ORIGINAL RESEARCH

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The state of the cardiovascular system in female students after use of different doses of caffeine

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Abstract

Our article is devoted to the study of the state of the cardiovascular system in female students after the use of different doses of caffeine. Drinking 200 mg of coffee leads to a significant increase in heart rhythm and diastolic blood pressure in girls. The maximum values of heart rate (HR) and blood pressure are reached 1 hour after caffeine intake. Thus, in this case, reported is an increase in the heart rhythm by 12.7% ($P < 0.05$), a rise in the high blood pressure by 8.8% and that in the low blood pressure level by 12.0% ($P < 0.05$), as compared to the respective initial values thereof. After drinking 100 mg of coffee, there are no significant changes in the indicators of the cardiovascular system performance recorded: an increase in the heart rate after 1 hour has been reported to be 9.5%, a rise in the systolic blood pressure (BPs) has reached 5.0% and that in the diastolic one (BPd) 6.4%, as compared with the values of the reference group. The use of different doses of caffeine does not lead to significant changes in the duration of the waves and segments on the electrocardiogram. 3 and 6 hours after drinking coffee, the indicators of the cardiovascular system are gradually decreasing, approaching their respective initial values.

Keywords

Caffeine, Heart rate, Arterial blood pressure, Waves and segments of the electrocardiogram

Imprint

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Coffee is recognized as favorite beverage for many people in the world. Many countries in Latin America both produce and heavily consume it since it is suggested that coffee is native to the Latin America region [15].

Coffee is a big industry in this region**.** It is known that there are about 90 species found throughout the world which belong to the genus *Coffea*.

Considering the volume of coffee produced by 65 countries in the world, Brazil is accounted for nearly 40 percent of the worldwide coffee production. The total output of coffee beans amounts to 4,5 million tons per year. There are about 50 countries in the world, which supply coffee to the global market [7].

Many of us have the habit of drinking our morning coffee. So, according investigations, people on Earth every day consume about 1600000 cups of this beverage.

There are two species of coffee which dominate in the coffee-drinking world: they are Arabica and Robusta, which comprise 98% of the total coffee production. Women are known to prefer Arabica because of having a more extensive tasting range and being softer and sweeter, while men like much more Robusta due to its harsher taste [11].

It is common knowledge that the benefits offered by coffee are attributed to its rich phytochemistry, which includes up to 20000 different substances and compounds.

Coffee contains a wide variety of organic constituents: proteins, fats, carbohydrates, acids and aromatic compounds [2].

The most attractive substance in the coffee composition is caffeine which has addictive properties [9].

So, the profiling component of coffee is caffeine, which is capable of enhancing the physical and mental performance, suppressing hypodynamia, eliminating fatigue and sleepiness [6]. In 1820, F. Runge isolated relatively pure caffeine for the first time; and in 1897 H. Fischer first synthesized caffeine from its chemical components [8].

According to the reference literature data, the caffeine effect can last up to 6 hours, however the level of caffeine in blood peaks about one hour after its consumption. It can take 24 hours to completely clear caffeine from the bloodstream.

Coffee is not a neutral product that has developed a wide variety of opinions on its use. Some research-

ers think it enhances the performance, boost memory, stimulate digestion and provide BMI control, while the other believe it makes a negative effect on the state of the cardiovascular system [4].

Due to an enhancement in excitability of the nervous system, coffee stimulates the performance of the cardiovascular system as follows: it increases the heart rhythm, provides a vasoconstricting effect and accelerates the blood flow in the blood vessels.

Caffeine provides relief for a headache induced by vasodilation because of making its vasoconstricting effect on the brain blood vessels [5].

This alkaloid by stimulating the respiration center produces an increase in the breathing rate per minute and in the tidal volume [3].

Caffeine is considered as one of the antidepressants, therefore the coffee lovers tend to show a reduced risk of suicide, demonstrate their resistivity to stress and a better adaptability, and they have lower mortality rates [16].

Regular coffee ingestion decreases risks of diabetes mellitus due to increasing the sensitivity of the organism to insulin [14].

It has been found that caffeine with its enhanced effect of producing some enzymes, preventing liver cancer and cirrhosis, is capable of counteracting these diseases [17].

At the same time, against the background of all the benefits and advantages listed above, coffee can be the major cause of such disorders like insomnia, stomach ulcer, infertility, premature delivery, function disorders of the liver, the adrenal glands, abnormal clearance of some mineral substances with a suppressive effect produced on the performance of all organs in the organism. The lethal dose of caffeine is a single dose of 10-20 mg [10].

The cardiovascular system is one of the most important systems in the organism, so that studies of the states of the cardiovascular system after the coffee consumption become topical.

Materials and methods

Our studies were conducted by the University's Laboratories of Physiology and Anatomy of Humans and Animals. The subject of our study has covered 50 female students, which have been divided into 2 groups, 25 girls in each group.

