

MORPHOFUNCTIONAL FEATURES OF THE ORGANISM IN ENERGY DRINK ABUSE

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Abstract

The literature review highlights the prevalence of energy drinks consumption, and describes their main ingredients (caffeine, taurine, guarana, ginseng, sweeteners). Numerous facts are given that testify to the negative impact on human health (including deaths) of the systematic use of large amounts of these beverages, both independently and in mixture with alcohol. It has been shown that the cardiovascular system, central nervous system and liver are most affected.

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Energy drinks (energotonics) are a special type of carbonated drinks, which are positioned by their manufacturers as such, which increase physical activity and improve performance when consumed. The first energy drinks appeared on the market in the 60s of the XX century. Drinks of this class became especially popular in the 2000s of the XXI century, as evidenced by increased sales volumes [1]. For example, in European countries, the number of these units of energy drinks increased by 4.2% from 2014 to 2019 [2]. The Russian market of energy drinks is also expanding. So, if in 2010 106.7 million liters of these drinks were sold, then in 2015 this volume already amounted to 164 million liters [3]. According to the marketing company "Academy Service", this market is growing by 13% annually and in 2015 reached a sales level of \$ 15 billion [4]. As of 2019, there are more than 400 trade names of energy drinks in the world, which differ significantly in their composition. At the same time, regardless of the specific brand, the unifying property of all such drinks is the content in them of high doses of substances with stimulating / toning effect (caffeine, guarana, taurine, ginseng, L-carnitine, B vitamins, etc.).

Caffeine is a common psychoactive ingredient. In energy drinks, caffeine is in the form of a synthetic alkaloid, unlike tea or coffee. The amount of caffeine in energy drinks varies widely: from 33 mg to 150 mg per 100 ml of the product. The content of caffeine in energy drinks, the so-called "shots" (cans of small volume about 60 ml), is approximately 5-10 times higher than its concentration in one cup of coffee [5]. The amount of caffeine in brewed or instant coffee varies widely from 49 to 320 mg per serving [6].

Coffee contains anti-oxidants that reduce the negative effects of caffeine on the cardiovascular and digestive systems of the body [7]. Taurine, a derivative compound of the amino acid cysteine, is found in most of the varieties of energy drinks on the market about as often as caffeine. However, it is worth

noting that this compound is natural for the human body, because it is synthesized and contained in large quantities in muscles, liver. The human body can receive taurine from the outside when consuming meat, milk and seafood. There are no noticeable negative effects from the use of taurine, however, there are data indicating side effects of the use of taurine in large quantities [8]. Taurine can reduce the negative effects of alcohol exposure [9]. Another common ingredient of energy drinks is guarana extract (its main active ingredient is guaranin). According to its pharmacological properties, guaranin is similar to caffeine. This fact may mean that energy drinks containing both guarana and caffeine may have a double stimulating effect. Such a dose of stimulants can increase the negative effects of taking energy drinks on the human body [10].

Manufacturers of energy drinks claim that their product contains natural ingredients that increase energy, attention, concentration and are harmless to health. At the same time, the medical community around the world is concerned about the unpleasant consequences associated with the use, especially excessive, of "energetics", which are being registered more and more often. According to the data of the Australian Toxicology Center for the last 7 years (2011-2018), the most common symptoms after the abuse of energy drinks were arrhythmias, nervous excitement, tremor of the extremities and disorders of the gastrointestinal tract [11]. In the period from 2000 to 2012, the US Poison Control Center reported 5,105 cases of negative effects of energy drinks on the body, among which: 554 deterioration of general well-being, 1 death, 25 serious and 528 moderate disorders of the cardiovascular system. It is important to note that 44.7% of cases occurred with children under the age of 18 [12].

The American Association for Food and Drug Control (FDA [U.S. Food and Drug Administration]) in the period from 2004 to 2012 documented 168 cases of side effects associated with the use of energy drinks, including 16 deaths [12]. It is noteworthy that the reports describe only cases of side effects of energy intake, but there is no data on the volume of energy consumed in each case [5]. The greatest number of side effects from the use of energy drinks are observed from the cardiovascular and nervous systems, and to a lesser extent from the digestive systems and kidneys [13].

The effect of energy drinks on the cardiovascular system.

The negative consequences for the cardiovascular system of energy consumption are associated with the presence of coffee in their composition. It is widely known that the use of cocaine, especially in large doses, increases blood pressure, accelerates cardiac activity and can cause arrhythmia. The literature has documented cases of atrial fibrillation in a patient with dilated cardiomyopathy who developed seizures after stopping excessive caffeine consumption [14]; conducted on volunteers, showed that the use of one can of "Red Bull" causes an increase in *cardiomyopathy* [25], *postural orthostatic tachycardia* Sappop M.E. et al. [18] described a fatal case of this arrhythmia in a girl with mitral valve prolapse, and Ward A.E. et al. *paroxysmal ventricular tachycardia* was diagnosed in a patient with a Fallot notebook [19]. In addition to arrhythmias, which are the most frequent violation of cardiac activity (observed in 34% of cases) [18] with the use/abuse of energy drinks, it should also be noted cases of *coronary spasm* [20], *acute myocardial infarction with ST segment elevation* [21], *prolonged QT syndrome* [22], *aortic aneurysm dissection* [23], *cardiac arrest* [24], *Takotsubo syndrome* [26], *acute coronary thrombosis* [27]. Studies by Grasser E.K. et al. showed that systolic pressure by 10 mmHg and diastolic pressure by 7 mmHg, increases the heart rate by 20 beats per minute and slows down the speed of cerebral blood flow by 7 cm/s. The authors point to caffeine and taurine as the most dangerous ingredients in the composition of energy tonics in relation to the cardiovascular system, and the main pathophysiological mechanisms are considered to be increased platelet aggregation and endothelial dysfunction. The effect of energy drinks on the liver. The liver is the most sensitive organ of the digestive system to excessive consumption of energy drinks. The first cases of liver damage caused by the use of energy drinks were described in the scientific literature in 2011. Thus, Vivekanandarajah et al. Described a case of acute hepatitis in a 22-year-old girl who consumed about 10 cans of drink a day every day for two weeks (the trademark is not specified). In the same year, Apestequi C.A. et al.

described a case of cholestatic hepatitis in a patient with a transplanted liver after drinking 16 cans of Red Bull for three days. A similar clinical situation was reported by Harb J.N. et al. A 52-year-old man who consumed 3-4 cans of energy (brand not specified) per day for 3 weeks. Signs of acute hepatitis were found: increased levels of amino transferases and direct bilirubin in the blood; increased echogenicity of the liver and diffuse thickening of the gallbladder wall during ultra sound examination; bridge necrosis and pronounced cholestasis in the biopsy material. The authors associate the hepatotoxicity of energy drinks with vitamin B3 (vitamin PP, nicotinic acid or niacin) contained in them, which exhibits hepatoprotective properties in small doses, and in excess amounts has a direct toxic effect on liver tissue.

Conclusion

Analysis of the literature data with a high degree of persuasiveness indicates that excessive consumption of energy drinks can have an extremely adverse effect on human health and can lead to the development of multiple organ failure, with damage primarily to the cardiovascular, central nervous systems, as well as the liver and kidneys. To substantiate the indications /counter-indications and recommendations for the use (volumes and dosages) of energy tonics, it is necessary to obtain a clear evidence base based on conducting comprehensive clinical, laboratory, instrumental and experimental morphological studies. Conflict of interest. The authors declare that there is no conflict of interest.

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