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Are students at Krakow universities turning to energy-boosting dietary supplements?

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Abstract

Introduction. Recent studies have revealed an increase in the consumption of dietary supplements including frequency of use of caffeine, which is addictive and potentially harmful in higher doses. Energy drinks include high doses of caffeine and are particularly targeted at young people.

Objective. The aim of the study was to investigate the frequency of use of caffeine-containing energy products, associated factors and understanding the associated side- effects in university students.

Materials and method. A cross-sectional questionnaire-based survey was conducted among students of the 5 largest Universities in Krakow. Statistical significance was set at the 0.05 level.

Results. Around 35% of respondents reported the use of different supplements including high doses of caffeine. Frequency of caffeine-containing products consumption was significantly higher in female students compering to males. Also, those respondents who originated from big cities were more likely to use caffeine-containing products. The study revealed that these substances were also more popular among those participants who study economics. Most students use these substances in order to reduce feeling tired and the duration of sleep, others mainly to increase concentration prior to examinations. Almost one fourth of the group who used these substances admitted to having experienced some side-effects in the past. They suffered mainly from insomnia, but also from excessive stimulation and muscle trembling. Almost half of the substances users did not know of any potential side-effects**.**

Conclusions. Attempts should be made to increase public awareness of the side-effects of these substances, particularly among the student population. These campaigns should be targeted especially at female students who come from bigger cities. This study is a step towards drawing attention to this issue.

Key words

energy-boosting supplements, university students, caffeine overdose

INTRODUCTION

The consumption of energy-boosting dietary supplements are on the rise worldwide [1]. In Poland, they are widely accessible and are currently being sold over the counter in a variety of forms: energy drinks, water-dissolving tablets, capsules, or other solid dosage forms. Caffeine, which is the main acting substance in energy boosters, is addictive and potentially harmful in higher doses. It is the most commonly used psychoactive substance in the world and imposes a potentially harmful influence on health, academic performance, and personal adjustments [2]. With an increased prevalence of energy drinks in more than 140 countries, the availability and use of energy drinks is higher than ever before [3]. A recent study which reviewed the history, safety, and efficacy of caffeine-containing dietary supplements in the United States and Canada revealed that caffeine-containing energy drinks have lately gained a foothold in the world market, together with concerns about their tolerability [4]. The target demographic of these beverages, as well as predominant advertising efforts, is typically adults aged 21–35 and includes athletes, students, and young professionals [5, 6]. According to the authors, people consume energy drinks with the aim l of decreasing levels of sleepiness, and increasing their levels of performance and concentration. In several studies, energy drinks have been found to improve endurance performance, although the effects could be attributable to the caffeine and/or carbohydrate content [7]. Gunja and Brown reported that young adults and adolescents are particularly attracted to energy drinks because of effective product marketing, peer influence and lack of knowledge of the potential harmful effects [8]. It has been confirmed that these drinks do provide energy to those who consume them: a study found that energy drinks had energizing effects when compared to a placebo, among 18–55 year old participants [9].

Energy drinks typically contain 50–505 mg of caffeine per 8 ounces, which is roughly the equivalent of a half-liter of coffee or more than 2 liters of caffeinated soft drink, such as Coca Cola or Pepsi [10, 11]. In addition to caffeine, energy drinks contain many other ingredients such as guarana, ginseng, and ginkgo biloba, B vitamins, amino acids, such as taurine, amino acid derivatives carnitine, and sugar derivatives, such

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as glucuronalactone and ribose. Various herbal derivatives may also be present [10, 12]. The increasing use of energy drinks in Australia has concurrently led to an increase in calls to poison control centres due to the caffeine toxicity caused by these drinks [3]. Overdoses related to energy drinks have not been adequately measured in most countries, but Germany, Ireland, Poland and New Zealand have reported seriously damaging outcomes and even death [3, 13].

Health problems related to the consumption of energy drinks and other caffeine containing beverages occur for many reasons. High amount of caffeine can leave the user severely dehydrated due to the diuretic quality of the beverage [10]. Studies have also shown that acute caffeine consumption reduces insulin sensitivity, increases mean arterial blood pressure and heart rate, as well as inducing insomnia and poor sleep quality [14, 15, 16]. Overuse has been associated with cardiovascular, gastrointestinal and renal deficits, and also increased nervousness [17, 18]. The most recent literature also reports an association with heavy caffeine use and cerebrovasculopathy, acute mania, and new onset seizures [19]. Moreover, one study performed by Arria et al., found strong associations between regular energy drink consumption and alcohol dependence [20]. Finally, it has been reported recently that the frequency of energy drink use is a significant predictor of the illicit use of prescription stimulants [21].