The cardiovascular system data were measured both before the use of 100 and 200 mg coffee (one and two Arabica coffee cups, respectively) and 1, 3 and 6 hr after the coffee consumption, employing the OMRON M3 Expert blood pressure machine and the Alton-03 ECG recorder.

For the purpose of biometric analysis of the experimental material we applied the Bio-statistics software.

Results and discussion

Table 1 and 2 supported by Figure 1 and 2 give us the data on the cardiovascular system performance in female students after the use of 100 and 200 mg caffeine, respectively.

Upon analyzing them, we may conclude that the average level of some data is above the upper limit of the respective physiological norm. Consumption of 100 mg caffeine does not lead to essential changes in the cardiovascular system performance data.

Upon expiration of one hour after the coffee congestion we recorded an increase in the heart rhythm by 7 beats, and after 3 and 6 hours we revealed an increase therein by 4 beats and 1 beat, accordingly, as compared with the initial value.

The level of systolic pressure measured 1 hour after the coffee use has increased by 6 mm Hg, and that recorded 6 hours thereafter has returned to its initial value of 119 mm Hg.

The blood diastolic pressure changes traced have been found to be similar to those of the systolic pressure. So, the diastolic pressure value recorded 1 hour after the coffee use has shown an increase of 5 mm Hg, and 6 hours after thereof it was reported to be 1 mm Hg lower than the reference value of 78 mm Hg.

The durations of the ECG waves and segments measured 1 hour after the coffee consumption are slightly reduced, and upon expiration of 6 hours their durations are found to be close or equal to the respective reference group values.

So, a reduction in the durations of the P wave, the PQ, QRS and QT intervals upon expiration of 1 hour has been recorded to be 0,005; 0,006; 0,005 and 0,009 seconds, respectively, and after 6 hours thereof the durations of the atrial systole and the atrium-ventricle conductivity time have reached their respective initial values again, while the QRS and QT durations have been reduced up to 0,001 below the reference group value.

Our analysis of the obtained data has shown that consumption of 200 mg caffeine induces significant changes in the heart rhythm and the diastolic pressure,

Table 1

Data on heart rate and arterial pressure in female students after the use of caffeine

Groups		Coffee dose, mg					
		100			200		
		Heart rate, per minute	Syst. AP mm Hg	Diast. AP mm Hg	Heart rhythm, beats per minute	High blood pressure, mm Hg	Low blood pressure, mm Hg
Reference		74±2,6	119±3,2	78±2,4	71±2,2	114±3,3	75±2,1
Time expired after coffee use, hrs	1	81±2,9	125±3,5	83±2,7	80±2,51*	124±3,6	84±2,4*
	3	78±3,5	122±4,1	80±3,3	76±3,1	119±4,2	78±3,1
	6	75±3,8	119±4,4	77±3,5	72±3,3	115±4,4	75±3,2

*P < 0,05

Table 2

Effect made by caffeine on ECG parameters in female students

ECG parameters	Coffee volume, mg			
	Reference	Hours after coffee use		
		1	3	6
100				
P, s.	0,073±0,0034	0,068±0,0037	0,070±0,0041	0,073±0,0044
PQ, s.	0,146±0,0089	0,140±0,0092	0,144±0,0098	0,146±0,0101
QRS, s.	0,088±0,0042	0,083±0,0044	0,085±0,0049	0,087±0,0052
QT, s.	0,338±0,0064	0,329±0,0067	0,334±0,0072	0,337±0,0075
200				
P, s.	0,078±0,0035	0,074±0,0040	0,076±0,0040	0,077±0,0041
PQ, s.	0,155±0,0088	0,149±0,0090	0,152±0,0092	0,154±0,0093
QRS, s.	0,092±0,0052	0,085±0,0055	0,089±0,0057	0,092±0,0060
QT, s.	0,349±0,0048	0,339±0,0054	0,345±0,0059	0,348±0,0059

while the other studied data in the female students have not shown any considerable changes.

So, an increase in the heart rate and that in the diastolic pressure value upon expiration of 1 hour after the coffee use has reached 9 beats per minutes (P < 0,05) and 9 mm Hg (P < 0,05), accordingly, as against their respective initial values.

The upper high pressure value upon expiration of 1 hour after the coffee consumption has become 10 mm Hg greater as compared with the reference, and 6 hours after the coffee use it has approached the reference group level.

The congestion of 200 mg caffeine has also not lead to any significant changes in the ECG parameters recorded in the girl students.

So, 1 hour after the use of 200 mg caffeine we observe a moderate decrease in the ECG parameters in the female students, and upon expiration of 6 hours the above parameters increase reaching the level recorded in the reference group.

