigned numerical values: female – 0, male – 1; the absence of the fact of smoking – 0, the fact of smoking – 1; the absence of the fact of drug use – 0,

the presence of the fact – 1. The level of education was ranked: 0 – primary, 1 – incomplete secondary, 2 – general secondary, 3 – specialised secondary, 4 – incomplete higher, 5 – tertiary. The results are displayed in *Table 1*, and the following conclusions can be drawn: male gender, low level of education, the fact of smoking tobacco, and drug use are predictors of more frequent consumption of EDs. Those who expressed a positive opinion about drug use in our online questionnaire were counted as drug users.

Thus, based on the findings, the following regression equation can be proposed:

$$Y=1.97+0.187981x_1-0.347661x_2+0.199570x_3+0.126855x_4,$$

with **x1** – respondent's gender, **x2** – educational level, **x3** – evidence of smoking, **x4** – the fact of drug use.

Table 1 | Influence of co-factors on the frequency of EDs consumption

No	Assumed predictors	Regression coefficient B	Standard error	p-value	VIF
1	Gender	0.187981	0.031208	<0.001	1.01
2	Level of education	-0.347661	0.030994	<0.001	1.001
3	Smoking	0.199570	0.031715	<0.001	1.056
4	Drug use	0.126855	0.031894	<0.001	1.054

The Kruskal-Wallis test was used to determine the association between the number of EDs consumed and respondents' religions. Hypothesis H1 assumes that non-believing respondents consume EDs more frequently, as they may not have any beliefs that forbid them to consume EDs. Hypothesis H0 suggests that there is no significant difference in the amount of EDs consumed by respondents of different religions. The frequency of consumption of EDs was ranked from 0 to 4: 0 – the respondent does not consume EDs, 1 – records sporadic consumption, 2 – drinks several times a month, 3 – several times a week, 4 – several times a day. The results are presented in *Table 2*, which shows that atheists consume EDs more frequently than Muslims and Christians.

Table 2 | The level of EDs consumption among people of different religions

Religion	Number of respondents	Mean Rank
Atheism	224	459.55
Islam	142	281.32
Christianity	167	331.24
"I don't want to answer that question."	218	386.11
Total	751	
P-value	<0.001	

On the basis of the regularity of their consumption of EDs, two groups were identified. The study group included 143 respondents who regularly consume EDs, including those who con-

sume EDs several times a week or more frequently. The control group included respondents who consume EDs several times a month or less often, or who do not consume EDs at all. The Mann-Whitney U-test was used to evaluate the relationship between respondents' age and frequency of consumption of EDs. The null hypothesis H0 and the alternative hypothesis H1 were formulated. Hypothesis H1 states that younger respondents consume EDs more frequently than older respondents. In formulating the null hypothesis, we assumed that the age of the respondents had no effect on their ED consumption. The analysis revealed a statistically significant difference in age ($Z = 7.96, p < 0.001$) between regular consumers of EDs and the rest of the respondents; the results are displayed in *Figure 5*.

The association of the frequency of consumption of EDs and severity of insomnia according to the ISI, depression according to the SDS, and AUDIT scores was studied using a non-parametric method – the Spearman rank correlation coefficient calculation. The frequency of consumption was ranked from 0 to 4 as described above. The analysis revealed statistically significant correlations, as presented in *Table 3*. Statistically significant correlations ($R = 0.081, p = 0.02$) were found between the severity of insomnia and the frequency of consumption of EDs, which indicates the presence of sleep problems among frequent ED users. The AUDIT scores were also significantly associated with the frequency of consumption of EDs ($R = 0.219, p < 0.001$). In contrast, the association of depression with the consumption of EDs was not statistically significant ($R = 0.017, p = 0.63$).

