German Federal Institute for Risk Assessment

FAQ

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EDKAR study: How does chronic high consumption of energy drinks affect the cardiovascular system of adolescents?

Energy drinks are caffeinated soft drinks that are often advertised as boosting concentration and physical performance. These drinks are very popular among adolescents. Possible acute effects associated with high consumption are well known, such as increased nervousness and excitability, tremors, sweating, increased blood pressure and palpitations. The EDKAR study, led by the BfR in cooperation with Charité - Universitätsmedizin Berlin, investigated whether long-term high consumption of energy drinks is harmful to the heart health of adolescents. Following the publication of the initial results, the BfR compiled a list of selected questions and answers.

What are energy drinks?

Energy drinks are caffeinated soft drinks that contain one or more additional substances such as taurine, glucuronolactone or inositol in addition to caffeine. The drinks are available in various portion sizes and are often advertised as increasing concentration and physical performance. Energy drinks should not be confused with hypo- or isotonic carbohydrate-containing sports drinks, which are designed to compensate for the loss of energy, water and electrolytes during physical exertion.

What does EDKAR stand for?

EDKAR stands for "Energy Drinks and Cardiological Risk". The study was conducted by the BfR in cooperation with Charité from March 2022 to May 2024. The aim was to investigate the possible health consequences of chronic high consumption of energy drinks on the cardiovascular system of adolescents (aged 15-18). A scientific publication of the first results was released in 2025 (more information here). A further publication is in preparation.

How is the EDKAR study structured?

The EDKAR study consisted of two phases, the first of which involved an online survey of 5,100 Berlin school students aged 15 to 18. Based on the information provided in the online questionnaire, the first phase of the study served as a screening study to identify adolescents with chronically high energy drink consumption and a control group. In the second phase of the study, some of the identified study participants underwent comprehensive cardiological examinations at Charité.

The EDKAR study is an observational study. As the name suggests, participants and any possible health effects of their behaviour are only observed and described in such a study. No active intervention was planned, as it is not ethically justifiable to give adolescents energy drinks containing caffeine in excess of the levels considered safe by the European Food Safety Authority (EFSA) over a longer period of time (3 milligrams (mg) of caffeine per kilogram of body weight per day).

What characterises the chronic heavy consumers and the control group in the EDKAR study?

The EDKAR study defined chronic heavy consumers of energy drinks as adolescents who had been drinking these beverages at least 4 days a week for at least 1 year and who had consumed more than 3 milligrams (mg) of caffeine per kilogram of body weight per day through these beverages. The European Food Safety Authority (EFSA) does not expect any adverse health impairments in children and adolescents up to this level of caffeine intake. With a commercially available caffeine concentration of 32 mg per 100 ml in energy drinks, adolescents weighing 50 kilograms would exceed this value by consuming one 500 ml can or two 250 ml cans per day. In the EDKAR study (study phase 2), the median caffeine intake from energy drinks among chronic high consumers of energy drinks was 4.5 mg of caffeine per kilogram of body weight per day. The minimum in this group was 3.02 and the maximum was 14.55 mg of caffeine from energy drinks per kg of body weight per day.

The identified adolescents in the control group had not consumed any energy drinks in the past 12 months and had not consumed more than 80 mg of caffeine per week from other caffeinated beverages such as coffee, tea, cola or certain sports drinks. To calculate weekly caffeine intake, the frequency of consumption of coffee drinks (90 mg caffeine/cup), black/green tea (38 mg caffeine/cup), drinking chocolate (30 mg caffeine/cup), cola/mate drinks (31 mg caffeine/glass), iced tea (10 mg caffeine/glass) or sports drinks (225 mg/serving) was used as a basis.

What was investigated in the EDKAR study?

For the first phase of the EDKAR study, 5,100 adolescents between the ages of 15 and 18 were initially surveyed at Berlin schools (including vocational schools) using an online questionnaire. In the questionnaire, the adolescents provided information about their consumption of energy drinks and other caffeinated beverages, as well as their leisure and health behaviours. Numerous lifestyle factors were surveyed, such as whether the adolescents smoked or drank alcohol and, if so, how much. The primary goal of this first phase of the study was to identify adolescents with chronic high consumption of energy drinks and a control group.