A reduction in the duration of the P wave reported 1 hour after the coffee use is 0,004 seconds, a decrease in the PQ interval duration reaches 0,006, a reduction in the duration of QRS is 0,007, and the lowering of the QT interval has been recorded to be 0,010 seconds referred to the respective initial values thereof.

6 hours later, the P wave, the PQ and QT durations have been found to be 0,001 seconds below the initial values, and the QRS duration has become equal to the respective initial parameter.

It is evident that the significant increase in the heart rate in the arterial pressure values in the girl students after the caffeine intake takes place due to stimulation of the activity of the sympathetic nervous system and the vasomotor center in the medulla oblongata.

There is no consensus among the researchers of how caffeine makes its impact on the heart rate since it may be explained both by an increased secretion of adrenaline and elevated excitability of the parasympathetic nerve suppressing the heart performance [21].

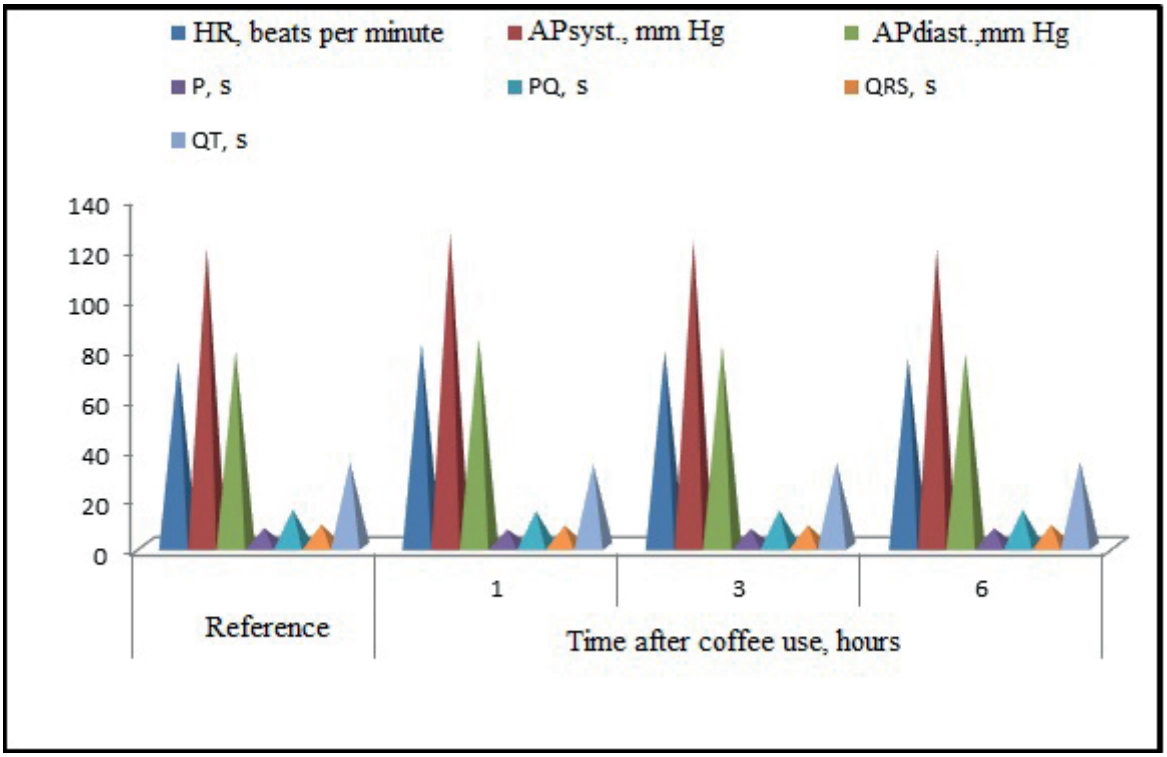

Figure 1. Dynamics of data on the cardiovascular system performance in female students after use of 100 mg caffeine

Caffeine induces an enhanced performance of the myocardium. This results in an increase in the heart rhythm and arterial pressure [19]. The heart contractility boost and a greater release of glucose by the liver are attributed to the action of adrenaline.

According to N.A. Agadjanian [1], the excitation of the vasomotor center is provided by the action of caffeine.

This initiates the vasoconstriction in the digestive system and the vasodilation in the heart that makes possible to re-distribute blood within the organism and accelerate blood velocity.