Table 3 | Association of the frequency of EDs consumption with the results of the scales applied

No	Scales applied	Spearman R	p-value
1	ISI	0.08128	0.02046
2	AUDIT	0.21876	<0.001
3	SDS	0.01694	0.62964

● 4 DISCUSSION

The prevalence of consumption of EDs was relatively high in our sample: 23% of the respondents had never tried an energy drink, while 42.4% reported occasional consumption, 17% consumed EDs several times a month, 12.4% several times a week, and 5.2% several times a day. The findings of our study can be compared with the results of a recent meta-analysis ($N = 92006$), in which 76.7% of the respondents consumed EDs less than once a week, 20.6% more than once a week, and 1.2% more than once a day (Nadeem et al., 2020). A number of demographic and SES characteristics such as young age, male gender, low level of education, cigarette smoking, and drug use were found to predict more frequent ED use. A similar conclusion was obtained in a large study ($N = 3923$) in Denmark (Friis et al., 2014). This means that the listed groups of people become more vulnerable to the negative consequences of chronic consumption of EDs. According to the data analysis, it is reasonable to say that the consumption of EDs is a widespread phenomenon, affecting different age groups and various segments of the population. Again according to the data analysis, it is reasonable to say that the consump-

Figure 1 | The main field of activity of participants

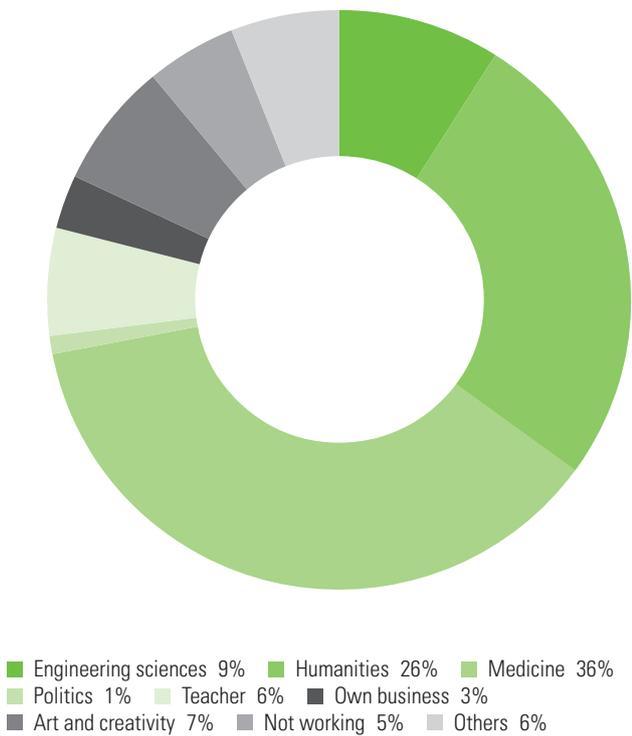


Figure 3 | Reasons for EDs consumption stated by respondents

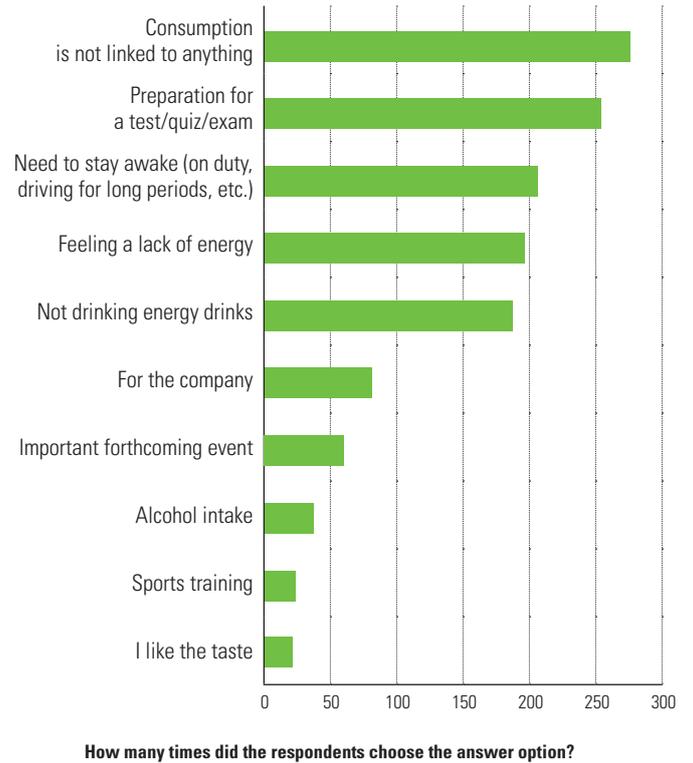


Figure 2 | Frequency of EDs consumption by respondents

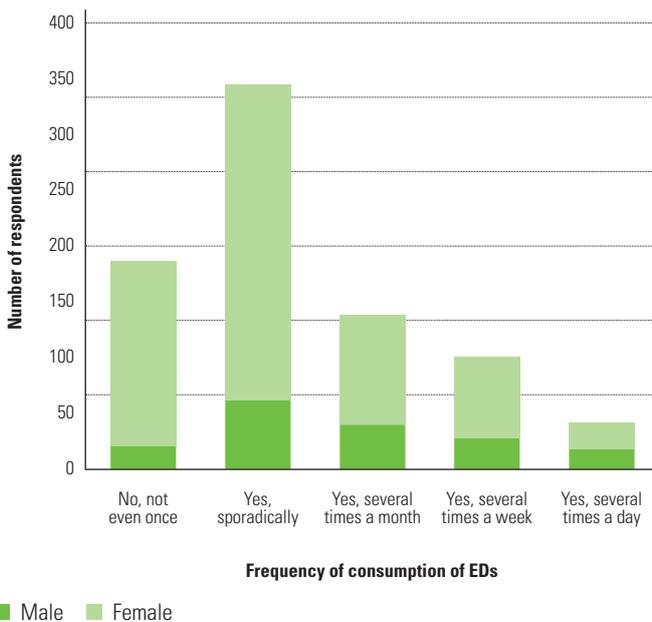


Figure 4 | Respondents' preferences for EDs composition

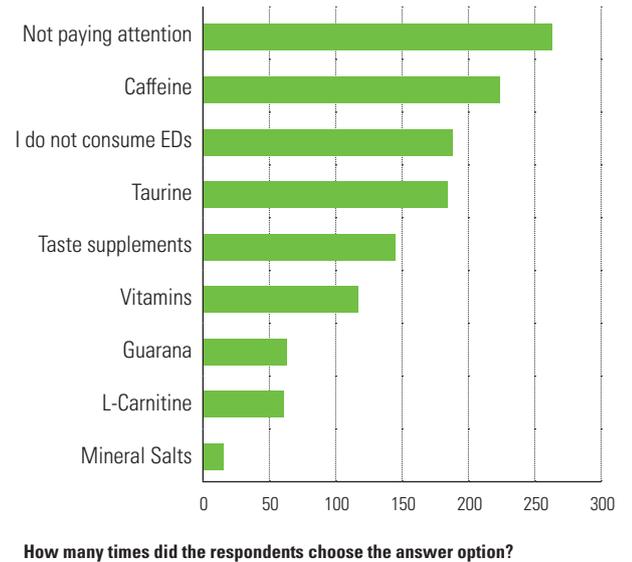
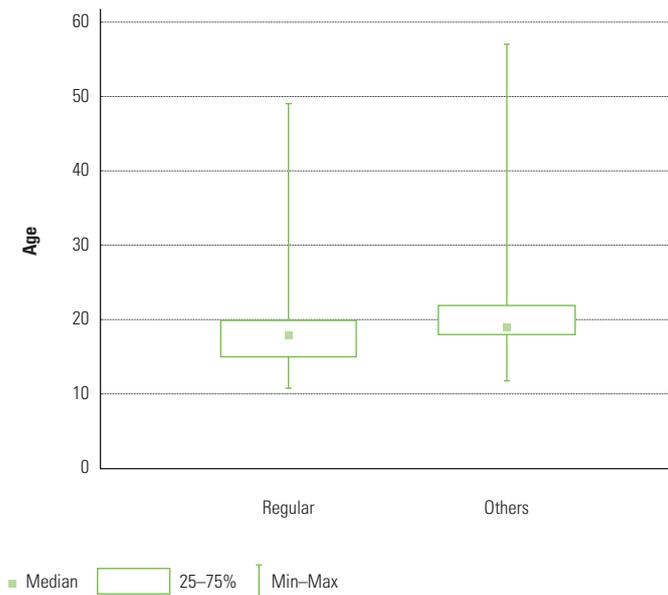


