Effects of energy drinks on heart rate and blood pressure

Food & Diet

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Introduction

Many people as well as university students ingest various energy drinks in order to keep them alert during extensive tasks and projects. There is very little evidence of energy drink effects on enhancement of mental and physical performance. However, it is generally thought that energy drinks provide uplift of energy.

Majority marketed energy drinks contain main ingredient caffeine, which sometimes accompanied by different types of simple sugars, amino acids and other ingredient, such as gindeng and guarana in order to promote caffeine potency (Heneman and Zidenberg-Cherr 2007). Caffeine is classed as methylxanthine. Pharmacologically, caffeine effect on central nervous system is primarily stimulation. It manifests itself as smooth muscle relaxation, cardiac muscle stimulation, diuresis enhancement, adenosine receptor antagonism and modulation of intracellular calcium. Caffeine blocked adenosine receptors in heart, inhibits coronary vasodilation through A2 receptors, increasing adenylyl cyclase activity, promoting cAMP, thus

making cell to polarize by decreasing outward K+ flux as well as providing ATP for muscle contraction (Greenberg et al. 2007). Adenosine receptor in the brain acts suppressive on sympathetic nervous system, thus its blockage by caffeine leads to increased sympathetic stimulus (Schwabe et al. 1991). Therefore, physiological effects of caffeine, such as heart rate, blood pressure and electrocardiogram (ECG) changes can be monitored.

Depending on the content of additional ingredients, caffeine usually has an absorption time of 30-60 minutes when caffeine is ingested orally, provided person has a normal gastrointestinal function. When caffeine has minimal additional ingredients absorption time is often at 30 minutes. It is noteworthy, that caffeine passes through main body boundaries including blood-brain-barrier easily and has around 4 hours of pharmacological half-life time in normal adults (Gilbert, S. 2006). Similar placebo controlled studies has been conducted in the past, which have demonstrated that caffeine decreases heart rate (in laboratory controlled conditions), increases blood pressure and increases plasma levels of catecholamines and free fatty acids (Suleman and Siddiqui, 2007).

This study aims to determine any significant effect on marketed energy drinks on cardio variables.

Study will measure changes of 3 variables which include heart rate (HR), systolic blood pressure (sysBP) and diastolic blood pressure (diaBP) within treatment and placebo groups. Emphasis will be placed on analysis of blood pressure. Although ECG presumably would indicate changes in heart muscle conductivity, it was left out due to complexity limitation of the study.

Methods

13 subjects volunteered to participate in the study. Since study was conducted in the context of university students, test subjects were between 19 and 31 years of age, who are most probably, were exposed to stress factors associated with studying. Subjects were not filtered or selected according to smoking, state of health, activity or regular caffeine use, although, questionnaire have been given to fill (see appendix 1). Protocol was explained with regards to possible risks, discomfort and procedure. Consent forms were acquired (see appendix 2).

All procedures were approved by University of Worcester.

The study was conducted over 20 days at various times during the day in either laboratory rooms or at home of the subject. Measurements were taken by 4 different researchers individually at different times. Subjects were allocated to the groups randomly, 2 of which were controlled and 11 treatments exposed. Participants were not instructed on dietary, activity, smoking, alcohol, sleep or caffeine intake matters. Due to this fact, assumptions on subjects' abstinence on caffeine, GI tract normality or cardio-vascular health were not made.

Although caffeine takes approximately 4 hours for half-life metabolism, this study investigated immediate effects in a range of 60 minutes. Measurements were taken before, 20 minutes after, 40 minutes after and 60 minutes after. To minimize equipment errors 3 variable measurements were taken before and at each 20 minutes interval of which average was drawn. Subjects were instructed to sit in comfortable position while resting one arm

on the desk or table in front. HR, sysBP and diaBP measurements were taken after blood pressure monitor was placed on the upper arm and fastened. Energy drinks were ingested immediately after. Test was repeated at 20 minute intervals 3 times.

Heart rate and blood pressure was measured using Omron MX2 pressure monitor.

Generic product energy drink was used and it contained ingredients as follows:

Carbonated water, Citric Acid, Taurine, Caffeine 30mg/100ml, Trisodium Citrate, Fruit extract (apple, carrot, hibiscus, lemon, saffower), Sugar, Potassium Sorbate, Inositol, Niacin, Vitamin B6, Vitamin B12 and Pantothenic Acid.