Since energy drinks and other energy-boosting dietary supplements including caffeine are sold over-the-counter, the prevailing belief is that they cannot be harmful. Seifert and others noted that although the US Food and Drug Administration limits caffeine content in soft drinks, which are categorized as food, there is no such regulation for energy drinks, which are classified as dietary supplements [3]. While there are some studies which evaluate energy-boosting dietary supplements' consumption in other countries, little is known about their current use among students. Despite the fact that caffeine is an addictive substance and potentially fatal in higher doses, there has been no study conducted in Poland about the prevalence of consumption of the substances with its high concentration among university students [22].

OBJECTIVES

The study was conducted with the following aims:
1) to estimate the current frequency of use of energy boosting dietary supplements (stimulants) among the students at Krakow Universities;
2) to determine participants' own reasons for choosing the surveyed substances;
3) to gauge this population's understanding of associated side-effects.

MATERIALS AND METHOD

A cross-sectional questionnaire-based survey was conducted between January – March 2014 on a voluntary-basis among University students in Krakow, with a convenience quota sample. Every third student who was leaving lecture halls was invited to take part in the study. The data was collected by medical students and physicians who had all received appropriate training and instructions regarding the study protocol. The field work lasted 5 weeks. The data were gathered 5 days a week, during lecture hours, between 08:00–18:00. The following eligibility criteria needed to be met in order to participate in the study: age of at least 18 years, ability to give informed consent, being a student at one of the universities included in the study, and agreement to take part in the study.

The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki. The survey study was authorized by the Dean of the Jagiellonian Univeristy, and complied with ethical standards for the protection of human participants in research. Data were collected with the participants' informed consent and under strict confidentiality. Participation in the survey was completely voluntary and there was no incentive for being a participant (e.g., college credits/monetary). The study was conducted according to the rules of Good Clinical Practice.

Sampling. In order to collect 500 questionnaires the field workers asked 546 students at 5 five of the biggest universities in Krakow to participate in the survey (response rate: 92%). The average age of respondents was 22 years (SD +/- 2.29), with min.18, max. 36 years. The surveyed universities were: Jagiellonian University (JU), University of Science and Technology (UST), Krakow University of Technology (UT), Krakow University of Economics (UE) and Krakow University of Agriculture (UA). Recruitment of students continued until the target sample size was reached. The number of respondents from each university was fixed to be in proportion to the size of the university..

Research tool. The initial questionnaire was prepared based on data acquired from a review of international literature. Content validity was verified by two research team members with experience in the construction of questionnaires for research purposes. The agreed version of the questionnaire was piloted for its face validity among 42 students. Based on their comments and remarks, the final version of the questionnaire was developed which consisted of 13 questions: 6 open, 4 closed, 3 semi-open. The essential part of the questionnaire explored the usage of stimulants and perceived aspects of their side-effects. Data on the socio-demographic characteristics of the participants was also collected.

Statistical analysis. Statistical analysis was performed using Statistica 10 software (StatSoft Inc.). In order to present the characteristics of the respondents, descriptive statistics were used. To estimate the association of the respondents' characteristics on the self-reported use of stimulants, the Chi-square test was used for variables measured on a nominal scale, and Mann–Whitney U-test used for quantitative variables. Statistical significance was set at the 0.05 level.

RESULTS

Respondents' characteristics. Women represented 53% of the analyzed group of respondents, 48% of the respondents were students of the Jagiellonian University, 28% of the University of Science and Technology. Participation of the students of the University of Technology and University of Economics was equal – both 9%, whereas students of the University of Agriculture accounted for 6% of the whole studied group.

One-third of the respondents came from towns with less than 100,000 residents, 14% from towns with between 100,000–500,000 inhabitants, and 18% of the students came from cities with over 500,000 inhabitants, whereas 35% came from villages. Almost half of the respondents (44.5%) were currently renting a flat, approximately one- third of the group (26.5%) were living in their own homes with parents, one-fifth in students' hostels and 8% in their own apartment without parents.

Current use of energy boosting dietary supplements. The study revealed that 35% of respondents reported the use of different supplements, including high doses of caffeine, and 45% stated that they used these substances only during the examination period. 41% of all substances used by the study group were energy drinks. Almost one-third of respondents used multi-component tablets to dissolve in water, which included 200 mg of caffeine, magnesium, lecithin and vitamins. Other respondents used substances such as guarana, ginkgo biloba and B vitamins, which are sold individually.