Figure 5 | Box plot showing age of respondents and level of EDs consumption



tion of EDs is a widespread phenomenon affecting different age groups and various segments of the population. The frequency of consumption of EDs has been found to be statistically significantly associated with insomnia, also reported by several studies (Marmorstein, 2017; Trapp et al., 2020) and the risk of alcohol abuse, mentioned by others (Marmorstein, 2017; Meredith et al., 2016; Arria et al., 2011). We identified the level of depression as not being related to the amount of EDs consumed by the respondents; the same result was shown in the study of Arria et al. (2011), but there are also a number of studies in the literature showing a relationship between depression and the consumption of EDs (Evren & Evren, 2015; Azagba et al., 2014; Hofmeister et al., 2010). These differences can be explained by methodological differences, as well as by the particularities in the samples used, which justifies a more in-depth study of this relationship. Religiosity was also identified as likely to discourage many respondents from consuming EDs frequently, as the consumption rate of atheist respondents was found to be significantly higher than that of religious respondents. This study confirms the suggestion that ED use is linked to mental health problems (Park et al., 2016; Kaur et al., 2020). The prevalence of ED use among adolescents is of particular concern. There are many groups and communities devoted to EDs on social media promoting products among young people, who consume EDs following “fashion” for no meaningful reason. The unrestricted sale of EDs and the availability of information about them have allowed EDs to spread among the child population, which can have a definite impact on their somatic and mental health.

On the evidence of the findings, more detailed research into different age groups and a larger sample are needed. The study of the negative effects of EDs in the child population is of particular interest.

4.1 Strengths and limitations

This study has several strengths, as well as some limitations. Its strength is that, despite being small enough to allow all the questions to be answered in a few minutes without tiring, the questionnaire was able to gather a great deal of information about the participants’ mental health. It was also able to collect data on the respondents’ SES status and relate this to the level of consumption of EDs, something that has not previously been covered in similar studies from Russia. Furthermore, our study included many age groups, which allowed us to trace the differences between them regarding the amount of EDs consumed. But since most active internet users are young people, most respondents turned out to be students, while those from other age groups were few, which is undoubtedly a limitation. In the final sample, 79% of the respondents were women, which can be interpreted by the distribution and high proportion of respondents among medical students, where the percentage of male students is low. In addition, the self-administered questionnaire and the reliability of the data provided may lead to bias.

5 CONCLUSIONS

In our sample, 77% of the respondents had tried EDs at some point, of whom 42.4% stated that they consumed them occasionally, 17% consumed them several times a month, 12.4% several times a week, and 5.2% several times a day. The respondents who consumed EDs frequently were found to be younger than those who seldom or never consumed EDs ($Z = 7.96$, $p < 0.001$). In a regression model explaining 22% of the variance, we determined that male gender ($B = 0.19$, $p < 0.001$), a low level of education ($B = -0.35$, $p < 0.001$), cigarette smoking ($B = 0.2$, $p < 0.001$), and drug use ($B = 0.13$, $p < 0.001$) predicted more frequent ED use. The frequency of consumption of EDs was found to correlate positively with the severity of insomnia ($R = 0.08$, $p = 0.02$) and risk of alcohol abuse ($R = 0.22$, $p < 0.001$); the level of depression was found to be unrelated to the amount of EDs consumed ($R = 0.02$, $p = 0.63$). Concerning religiosity, we found that the atheist respondents had a higher level of consumption of EDs (Mean Rank = 459.55, $p < 0.001$) than the Muslim (Mean Rank = 281.32, $p < 0.001$) and Christian respondents (Mean Rank = 331.24, $p < 0.001$).

