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RESEARCH ARTICLE

Effects of Caffeinated Beverages on Cardiac Dynamics Monitoring Data and Physically Subjective Perceptions of Adolescents in China

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ABSTRACT: This study aimed to determine if drinking caffeine-containing beverages harms Chinese adolescents' hearts and poses a host of other risks if they rely solely on the stimulant to maintain their mental clarity. This study was planned as a double-blind, randomized control. Twenty participants participated in this experiment and were split into two groups with equal numbers of each gender. Volunteers were instructed to stay seated and abstain from food and water for two hours before consuming caffeinated beverages. Each participant in Group 1 had to consume 450 ml of caffeine-containing beverages containing 110 mg of caffeine. In contrast, each volunteer in group 2 had to consume 450 ml of caffeine-containing beverages containing 200 mg of caffeine. We took their blood pressure and heart rates at different time periods. This study revealed the results we didn't expect. We disproved the common misconception that consuming more caffeine can have a negative impact on adolescent heart health by concluding that there was no significant difference in systolic blood pressure, diastolic blood pressure, or heart rate over the same time period in carefully controlled experiments. The symptom of experiencing heart palpitations has become one of the key reflections of the vast majority of subjects in the subjective evaluation of subjects' personal experiences.

KEYWORDS: Biochemistry; General Biochemistry; Caffeinate Beverage; Cardiology; Chinese adolescents.

Introduction

Different caffeinated beverages have already established themselves as crucial study aids for Chinese high school students who study late at night. As a result, high school kids have begun to depend on caffeinated drinks like coffee, tea, and functional drinks daily. There has long been worry that caffeine may increase the risk of cancer and cardiovascular disease, even though these caffeinated beverages are effective for improving mental function and attentiveness due to enhanced alertness.[1,2]

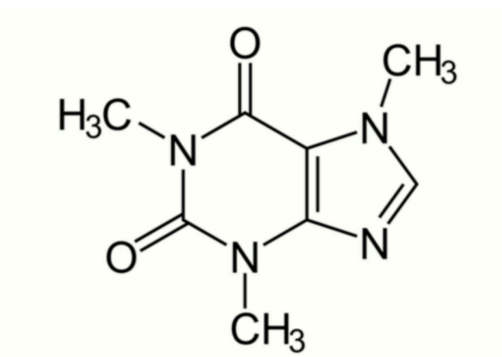

Figure 1: Chemical structure of Trimethyl xanthine 1,3,7(caffeine).

As shown in Figure 1., Trimethyl xanthine 1,3,7 is another name for caffeine.[3, 4] There are two layers to its impact. First, caffeine is an antagonist of the adenosine receptor and an inhibitor of phosphodiesterase (PDE), shown in Figure 2., at the level of the physical cell.[5, 6] Smooth muscle relaxation, slowed lipolysis, decreased release of adrenal hormones, and other actions can be brought on by adenosine receptor activation (slowing down the work of cells).[7] Caffeine thereby accelerates the work that cells do.[8] Second, PDE is an enzyme that breaks down cyclic adenosine monophosphate (cAMP), which helps cells break down ATP.[9] Thus, caffeine's inhibition of PDE is comparable to encouraging the breakdown of cellular ATP, which speeds up the work of cells.[10]

Figure 2: Protein structure of phosphodiesterase (PDE).

Additionally, due to the aforementioned actions, caffeine can support the adrenal gland's function (which includes other endocrine glands), increasing the release of glucocorticoids, aldosterone, and adrenaline (at least in advance).[11, 12] The production of these hormones will rise, indirectly affecting energy and focus. Trimethyl groups are soluble in fat, can enter the brain, and are also present in caffeine. Caffeine also inhibits adenosine A receptors in the brain, primarily found in neurons

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connected to the acetylcholinergic system. Caffeine, therefore, has a beneficial "refreshing" effect on work and learning because it is equivalent to stimulating acetylcholinergic neurons, primarily linked to memory, association, and learning.[13] Some studies claim that very high concentrations of caffeine will cause GABA receptor antagonistic activity in the brain, although investigations have yet to be conclusive.[14]

Clinical studies have shown that caffeine increases blood pressure and heart rate, but no studies have been done on the physical characteristics of other ethnic groups, particularly Chinese teenage groups. Therefore, we will conduct this experiment to determine whether caffeine-containing beverages significantly affect Chinese teenagers' heart rates and blood pressure and indirectly contribute to associated risks.

