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IMPACT OF ENERGY DRINKS ON COGNITIVE FUNCTIONS AND CARDIOVASCULAR STATUS IN STUDENTS

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Abstract
Over the past decades, the consumption of energy drinks has increased significantly worldwide, particularly among adolescents and university students. These beverages are commonly used during periods of intense mental and emotional stress, such as exam preparation, late-night studying, or prolonged intellectual work. According to various studies, a considerable proportion of students regularly consume energy drinks in order to improve alertness, enhance concentration, and reduce feelings of fatigue.

Introduction

The main components of most energy drinks include caffeine, taurine, glucuronolactone, B-group vitamins, and various carbohydrates, most commonly glucose or sucrose. Caffeine is the primary pharmacologically active substance responsible for the stimulating effects of these beverages on the central nervous system. Its mechanism of action is mainly associated with antagonism of adenosine receptors (A1 and A2A), which leads to increased neuronal activity, enhanced release of neurotransmitters such as dopamine and norepinephrine, and activation of the sympathetic nervous system. From a pharmacokinetic perspective, caffeine is rapidly absorbed in the gastrointestinal tract,

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typically reaching peak plasma concentrations within 30–60 minutes after ingestion. Its elimination half-life averages 3–5 hours but may vary depending on individual metabolic characteristics.

Taurine is a sulfur-containing amino acid that plays an important role in regulating cellular osmotic balance, supporting the function of the nervous and cardiovascular systems, and modulating calcium flux in cardiomyocytes. It has been suggested that taurine may exert neuromodulatory and cardiotropic effects; however, its specific role within energy drink formulations remains the subject of ongoing research. Glucuronolactone is a glucose metabolite involved in detoxification processes and energy metabolism, although its physiological significance in the context of energy drink consumption is still not fully understood.

Despite their proposed stimulating effects, energy drinks may also be associated with a range of physiological changes, particularly affecting the cardiovascular system. Several studies have shown that even a single intake of energy drinks can lead to increases in blood pressure, elevated heart rate, heightened sympathetic nervous system activity, and alterations in cardiac electrophysiological parameters, including possible prolongation of the QT interval. These changes may have clinical relevance, especially in cases of frequent consumption or in individuals with underlying cardiovascular conditions.

In addition to cardiovascular effects, energy drinks may influence cognitive functions. Due to the presence of caffeine and other biologically active components, these beverages can temporarily increase wakefulness, improve attention, reduce subjective fatigue, and shorten reaction time. Some studies have also reported improvements in working memory and overall cognitive performance following energy drink consumption. However, findings in this field remain inconsistent. Alongside the reported positive effects, there is evidence suggesting potential adverse outcomes, such as increased anxiety, sleep disturbances, and possible impairment of decision-making processes at high doses of caffeine.

Thus, despite the widespread use of energy drinks among students, their impact on the human body remains a topic of ongoing scientific debate. In particular, it is important to evaluate both the acute cardiovascular responses and the potential effects on cognitive functions associated with their consumption.

Objective

The aim of this study was to evaluate the acute effects of an energy drink on cardiovascular parameters in university students, as well as to analyze data from contemporary scientific literature regarding the impact of energy drinks on cognitive functions.

Materials and Methods

This study was conducted to evaluate the short-term effects of an energy drink on cardiovascular parameters in university students. The research had an experimental design and was carried out at the Department of Propaedeutics of Internal Diseases No. 1 of Tashkent State Medical University.

The study included 14 volunteers—students in their 2nd to 4th years of study, aged between 19 and 23 years. At the time of the experiment, all participants were considered generally healthy and had no history of chronic cardiovascular diseases, endocrine disorders, or other conditions that could

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potentially influence the study results. Prior to the start of the study, the participants were informed about the purpose and procedures of the research and voluntarily agreed to participate.

To minimize the influence of external factors, participants were advised to refrain from consuming caffeine, energy drinks, alcohol, and nicotine for 24 hours before the experiment. They were also instructed to avoid taking medications and to limit intense physical activity during this period.

The tested beverage was a 250-ml can of the energy drink Red Bull. During the experiment, each participant consumed one can of the drink within approximately 5–10 minutes.

Cardiovascular parameters were assessed at three time points:

1. before consumption of the energy drink (baseline);
2. 30 minutes after consumption;
3. 2 hours after consumption.

At each stage, key physiological parameters were measured, including systolic and diastolic blood pressure and heart rate. Measurements were taken in the seated position after a short rest period using a standard sphygmomanometer.

In addition, all participants underwent electrocardiogram (ECG) recording in standard leads. Particular attention during ECG analysis was given to the QT interval and its corrected value (QTc), since changes in these parameters may indicate an effect of the beverage on the electrical activity of the heart.

Along with objective physiological measurements, subjective sensations reported by the participants were also recorded. After consuming the drink, students were asked to report any changes in their well-being, such as feelings of anxiety, tremor, headache, a sensation of increased energy, or palpitations.

The obtained data were processed using descriptive statistical methods. The main results are presented as mean values with standard deviation (M ± SD), which allowed a clear assessment of changes in the studied parameters at different stages of the experiment.

Results

Analysis of the obtained data showed that noticeable changes in several physiological parameters were already observed 30 minutes after the consumption of the energy drink. In particular, an increase in blood pressure and heart rate was recorded compared with baseline values.