Annex 1 | Authors' questions on socioeconomic status (SES)

No	Question	Answer options
1	What is your occupation?	<input type="checkbox"/> Studying at a university or secondary school <input type="checkbox"/> Working in my profession <input type="checkbox"/> Working out of my profession <input type="checkbox"/> Own business <input type="checkbox"/> Not working <input type="checkbox"/> Other
2	What is your level of education?	<input type="checkbox"/> Primary <input type="checkbox"/> Incomplete secondary <input type="checkbox"/> General secondary <input type="checkbox"/> Secondary education <input type="checkbox"/> Incomplete higher education <input type="checkbox"/> Higher <input type="checkbox"/> Other
3	What field do you work in? (What is your profession)	<input type="checkbox"/> Engineering sciences <input type="checkbox"/> Humanities <input type="checkbox"/> Medicine <input type="checkbox"/> Political activity <input type="checkbox"/> Teaching activities <input type="checkbox"/> Business <input type="checkbox"/> Art and creativity <input type="checkbox"/> Other
4	What religion do you practise?	<input type="checkbox"/> Islam <input type="checkbox"/> Christianity <input type="checkbox"/> Atheism <input type="checkbox"/> I do not want to answer this question <input type="checkbox"/> Other

Annex 2 | Authors' questions on consumption of EDs

No	Question	Answer options (<input type="checkbox"/> – one of, <input type="checkbox"/> – multiple choice)
1	Do you consume EDs and how often?	<input type="checkbox"/> Yes, several times a day <input type="checkbox"/> Yes, several times a week <input type="checkbox"/> Yes, several times a month <input type="checkbox"/> Yes, on sporadic occasions <input type="checkbox"/> No, never
2	What is taking an ED associated with?	<input type="checkbox"/> Sports training <input type="checkbox"/> Important upcoming event <input type="checkbox"/> Preparing for a test/quiz/exam <input type="checkbox"/> Feeling a lack of energy <input type="checkbox"/> Alcohol intake <input type="checkbox"/> Having company <input type="checkbox"/> Need to stay awake (on duty, driving for long periods, etc.) <input type="checkbox"/> Intake is unrelated to anything <input type="checkbox"/> Other
3	What ingredients do you look for when buying an ED?	<input type="checkbox"/> Caffeine <input type="checkbox"/> Taurine <input type="checkbox"/> Lcarnitine <input type="checkbox"/> Guarana <input type="checkbox"/> Vitamins <input type="checkbox"/> Mineral salts <input type="checkbox"/> Flavourings <input type="checkbox"/> Don't pay attention
4	Do you consider the caloric value of an ED when choosing it?	<input type="checkbox"/> Yes, I prefer high-calorie drinks <input type="checkbox"/> Yes, I prefer low-calorie drinks <input type="checkbox"/> No, I do not
5	Do you consider the amount of caffeine and taurine in your ED when you buy it?	<input type="checkbox"/> Yes, I prefer high doses (caffeine 135 mg, taurine 600 mg) <input type="checkbox"/> Yes, I prefer medium doses of these products (caffeine – 30 mg, taurine – 200–240mg) <input type="checkbox"/> Yes, I prefer low doses of these products (caffeine – 20 mg, taurine – 100 mg) <input type="checkbox"/> No, I do not

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