■ Methods

Our study was planned as a double-blind, randomized control. Twenty teens (aged 17+–1), including ten boys and ten girls of Chinese heritage, participated in the experiment. Twenty participants participated in this experiment and were split into two groups with equal numbers of each gender. Volunteers were instructed to stay seated and abstain from food and water for two hours before consuming caffeinated beverages. To lessen the impact of participants' mental health on the study's outcomes, volunteers were also instructed to relax by listening to calming music twenty minutes before administering caffeine-containing beverages.

Each volunteer in Group 1 was required to consume 450 ml of beverages containing 110 mg of caffeine, whereas volunteers in Group 2 were instructed to consume 450 ml of beverages containing 200 mg of caffeine. We measured their blood pressure and heart rates 30 minutes, an hour, 1.5 hours, and two hours after drinking. First, the results were compared to those obtained before drinking caffeinated beverages to determine whether the change was statistically significant. Next, the p-value was calculated. Finally, we also calculated the difference between the two data groups to assess whether different caffeine doses will have other effects on Chinese teens' pressure and heart rates. We evaluated whether there were any significant changes.

We created the following questionnaire to examine how caffeine-containing beverages affect the subjective emotions of adolescent volunteers. There are seven questions in all on this survey: Are you anxious? Do you feel weak and easily exhausted? Can you feel your heart racing? Do you feel queasy and uneasy? Do you feel flustered and have heart palpitation? Does your breathing feel labored? Do you feel sweatier? The proportion of survey responses to the aforementioned questions allowed us to quantitatively assess the patients' subjective reactions to caffeine-containing beverages.

■ Results and Discussion

After statistical data, we obtained the following data:

Table 1: Data of the 110mg caffeine experimental group (The data in each column from left to right are systolic blood pressure, diastolic blood pressure, and heart rate). Statistically, the change in systolic blood pressure was greater in the 110 mg experimental group patients, with six patients experiencing varying degrees of increase in systolic blood pressure half an hour after caffeine intake.

110mg	Before drinking	Half an hour	An Hour	Two Hours
1	115/72/87	121/78/81	129/82/75	109/68/77
2	119/70/90	117/72/75	124/76/84	118/71/77
3	110/71/80	111/60/91	118/69/78	119/65/76
4	119/76/72	122/77/70	107/66/70	116/78/71
5	109/68/80	118/73/74	120/63/70	110/73/69
6	107/65/81	138/77/77	106/63/70	108/74/68
7	116/79/92	110/64/73	116/70/75	110/68/69
8	121/69/80	105/63/72	118/75/74	107/68/72
9	113/69/88	120/63/74	115/70/73	117/72/75
10	120/70/80	112/60/71	109/68/72	110/69/75

We started by setting the confidence threshold to a p-value of 0.05 or less. Then, by comparing the values of the three time periods with the values before the caffeine intake, we obtained the following findings in ten patients who consumed 110 mg of caffeine:

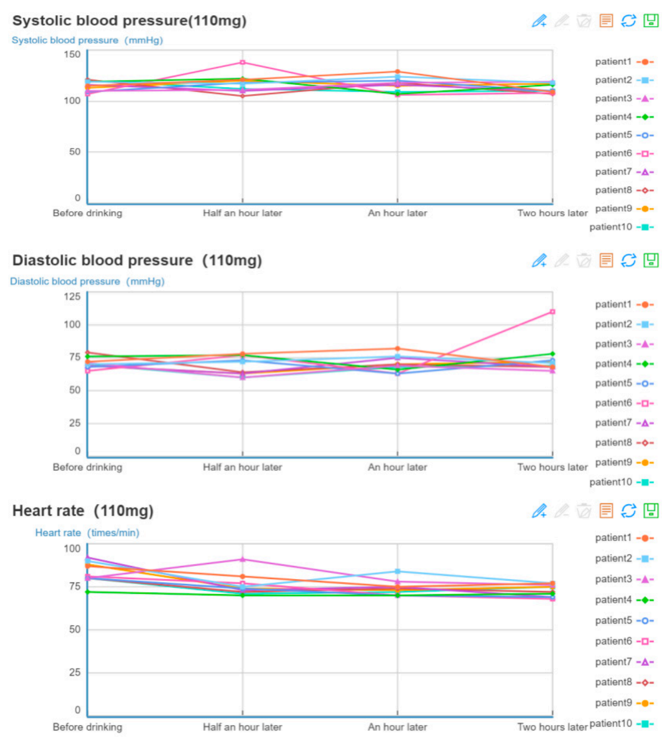

Figure 3: Trend chart of various data in the 110 mg caffeine experimental group. According to the image data, the diastolic blood pressure of patient 6 increased sharply two hours after caffeine intake, which was an exceptional case. In contrast, the heart rate images consistently maintained a steady downward trend.