Associations of respondents' characteristics with the use of energy boosting dietary supplements. The survey revealed that female students use substances to increase their concentration significantly more often than male respondents: 43% vs. 26% (p<0.001). The study showed that there is a significantly higher proportion of the stimulant use among students who originate from cities with a population greater than 500,000 (p=0.009), in fact, almost half of such students use these substances.

The study was further able to demonstrate that the popularity of energy boosting dietary supplements varied between universities. Students of the University of Economics reported a greater use of the studied substances than their colleagues from other surveyed universities (p=0.02). The survey did not reveal any associations between the energy boosting dietary supplements with participants' age nor location of residence during study period.

Details of respondents' comparative features are presented in Table 1.

Reasons for using energy boosting dietary supplements. The major reason for using stimulants reported by almost two-thirsd of stimulant users was a need to reduce the feeling of being tired and reduce the duration of sleep. Only slightly fewer of the respondents wanted to increase concentration prior to an examination. Almost a quarter of the stimulant users declared that they used them to increase their concentration during an examination. Among other reasons given by the respondents (10% of stimulant users) were: enjoying the effects of caffeine (4%), magnesium supplementation (2%), mood improvement (2%), stress reduction and stimulation before physical activity (1% each).

Interestingly, using energy boosting dietary supplements in order to increase concentration before an examination was statistically the reason more often given by those students who used those substances only during the examination period, compared to those using them during the whole year (67% vs. 50%; p=0.027). No other significant differences were found in motivations for stimulants' use, neither between students taking them all year and in examination time, nor between male and female students.

Table 1. Comparative features of students who declared using and not using stimulants

Respondent's characteristics	Stimulant User n=174 (35%)	Does not use stimulants n=326 (65%)	P-value
Gender			p<0.001
Female n(%)	114(43)	151(57)	
Male n(%)	60(26)	175(74)	
Age in years mean (+/-SD)	21.37 (1.71)	21.62 (2.54)	p=0.252 NS
Place of residence			p=0.009
Village n(%)	50 (28)	126 (72)	
Town <100,000 residents n(%)	55 (33)	113 (67)	
Town 100,000–500,000 residents n(%)	26 (38)	42 (62)	
City >500,000 citizens n(%)	43 (49)	45 (51)	
University			p=0.02
UE n(%)	21 (46)	25 (54)	
UA n(%)	12 (43)	16 (57)	
JU n(%)	91 (38)	151 (62)	
UT n(%)	16 (37)	27 (63)	
AGH n (%)	34 (24)	107 (76)	
Living away from parents			p=0.852 NS
Yes n(%)	37 (36)	67 (64)	
No n(%)	137 (35)	259 (65)	
Living with parents			p=0.785 NS
Yes n(%)	45 (34)	88 (66)	
No n(%)	129 (35)	238 (65)	

The reasons for using stimulants according to the respondents' gender and duration of use are presented in Figure 1.

Assessment of the effectiveness of energy boosting dietary supplements. Three-fourths of the students who reported using energy boosting dietary supplements believe that they are effective, whereas one-fifth of the same group were unsure about their effectiveness. Only 5% of the studied substances' users reported that they believe they are not effective.

Interestingly, the study showed that men considered energy boosting dietary supplements to be effective significantly more often than women (83% vs. 73%; p=0.012).

Knowledge of potential side-effects of energy boosting dietary supplements and prevalence of side-effects. Almost half of the students who used the surveyed substances

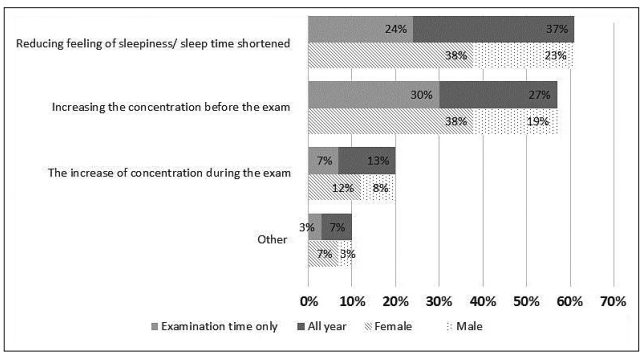

Figure 1. Reasons for use of stimulants by gender and duration of use

reported that they did not know of any possible side-effects, and 7% believed that there are no possible side-effects to using them. Students who were aware of possible side-effects, listed: insomnia (20%), excessive stimulation (25%) and addiction (15%). Also, these students indicated: gastrointestinal (GI) problems (13%), increase in blood pressure (11%) and trembling of hands (8%).