In this case, an insignificant increase in the blood pressure is observed. All the changes are aimed at promotion of the battle of the organism against fatigue. Upon the caffeine effect, the coronary vessels of the

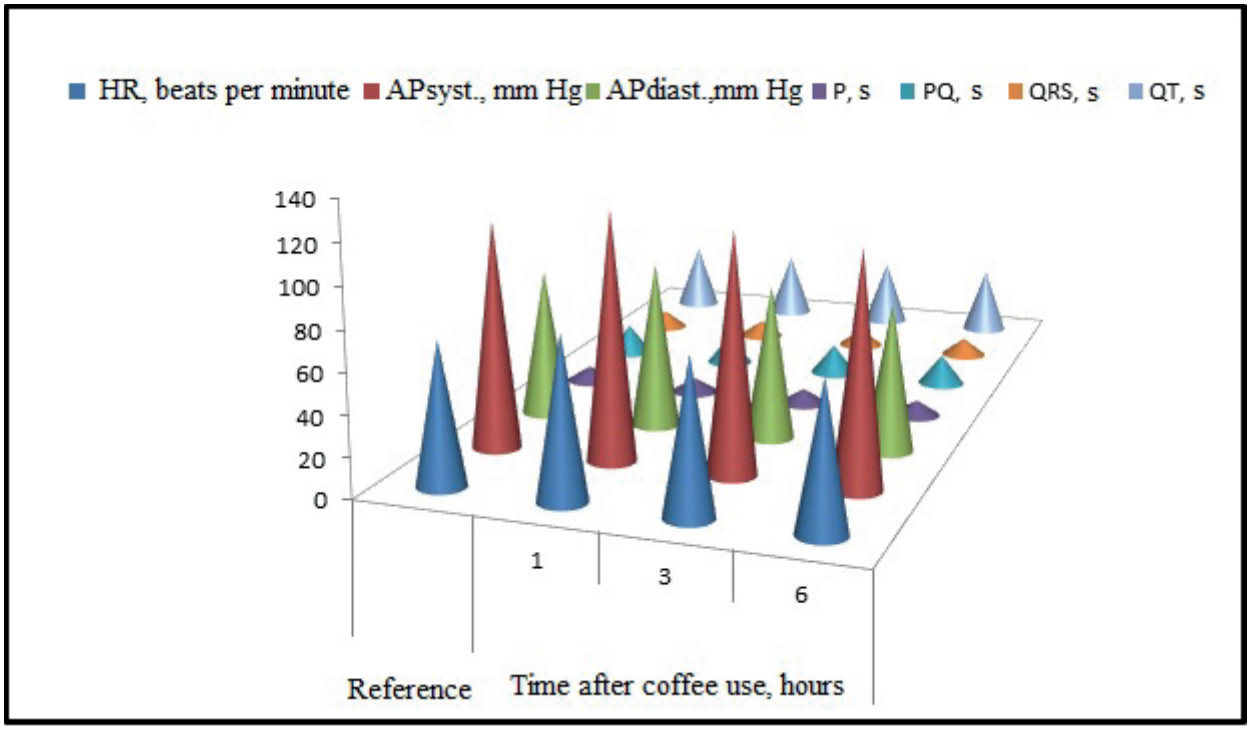

Figure 2. Changes in the data on the cardiovascular system performance in female students after intake of 200 mg coffee

heart dilate, while the cerebral blood vessel constrict that is the reason of taking caffeine in migraine [13].

As reported by Lovallo W.R. [et al.], the coffee consumption by human individuals with low and normal blood pressure induce an insignificant blood pressure rise, and the use of coffee by human subjects with higher blood pressure causes a significant increase in their blood pressure level. Irregular coffee congestion is capable of raising the arterial pressure by 10 mm Hg [18]. The coffee lovers show a minor dependence of the arterial pressure on the coffee use [20].

The consumption of the coffee amount of 100 mg has not lead to any significant changes in the examined parameters, while the intake of 200 mg, upon expiration of 1 hour, has resulted in the significant increase in the heart rhythm and the diastolic pressure value in the female students.

Conclusions

1. The consumption of 100 mg caffeine does not make any significant impact on the parameters of the cardiovascular system performance in the female students participated in the study.
2. Upon expiration of one hour after the use of 200 mg coffee, observed are a significant increase in the heart rate and the diastolic pressure values in the female students.
3. The heart rate recorded 1 hour after the intake of 100 and 200 mg caffeine increases by 9,7 and 12,7 beats per minute ($P < 0,05$), respectively, and the systolic pressure by 5,0 and 8,8 mm Hg, accordingly, as compared with the respective initial values.
4. After the consumption of 100 and 200 mg caffeine, observed has been a rise in the diastolic pressure of 6,4 and 12,0 mm Hg, respectively ($P < 0,05$) as against the values in the reference group.
5. The durations of the ECG waves and segments measured within one hour after the use of different doses of coffee show minor reductions, and those traced 6 hours after the coffee intake are found to be close to the respective reference group values.

Statement on ethical issues

Research involving people and/or animals is in full compliance with current national and international ethical standards.

Conflict of interest

None declared.

Author contributions

The authors read the ICMJE criteria for authorship and approved the final manuscript.

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