All data was reported as mean ± SD and change Δ. Acquired data was plotted on the graphs using (Microsoft office excel 2007). Statistical significance was calculated using windows version SPSS 17 advanced statistics, Repeated Measures ANOVA, paired t-test for differences between time intervals (before – 20minutes, before – 40minutes, before -60 minutes). Statistical significance for all tests was set at $p \leq 0.05$.

Results

Data for the blood pressure and heart rate variables can be seen in (appendix 3). Increase in systolic pressure can be noted in the (Figure 1. 1) and was found to be significant at 60 minutes time interval using paired t-test $p < 0.016$ (Figure 1. 2). Consequently, repeated measures ANOVA was

conducted to see significant variance between the groups and was found to be insignificant p > 0. 066 (Figure 1. 3) despite variance of treatment vs control seen on the graph (Figure 1. 1).

Diastolic pressure Δ can be seen in (Figure 2. 1), where slight increase can be noted however was not significant at any time intervals (Figure 2. 2). It was also 2 fold lower that systolic pressure.

Heart rate can also be seen increasing (Figure 3. 1); however, it was not significant (Figure 3. 2) neither it varied from controls.

Discussion

Caffeine is mostly associated with cardiovascular and central nervous system effects and it was also observed to have effects on glandular tissue, diuresis induction via kidney modulation and relaxation of smooth muscles at high doses and constriction at lower. Three cellular actions of caffeine on blood pressure have been suggested and they are: Translocation of intracellular calcium, Increased accumulation of cAMPs and blockage of adenosine receptors (Suleman and Siddiqui, 2007).

Caffeine ability to inhibit cAMP phosphodiesterases sometimes cited as the pathway of the effect on blood pressure. However, there isn’t much evidence to support it. Also, Caffeine plasma levels that increase blood pressure are significantly below the levels required to inhibit phosphodiesterases (Robertson et al. 1978, Robertson et al. 1981). This eliminates as a candidate pathway and thus will not be discussed further.

Caffeine ability at high doses to interfere with Ca2+ storage uptake by the sarcoplasmic tissue was extensively researched. This could possibly partially explain why systolic pressure increase was much higher than diastolic pressure, as this would increase the strength and length of contraction occurring during heart beats. However, this mechanism of action is not clear as similar effects may be induced through adenosine receptor blockage (Fredholm, 1980).

It is worth mentioning that there are several other types of action that might prove to be important, such as inhibition of prostaglandin synthesis (Vinega et al 1976) and reduced uptake of catecholamines in non neural tissues (Kalsner, 1971); however, these are out of the scope of this study.

This leaves adenosine receptor blockage as primary candidate. Caffeine acts as an adenosine competitor and its effects are opposite of those seen with exogenous adenosine administration. In addition plasma levels that raise blood pressure appear to be within the range for adenosine antagonism (Berne et al. 1983). At therapeutic doses via adenosine receptor blockage sympathetically modulated vasoconstriction has been proposed. One study shows that at rest 250mg of ingested caffeine increased circulating adrenaline by 207%, norepinephrine by 75% and plasma rennin activity by 57% (Robertson et al. 1978). Physical activity seems to have additive to caffeine release of epinephrine (Sung et al. 1990). Consequently, caffeine and exercise has additive effects on systolic blood pressure. Although, diastolic pressure has been shown to be weakened, proposing another explanation of why we have seen variance between systolic and diastolic

pressure, provided our subject engaged in physical activity before test (Pincomb et al. 1991). Also, physiological stress has been demonstrated to have additive to caffeine effect on systolic and diastolic pressure increases (Pincomb et al 1987). Some studies show that regular caffeine consumption does not influence acute caffeine response in healthy people given 12 hours clearance period before test (Lane et al. 1990). Others have noted regular caffeine consumers were less responsive than non caffeine users (Robertson et al. 1981). Greater response was found in people with hypertension and high percentage of body fat (Pincomb et al. 1991). In addition, oral contraceptives have significant effect on methylxanthines excretion (Lane, 1983). Therefore, all of these factors may have influenced and implicated our study.

Conclusion

Similar results to other studies with regards to blood pressure.

Not enough controls. Timing. Same room. Equilibration period. Instructions

Better error minimization. Better control of subjects. Better time organization. Taurine, inositol.

Heart rate increases on non laboratory conditions because of catecholamines.

In addition, caffeine has huge variety of direct and indirect effects, which also tremendously depends on subjects condition, thus analyzing effects of such compounds on single variable can be deceiving and therefore

Therefore, all these factors should have been taken into consideration and appropriate instructions should have been provided to the subjects.