The data from the online questionnaire in study phase 1 was used to identify adolescents with chronic high consumption and the control group. A total of 288 chronic high consumers of energy drinks and 424 adolescents for the control group were invited to participate in study phase 2, which involved a cardiological examination at the Charité hospital. Of the 288 high consumers invited to participate, 99 young people responded, while 160 of the 424 young people invited to participate in the control group responded, meaning that a total of 259 schoolchildren underwent cardiological examinations. Data from 97 young people with chronic high consumption could be included in the statistical analysis; one participant had to be excluded due to lower energy drink consumption ($\leqslant$ 3 mg caffeine/mg body weight/day) and another due to a pre-existing cardiac condition. With regard to the control group, all 160 pupils examined could be included in the statistical analysis.

As part of the cardiological examination, electrocardiogram parameters, blood pressure and heart rate were determined, and the heart structures were analysed in detail using echocardiography. A total of 27 cardiological parameters were determined for all participants. The study physicians were blinded during the examinations, meaning they did not know whether they were examining a person from the chronic high-consumption group or the control group. The study examined whether there were differences in the parameters examined between the two groups.

How did the adolescents who chronically consumed large amounts of energy drinks differ from the control group, apart from their energy drink consumption?

In addition to the cardiovascular parameters analysed, a wide range of other characteristics were recorded for the participants examined, including age, gender, type of school, smoking behaviour, physical activity and sleeping habits. There were no differences between the two groups in terms of age and gender. However, compared to the control group, the adolescents with chronic high energy drink consumption had a higher BMI (body mass index), smoked tobacco and/or marijuana more frequently and drank alcohol more often. They also slept less during the week than adolescents who did not drink energy drinks. More than half of the high consumers (53.6 per cent) slept less than 6 hours on school days, compared to significantly fewer in the control group (12.7 per cent). The picture was similar at weekends.

The lifestyle factors examined are important influencing factors for cardiovascular function; they are known as "confounders". They were therefore taken into account in the statistical analysis of the cardiovascular parameters. The researchers first conducted a simple comparison to identify differences in cardiological parameters between chronic heavy consumers and the control group. The influence of confounding factors such as age, gender, physical activity, smoking, marijuana use, alcohol consumption and school type was then taken into account in the statistical models.

What is the result of the cardiological examination in the EDKAR study?

The evaluation of the data from phase 2 of the study showed that, when confounders were taken into account, the cardiac parameters examined in adolescents with chronic high consumption (97 individuals) did not differ from those in the control group (160 individuals). No differences were found in systolic and diastolic blood pressure values, and no

abnormalities were found in the ECG; the values of almost all test subjects were within the normal domain. The normal values for adults were used for the assessment. Taking into account the physical constitution (weight and height) of all EDKAR participants who underwent cardiological examinations, as well as their age of 15-18 years and their proximity to adult values, it is reasonable to use the limit values for adults.

In the echocardiographic examination, which allows the heart structure to be analysed in detail, the researchers initially found a statistically significant difference between participants with chronic high consumption of energy drinks and the control group in one of the 21 parameters examined: The septum, i.e. the wall separating the left and right sides of the heart, was thicker in high consumers than in the control group – but only when confounding factors such as age, gender, smoking behaviour and alcohol consumption were not taken into account in the statistical evaluation (see question "How do adolescents who chronically consume large amounts of energy drinks differ from the control group, apart from their energy drink consumption?"). When the various confounding factors were included in the analysis, the difference was no longer statistically significant.

In addition, such a large number of comparisons (21 different parameters in the echocardiographic examination alone) requires statistical control of so-called "false positive results". This is because when a large number of tests are performed, the probability that a result will be significant by chance alone increases. After applying the appropriate statistical correction, no differences in the cardiological parameters examined were found between the two groups, even without taking confounders into account.

Why were not all adolescents with chronically high energy drink consumption examined cardiologically?

Of the 5,100 participants, the identified chronic high consumers and controls were given an invitation (by letter) for phase 2 of the study by the teaching staff in the second phase of the study. The students responded to this invitation individually by telephone, e-mail or enclosed reply form to the study centre at the BfR. A total of 288 chronic high consumers of energy drinks and 424 corresponding controls (no energy drink consumption; less than 80 mg of caffeine from other caffeinated beverages per week) were invited to participate in the cardiological examination at the Charité University Hospital ( ) .

Of the 288 heavy consumers invited, 99 adolescents responded and agreed to undergo the cardiological examination. One subject had to be excluded from the statistical analysis because their energy drink consumption was actually lower (≤ 3 mg caffeine/mg body weight/day) and another because they had a pre-existing cardiac condition (exclusion), so that in the end, data from 97 boys and girls who underwent cardiological examinations at the Charité could be included in the statistical evaluation. Of the 424 adolescents invited from the control group, 160 responded to the invitation and underwent cardiological examination. In the case of minors, the cardiological examination was carried out in both groups with the consent of their parents.