The mean systolic blood pressure before consumption of the drink was 115.6 ± 4.1 mmHg. Thirty minutes after intake, this value increased to 123.2 ± 4.8 mmHg. Two hours after consumption, a partial return toward baseline was observed, with the value decreasing to 118.3 ± 4.6 mmHg.

A similar trend was observed for diastolic blood pressure. The baseline value was 72.8 ± 3.5 mmHg. Thirty minutes after consumption of the energy drink, it increased to 77.4 ± 4.1 mmHg, and after two hours it decreased to 74.9 ± 3.8 mmHg, approaching the initial level.

Changes were also observed in heart rate. The mean baseline heart rate was 71.4 ± 5.0 beats per minute (bpm). Thirty minutes after consumption of the energy drink, this parameter increased to 81.6 ± 5.9 bpm, indicating a stimulatory effect of the beverage on the cardiovascular system. Two hours after intake, the heart rate decreased to 76.2 ± 5.3 bpm, although it remained slightly above the baseline level.

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Analysis of electrocardiographic parameters revealed an increase in the duration of the corrected QT interval (QTc). Before consumption of the drink, the mean QTc value was 402.6 ± 16.3 ms, whereas 30 minutes after intake it increased to 418.4 ± 17.9 ms. In two participants, QTc values exceeded 440 ms, which may be considered a potentially unfavorable electrophysiological finding.

In addition to objective physiological changes, subjective sensations reported by the participants were also recorded. During the first hour after consumption of the energy drink, 3 students (21%) reported short-term symptoms such as anxiety, mild tremor, or headache.

When evaluating overall well-being, the majority of participants (approximately 60%) reported a temporary increase in energy and alertness during the first hour after consuming the drink. However, about two hours after intake, some participants experienced a gradual decline in their subjective energy levels.

Discussion

The results of the present study indicate that a single intake of a 250-ml energy drink may lead to short-term changes in cardiovascular parameters in healthy students. As early as 30 minutes after consumption, increases in systolic and diastolic blood pressure, heart rate, and prolongation of the QTc interval on electrocardiography were observed. These changes can largely be explained by the pharmacological effects of the main components of energy drinks, particularly caffeine.

Our findings are consistent with the results of several international studies. For example, in a study conducted by Steinke et al. involving healthy volunteers, the consumption of a 500-ml energy drink resulted in an average increase in systolic blood pressure of approximately 7–10 mmHg, as well as an increase in heart rate of about 5–7 beats per minute one hour after intake. The authors also reported prolongation of the QTc interval, suggesting that energy drinks may influence the electrophysiological properties of the myocardium.

Similar results were reported in a study by Shah et al., which evaluated the effects of energy drinks on electrocardiographic parameters in healthy individuals. The authors found that two hours after energy drink consumption, the QTc interval increased on average by 10–20 ms, along with a moderate rise in blood pressure. According to the researchers, these changes may have clinical significance, particularly in individuals who regularly consume energy drinks.

The increase in heart rate and blood pressure following energy drink consumption is primarily associated with the stimulating effects of caffeine. Caffeine acts as an antagonist of adenosine receptors and increases the activity of the sympathetic nervous system, which leads to enhanced catecholamine release, increased cardiac activity, and vasoconstriction. In addition, caffeine stimulates the central nervous system, thereby increasing alertness and reducing the sensation of fatigue.

Beyond cardiovascular effects, energy drinks may also influence cognitive functions. Several studies have shown that beverages containing caffeine and taurine can temporarily improve attention and reaction time. For instance, in a double-blind, placebo-controlled study conducted by Seidl et al., participants who consumed a beverage containing caffeine and taurine demonstrated improved cognitive performance and shorter reaction times during attention-based tasks.

Comparable findings were reported in a study by Giles et al., which examined the effects of individual components of energy drinks on cognitive performance. The authors found that caffeine improved

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working memory, enhanced concentration, and reduced reaction time during cognitive tasks. Participants also reported decreased fatigue and increased alertness.

In a study by Howard and Marczinski, energy drink consumption was shown to reduce simple reaction time and improve attention in young adults; however, it was also associated with increased levels of subjective anxiety and physiological arousal. Similar findings have been reported in several other studies, suggesting that the stimulating effects of energy drinks on cognitive performance are generally short-lived.

Nevertheless, the findings reported in the scientific literature remain inconsistent. Some studies have not demonstrated significant improvements in cognitive performance following energy drink consumption. For example, Peacock et al. reported that a combination of caffeine and taurine did not produce statistically significant changes in cognitive performance compared with placebo in healthy volunteers.

Overall, the results of our study support previous findings indicating that energy drink consumption may lead to short-term cardiovascular changes, including increased blood pressure, elevated heart rate, and prolongation of the QTc interval. At the same time, an analysis of the existing literature suggests that energy drinks may temporarily enhance certain cognitive functions, such as attention and reaction speed. However, these effects appear to be transient and may be accompanied by undesirable physiological responses.

Conclusion

Even a single consumption of an energy drink may lead to short-term changes in cardiovascular function, including increased blood pressure, elevated heart rate, and prolongation of the QTc interval. At the same time, energy drinks may temporarily improve attention, concentration, and reaction speed, which partly explains their popularity among students.

However, these effects are short-lived and may be accompanied by unpleasant symptoms such as anxiety or headache. Therefore, energy drinks should be consumed with caution and should not be considered a safe or reliable method for enhancing performance.

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