As shown in Table 1. and Figure 3. above, regarding the change in vascular hypertension, the rising rate over three periods was not statistically significant (p-values = 0.229, 0.32, and 0.87). The diastolic pressure section showed the same outcome, and the data for the three time periods did not significantly rise (p-value = 0.789, 0.618, and 0.567). We made a startling discovery regarding the rate of change in heart rate when we discovered that the subjects' heart rates reversed after consuming caffeine. The value of the reverse growth is statistically significant, demonstrating that it reversed (p-value=0.008605, 0.000821 0,00021).

Table 2: Data of the 200 mg caffeine experimental group (The data in each column from left to right are systolic blood pressure, diastolic blood pressure, and heart rate.) The systolic blood pressure of all patients in the 200 mg experimental group increased to varying degrees half an hour after caffeine intake; this phenomenon was also confirmed in the statistical calculations (p-value).

200mg	Before drinking	Half an hour	An Hour	Two Hours
1	105/75/98	120/83/75	113/78/82.5	113/77.5/88
2	113/64/64	124/76/60	118/72/61	115/65/58
3	115/74/98	128/70/67	118/71/73	114/66/80.5
4	113/80/91	122/71/83	113/71/72	118/75/71
5	122/61/86	129/67/85	116/60/70	116/62/76
6	116/65/76	125/69/83	128/68/89	119/66/87
7	114/80/91	122/80/80	125/85/82	117/78/88
8	102/64/81	116/77/85	118/79/88	109/65/77
9	109/66/82	115/67/86	118/67/89	111/65/80
10	110/71/69	122/71/87	122/75/88	118/77/87

As shown in Table 2. and Figure 4., the 200 mg experimental group's hypertension growth rate in three periods showed a trend toward a statistically significant increase (p-values = 0.000152, 0.0043, and 0.078). The diastolic pressure growth rate did not fall inside the established confidence interval (p-value=0.417, 0.209, 0.546). Although there is still a subtle counter-growth trend in the heart rate data, it is not statistically significant (p-value=0.173 0.199 0.185).

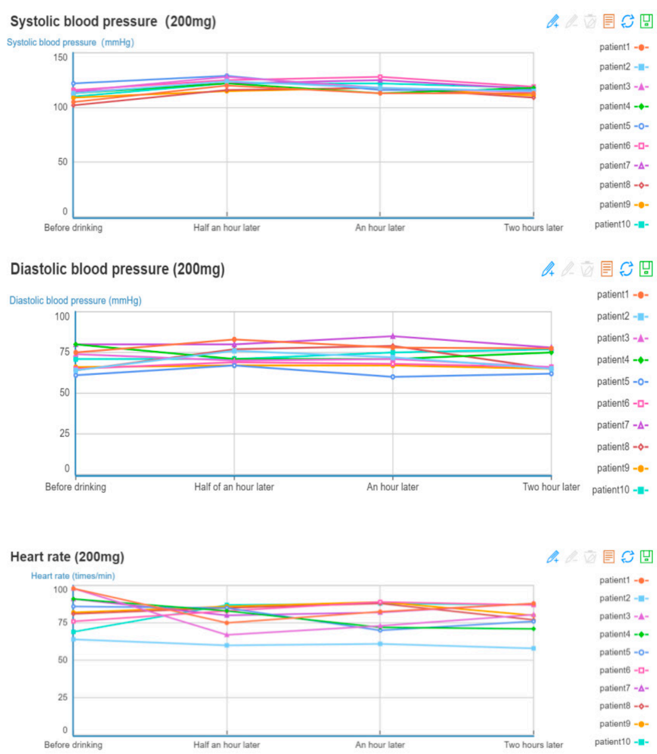

Figure 4: Trend chart of various data in the 200 mg caffeine experimental group. According to the image, all subjects in the 200 mg experimental group showed relatively similar trends in all data.

In evaluating data from two distinct dose test groups in a controlled experiment. After taking caffeine doses of 110 mg and 200 mg, we compared if there were any significant differences in the results throughout the course of the subsequent hour. We discovered no significant difference after comparing the three values of systolic blood pressure, diastolic blood pressure, and heart rate between the two test groups (p-value=0.152, 0.271, 0.363).