The survey showed that almost one-fourth of the students who declared that they used stimulants admitted to having experienced some side-effect in the past. Analysis of the data revealed that energy boosting dietary supplements users who experienced side-effects suffered mainly from insomnia (23%), excessive stimulation (20%) and muscle trembling (15%). Among GI problems (13%), students mentioned abdominal pain, nausea and diarrhea. Other forms of side-effects reported were addiction and increase in blood pressure (5% equally).

Figure 2 presents prevalence of side-effects among respondents who have used energy boosting dietary supplements and reported having side-effects, according to their gender and duration of use.

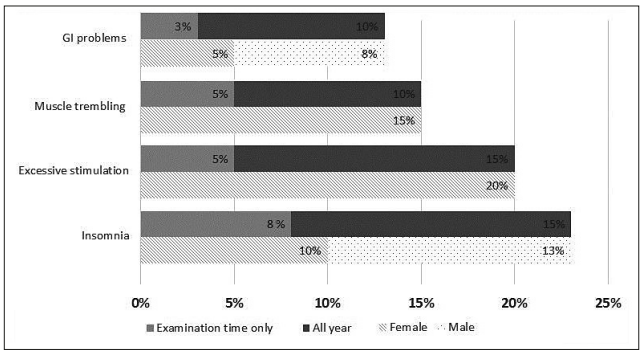

Figure 2. Prevalence of side-effects among respondents who have used stimulants and reported having side-effects, by gender and duration of use

DISCUSSION

Overview of main findings. The survey revealed that the most commonly used energy boosting dietary supplements among the surveyed group were energy drinks, followed by other multi-component products containing high doses of caffeine.

Despite the appearance of some serious side-effects from the surveyed substances use in the study group, its consumption was high. Moreover, almost half of the students taking these substances had no knowledge about any of the potential side-effects of using them.

Comparison with other studies. By documenting the frequency of use, reported side- effects and motivations behind consumption, it was possible to compare the obtained results with those of similar profile abroad. A study of energy drink consumption among college students attending a central Atlantic University in the USA found higher use in that area, with 51% of college students reporting consuming more than one drink per month [23]. Socio-economic or advertising prevalence could be factors contributing to this discrepancy, and future studies may seek to include such data in the surveys.

The current study found that the number one reason for students in using energy drinks was to reduce sleepiness, thereby confirming that students in both countries battle fatigue, and would benefit from information on improving sleep hygiene and the negative effects of reduced sleep. This information is relevant for the administrators of such institutions as they seek to understand what factors encourage stimulant usage. A frequently reported reason for energy drink consumption in the USA was to co-consume with alcohol while partying [23]. The growing trend of using energy boosting dietary supplements together with alcohol while partying is an increasing problem, and a future Polish study would benefit from exploring this issue [24, 25].

Another study found that energy drink users reported similar side-effects to those found in the current study, including palpitations and agitation [26]. Interestingly, in this cited study the authors found that some side-effects were occasionally reported even at manufacturer-recommended amounts of energy drink consumption, and were frequently reported with recreational use. In addition to the above-mentioned side-effects, agitation, gastrointestinal upset, chest pain, dizziness, paraesthesia, insomnia, respiratory distress and headaches were also reported by the respondents. This differs from results of the current study and may be due to the fact that energy drink consumers in Australia have a greater awareness regarding the possible side-effects of energy drinks. A Turkish study found that energy drink use among students of the arts and sports were the highest, whereas in the findings of the current study, students of economics were among the highest; however, students of economics were not included in the Turkish study [27]. In other studies it was noticed that energy drinks consumption was most common among Physical Education and Sport students [28, 29]. The presented study did not include students from this faculty, although it may be assumed that the most physically active students among all the included universities were from the faculty of economics.

The fact that JU students were using energy stimulants less often than others may be due to the fact that many of these students were from medical faculties. This group of students are expected to have more knowledge about the side-effects of the surveyed substances, and it can be assumed that they avoid consuming them. As shown in other studies, the percentages of medical students drinking energy drinks were lower than others.

A study performed in Turkey also found a statistically significant correlation with energy drink consumption and monthly income and alcohol use, thereby strengthening the argument for including these issues in future studies. This study found a similar lack of awareness of side-effects among college students [27]. A study performed in the USA found a similar level of use to the previously mentioned American study with 61% of users reporting using energy drinks [19]. They also demonstrated a correlation between frequency of energy drink use and alcohol addiction. This higher use reaffirms that there may be socio-economic reasons that promote consumptions of these beverages given their high cost.