Are there any differences between the study participants who agreed to undergo the cardiological examination and those who did not want to participate?

A total of 288 chronic heavy consumers were invited to undergo a cardiological examination, but only a third of these adolescents actually took part. The remaining participants did not accept the invitation. (See question: "Why were not all adolescents with chronically high energy drink consumption given a cardiological examination?"). In order to rule out any differences between the groups that could influence the examination results, the researchers compared the characteristics of the participants in detail. They found no differences between participating and non-participating heavy consumers in terms of gender, age, education, BMI, sporting activity and alcohol consumption.

In the control group (424 invitations, 160 participants in the cardiological examination), only statistical differences were found in terms of gender, education and alcohol consumption: boys, vocational school students and participants with higher alcohol consumption were less likely to accept the invitation.

What does the study say about the possible long-term effects on the heart of high energy drink consumption?

The study results do not mean that no health consequences for the heart could become apparent in later years. The EDKAR study examined adolescents who stated in the survey that they had been consuming large amounts of energy drinks regularly for at least 12 months (see question: "What characterises the 'chronic heavy consumers' in the EDKAR study?"). For this specified period, the researchers were unable to identify any negative effects of energy drink consumption on the heart health of adolescents aged between 15 and 18 in the cardiological examinations they carried out. The cardiovascular system of adolescents between the ages of 15 and 18 may be sufficiently adaptable to cushion the potential cardiovascular effects of chronic high energy drink consumption. The EDKAR study was conducted as a cross-sectional study. In this observational study, participants were asked about their energy drink consumption on a one-off basis and underwent a cardiological examination. Therefore, the EDKAR study does not allow any conclusions to be drawn about the health consequences of high energy drink consumption later in life. This also applies to the other risk factors examined or to the combined consumption of energy drinks and alcohol.

The acute negative effects of high energy drink consumption were not investigated in the EDKAR study. These were already assessed in an earlier opinion by the BfR in 2019.

Is the consumption of energy drinks associated with health risks in adolescents?

The BfR has repeatedly stated that high consumption of energy drinks can have acute negative health consequences. Excessive consumption of energy drinks can lead to temporary heart palpitations, shortness of breath, muscle tremors, severe nausea, anxiety, nervousness and changes in the electrocardiogram due to high caffeine intake.

In particular, the simultaneous consumption of large amounts of alcohol and/or extensive physical activity can have an additional negative effect on the cardiovascular system as the effects could reinforce each other.

Case reports[1] have documented the following symptoms after high consumption of energy drinks and simultaneous consumption of large amounts of alcohol or other drugs, or simultaneous intensive exercise, serious health impairments such as cardiac arrhythmia, in some cases resulting in death. It is not possible to determine whether one factor is causally responsible for these consequences or whether it is the interaction of all parameters cannot be deduced from Do not derive from case reports. In addition, pre-existing medical conditions may also have played a role.

Many energy drinks have a relatively high sugar content. Although they provide a lot of energy in the short term, the high sugar content can delay fluid absorption through the digestive tract.

Are the results obtained from schoolchildren in Berlin transmissible to other regions?

The EDKAR study only examined schoolchildren from Berlin. The result cannot therefore be readily transmissible to adolescents from other regions, e.g. rural areas or other cities, as they may differ in terms of consumption behaviour and the other lifestyle factors mentioned.

Further information on Energy Drinks

Chronic high consumption of energy drinks is not initially associated with cardiological impairment in adolescents
https://www.bfr.bund.de/en/press-release/chronic-high-consumption-of-energy-drinks-is-not-initially-associated-with-cardiological-impairment-in-adolescents/

Coffee, energy drinks and caffeine powder: Energizers with health risks?
https://www.bfr.bund.de/en/service/frequently-asked-questions/topic/frequently-asked-questions-on-caffeine-and-foods-containing-caffeine-including-energy-drinks/

Excessive consumption of energy drinks increases health risk for children and adolescents
https://www.bfr.bund.de/en/press-release/excessive-consumption-of-energy-drinks-increases-health-risk-for-children-and-adolescents/

[1] https://www.tandfonline.com/doi/epdf/10.1080/00325481.2015.1001712?needAccess=true

About the BfR

The German Federal Institute for Risk Assessment (BfR) is a scientifically independent institution within the portfolio of the German Federal Ministry of Agriculture, Food and Regional Identity (BMLEH). It protects people's health preventively in the fields of public health and veterinary public health. The BfR provides advice to the Federal Government as well as the Federal States ('Laender') on questions related to food, feed, chemical and product safety. The BfR conducts its own research on topics closely related to its assessment tasks.

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