Following data analysis, we discovered that 60% of the respondents who consumed 110 mg of caffeine reported, while this number rose to 80% for those who used 200 mg of caffeine.

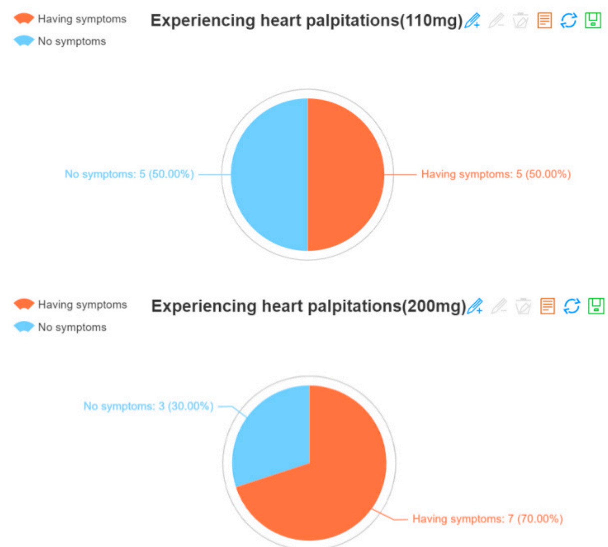

Figure 5: The proportion of palpitations in different test groups (110 and 200 mg). According to the data, 50% of the patients in the 110 mg group experienced heart palpitations. This ratio increased to 70% in the 200 mg group.

Additionally, as shown in Figure 5. above, patients who consumed 110 mg and 200 mg of caffeine generally responded (greater than 50%) to two side effects, including increased sweating at constant room temperature and some dizziness. The 110 mg caffeine intake values were correspondingly 50% and 70%. 200 mg of caffeine is consumed at rates of 60% and 70%, respectively. It also demonstrates that caffeine does cause the four reactions stated above in Chinese teenagers, even though the difference in the proportions of subjects in each data set between the two cases is not statistically significant (p-value>0.05).

Discussion

The first two results of the 110 mg experimental group are familiar because most Chinese teenagers only consume an average of 110 mg of caffeine daily. However, a considerable inverse heart rate growth must be more consistent with our earlier hypotheses. Because it makes sense that a stimulant like coffee would stimulate the heart to beat more frequently, this discovery challenges this theory. Because the caffeine intake of the 200 mg experimental group's coffee was higher than that of Chinese adolescents as a whole, the growth rate of the high-pressure data was statistically significant and did not exceed our expectations. Drinking more coffee stimulates the nervous system more, which raises systolic blood pressure. The higher caffeine dose did cause the subjects' heart rates to slightly reverse their growth trend, but this was not statistically significant, which perplexed us. In fact, this finding calls into doubt many of the prevalent hypotheses on a quick heartbeat.

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Regarding the analysis of subjective experiences, coffee can interfere with the action of a chemical called adenosine, which is why most subjects experience panic and heart palpitations. Caffeine competes with adenosine's receptors, preventing the natural impact of adenosine on the heart that lowers heart rate. We discovered that most of the few subjects who did not experience this feeling had regularly consumed caffeinated beverages (more than two consecutive months). Although we do not yet have a scientific explanation, their bodies appear to have evolved a resistance to the interaction between coffee and adenosine.

No significant differences in the data were found in the controlled studies. This demonstrates that varying caffeine dosages did not affect Chinese teenagers' cardiac statistics. It also dispels the myth that caffeine consumption among Chinese teenagers may affect their heart health.

The following two conclusions can help to explain the experience of vertigo brought on by caffeine in subjects. First, because caffeine stimulates the brain's nerves, those susceptible to it may experience symptoms of lightheadedness after drinking coffee; Second, caffeine, which is frequently present in caffeinated beverages, can rapidly lower blood sugar levels. As a result, consuming coffee will result in a hypoglycemia reaction, which will create symptoms of dizziness. We hypothesize that the following theories can account for why caffeinated beverages increase sweating at constant temperatures: Because excitatory nerves will increase metabolism, which leads to increased sweating and disorders of sweat gland secretion, caffeine has the effect of stimulating excitatory nerves. However, precisely how caffeine stimulates nerves and affects sweat glands' secretion is still being determined.[15]

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