Various case reports are available on the very serious consequences of large consumption of energy drinks, such as seizures, cardiac ischemia and hallucinations [26]. The lack of such reporting in the current survey might be due to the fact that energy boosting dietary supplements were

introduced to Polish market later than in other countries. One can expect an increase in consumption and therefore a growing problem concerning usage of those substances among Polish students. Additionally, long term-follow up studies are warranted given the findings of increased use in at-risk populations [3]. The findings of higher consumptions amongst students originating from urban areas points to an economic correlation with consumption, such as that found by Attila [27].

In another Polish study performed in 2011, the consumption of energy drinks among students was higher than in the presented study, over half the subjects drank energy drinks during examinations. This difference may have arisen from the fact that half of the respondents were students of the Faculty of Physical Education, who may be expected to be more physically active and wish to increase their fitness and performance levels to help them achieve better sports rankings [30]. Nevertheless, the authors of the current study did not analyze other energy boosting dietary supplements than energy drinks.

Contextualization of the findings. Although previous studies have examined the effects of energy drinks, other substances including high doses of caffeine should be considered a novel exposure. The high doses of caffeine, often in combination with ingredients with unknown safety profiles, mandates urgent research on the safety of these substances in students.

It is worth adding that the overuse of caffeine has been recently defined as 'Caffeine Use Disorder' in the classification of Substance-Related and Addictive Disorders in the fifth edition of the American Psychiatric Association's (APA) Diagnostic and Statistical Manual of Mental Disorders (DSM-5), which is also being considered by other countries [32]. While t current concerns of the US Food and Drug Administration about caffeine and caffeine-containing energy products has been reported recently, along with the current activities to address those concerns, there are no such publications in Poland [33].

Another important aspect of the topic are the other ingredients of the 'stimulants' widely used. In March 2003, the European Union's Scientific Committee on Food published a report summarizing its investigation into potential interactions of the ingredients in energy drinks. At the cardiovascular level, they concluded that: 'If there are any interactions between caffeine and taurine, taurine might reduce the cardiovascular effects of caffeine' [22]. One can expect that because of the lack of taurine in some energy boosting dietary supplements, they may potentially be more harmful than energy drinks.

This study has attempted to deal with the problem of substance use disorders and draw attention to risk for developing substance use disorders and addictions among students. Thus, early intervention in the area of substance use disorders should be strengthened, a development that appears to be highly desirable from the perspective of public health.

Strengths and limitations of the study. Despite large increases in the consumption of energy-drinks and other energy boosting dietary supplements, there are no studies analyzing this situation in Poland. To the best of the knowledge of the authors of the presented study, this is the first study of its kind. The strengths of the study are: a relatively large sample size and coincidental choice of respondents. It is also important to emphasize that the study was conducted in all the largest universities in Krakow, with a variety of students across different disciplines. The obtained data allowed determination of the individual factors which may have influenced the behaviour and habits of the students. The study was performed anonymously and it may therefore be assumed that the respondents answered the questions truthfully.

Nevertheless, the study also has some limitations. 1) Non-probability sampling was used for convenience. However, the aim was to gather useful data and information which would not have been possible using probability sampling techniques which require formal access to lists of surveyed populations. 2) Physical Education and Sport students were not included, and no separation was made between the medical faculties students and all JU students. Also, no generalizations can be made from the results among the Polish student population, as the survey was only conducted in Krakow. Differences in behaviours and attitudes can be expected between students of other academic centres in Poland.

CONCLUSIONS

The use of substances that increase the level of concentration is currently a popular practice among Krakow University students, despite the occurrence of some serious side-effects. This study showed that the awareness among students of the side-effects of energy boosting dietary supplements is unsatisfactory. This lack of knowledge shown among almost half of the study respondents could lead to some health problems. Therefore, a serious attempt should be made to increase public awareness of the side-effects of these substances, with particular emphasis among the student population. These campaigns should be targeted particularly at female students from the bigger cities, and to those studying economics, who are more at risk, as shown by this study. Young people should be aware of changes which energy boosting dietary supplement can cause to their bodies. Legal regulations regarding the marketing and advertising of energy drinks should be reconsidered in Poland.

Declarations

Ethics approval and oral consent to participate was obtained from the study participants, as well as oral consent for publication of the study results. The data and material collected is available on request from the corresponding author. The authors received no funding to perform the presented study, and declare that they have no competing interests.

Authors' contributions. All authors made substantial contribution to the study:

KN and AW designed the study and wrote the protocol. MN conducted literature searches and provided summaries of previous research studies, designed figures and table. AKK conducted the statistical analysis. JK, DD and SK collected the data and created the database. AW revised the article critically for important intellectual content. KN wrote the first draft of the manuscript and all authors contributed to, read and approved the final manuscript.

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