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Effect of Energy Drink and Sports Drink on Cardiology Parameters and Alertness Amongst Young Medical Undergraduate: A Randomized Controlled Trial Study

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Abstract

Introduction: Young healthy adults are frequently exposed to the consumption of energy drinks and sports drink for various reasons. Energy drinks has higher tonicity and contains caffeine. Therefore, the objective of this study is to investigate the effect of energy drink and sports drink on cardiology parameters and alertness in comparison to mineral water among young healthy adults. Methodology: A randomized controlled trial was done in a private medical college in Malaysia from June 2018 to August 2018. Participants were divided into 3 intervention groups [hypertonic solution (n=37), isotonic solution (n=37), mineral water (n=37)]. They were given the intervention drink (250ml) and later given questionnaire (24 components) to assess alertness and record cardiology parameters (systolic and diastolic blood pressure, heart rate). The change in blood pressure and heart rate were analysed using ANOVA and independent T-test with Bonferroni adjustment. The adverse events of each intervention was analysed using Chi-square test and relative risk was calculated. Results: There was no significant differences among the three intervention groups except in hypertonic group there was significant difference in improvement of mental alertness, increase in systolic blood pressure and 5.5 times more likely to experience palpitation compared to mineral water group while mineral water group had significant difference in decreased heart rate. Conclusion: Hypertonic drink can improve the alertness but 29.7% of the participants experienced palpitation which was higher compared to other groups. However, there is no difference between mineral water and isotonic drink in terms of cardiology parameters and alertness.

Keywords

Hypertonic, Isotonic, Mineral Water, Alertness, Cardiology Parameters

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1. Introduction

Young healthy adults are more frequently exposed to the consumption of energy drinks and sports drink for various reasons. [1] Sports drinks and energy drinks are significantly different products. [2] Energy drinks can be classified as dietary supplements rather than beverages. [1] They are used by the consumers as an energy booster, to promote wakefulness, maintain mental alertness, and provide cognitive and mood enhancement. [3] A standard energy drink mostly contain high amount of caffeine. [1] Along with that, energy drinks also contain nutritional supplements such as taurine, l-carnitine, carbohydrates, glucoronolactone, vitamins, and other herbal supplements like ginseng and guarana. [1, 3] It was also known that additives such as guarana, yerba mate, cocoa, and kola nut may increase the caffeine content of energy drinks to the consumers. [3]

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However, manufacturers of these products do not need to be approved by the Food and Drug Administration (FDA) and the caffeine content of these herbal supplements are not required to be listed with the product information. [1, 3]

Sports drinks are flavoured beverages that are rich in carbohydrates, minerals, electrolytes such as sodium, potassium, calcium, magnesium, and sometimes vitamins and nutrients. [2] However, sports drinks are caffeine-free as compared to energy drinks. [2] These are beverages whose stated purpose is to help replace water, electrolytes, and energy before, during and after exercise. [4] Most sport drinks are approximately isotonic, having about 4 to 5 teaspoons of sugar per five ounce (13 and 19 grams per 250ml) serving, whereas most energy drinks are hypertonic. [4] Therefore, the terms between sports drink and energy drink are not interchangeable. [2]

Even though sports and energy drinks are a large and growing beverage industry but only few have aware of their adverse physiological and psychological effects. [2, 3] Only small number of publications that have documented the potential adverse risks associated with the use of these beverages. Whereas most studies to date have examined the physiological effects of energy drinks, article reviews and compiles the body of knowledge of this increasingly important topic by examining the psychological effects of energy drinks on cognitive functions, mood, sleep, decision making, and overall impact on well-being and quality of life. [3]

Previous intervention studies has been done to evaluate the effect of tonicity of the solution intake with cardiology parameter (systolic and diastolic blood pressure, pulse rate) and mental performance. [5] It was predicted that the hypertonic energy drink would increases the blood pressure and heart rate. [6] A number of investigations focused on the hemodynamic effects of the consumption of energy drinks on healthy individuals; some of which found a statistically significant effect on heart rate (HR) and blood pressure (BP), and some others detected either no or minor non-significant effects. [3]

Therefore, the main objective of this research is to investigate the effect of energy drink and sports drink on cardiology parameters (systolic blood pressure, diastolic blood pressure, heart rate) and alertness in comparison to mineral water among young healthy adults. The research questions are as follows:

1 Does energy drink and sports drink affect the heart rate and blood pressure compared to mineral water?

2 Does energy drink and sports drink enhances the mental alertness of the young healthy adults compared to mineral water?

The hypothesis of this research is that there is a difference in energy drink and sports drink on cardiology parameters and alertness when compared to mineral water. The sports drink (isotonic) decreases the heart rate and blood pressure however energy drinks (hypertonic) enhances the mental alertness of a young healthy individual.

2. Methodology

Study design, Study setting and Study time

The effect of energy drink and sports drink on cardiology parameters and mental alertness amongst the young healthy adults in Melaka-Manipal Medical College (MMMC) students were identified for this experimental randomized controlled parallel study, where the independent variable were isotonic drink, hypertonic drink and mineral water whereas the dependent variables (outcome) are cardiology parameters (systolic blood pressure, diastolic blood pressure, heart rate) and mental alertness. The research was directed to the healthy young students of Melaka-Manipal Medical College (MMMC) from both Muar and Melaka campus in Malaysia. The research was conducted from June 2018 till August 2018, total duration of two months.

Study population and Sample size

MMMC students belonging to MBBS (Batch 36 and 37) were chosen to be part of our study.

Sample size calculation.

According to a cohort study done on coastal inhabitants of Bangladesh regarding drinking water salinity and raised blood pressure [7], we used the confidence level of 95% and a marginal error of 5% to calculate the standard error, then we calculated the standard deviation using this formula:-

$$SE = \frac{upper\ limit - lower\ limit}{3.92}$$

$$= \frac{-0.64 - (-1.14)}{3.92}$$

$$= 0.13$$

$$\sigma = \frac{SE}{\sqrt{\frac{1}{N_E} + \frac{1}{N_C}}}$$

$$\sigma = \frac{0.13}{\sqrt{\frac{1}{220} + \frac{1}{210}}}$$

$$\sigma = 1.35$$

Where,

SE = standard error

σ = standard deviation

N_E = population exposed

N_C = population controlled

$$n = \frac{2K\sigma^2}{\Delta^2}$$

$$n = \frac{2(7.84)(1.35)^2}{(-0.89)^2}$$

$$n = 36.077$$

$$n \approx 37$$

Where,

n = sample size

K = constant, power 80%, type 1 error 5% (7.82)

$\Delta = (\mu_1 - \mu_2)$

The minimum number of participants required was 37 participants in each group (isotonic drink group, hypertonic drink group and mineral water group as the control group). In total, one hundred eleven (111) participants was required as sample size to conduct this study.

Inclusion criteria were young MMMC students from MBBS Batch 36 and 37, those students who are willing to participate by giving written informed consent, those who were physically healthy and those who did not consume caffeine, isotonic and hypertonic drinks within minimum of 6 hours. Exclusion criteria were the participant who did not sign the written informed consent, those did not answer the questionnaires completely, those with previous medical history of cardiovascular disease and those want to withdraw from the study.

Sampling and Randomization

Volunteers were selected based on fixed inclusion and exclusion criteria's. Randomization was done using https://www.randomizer.org/. Block randomization was recognized for this study. Block size of 3 were used which are isotonic drink, hypertonic drink and mineral water.

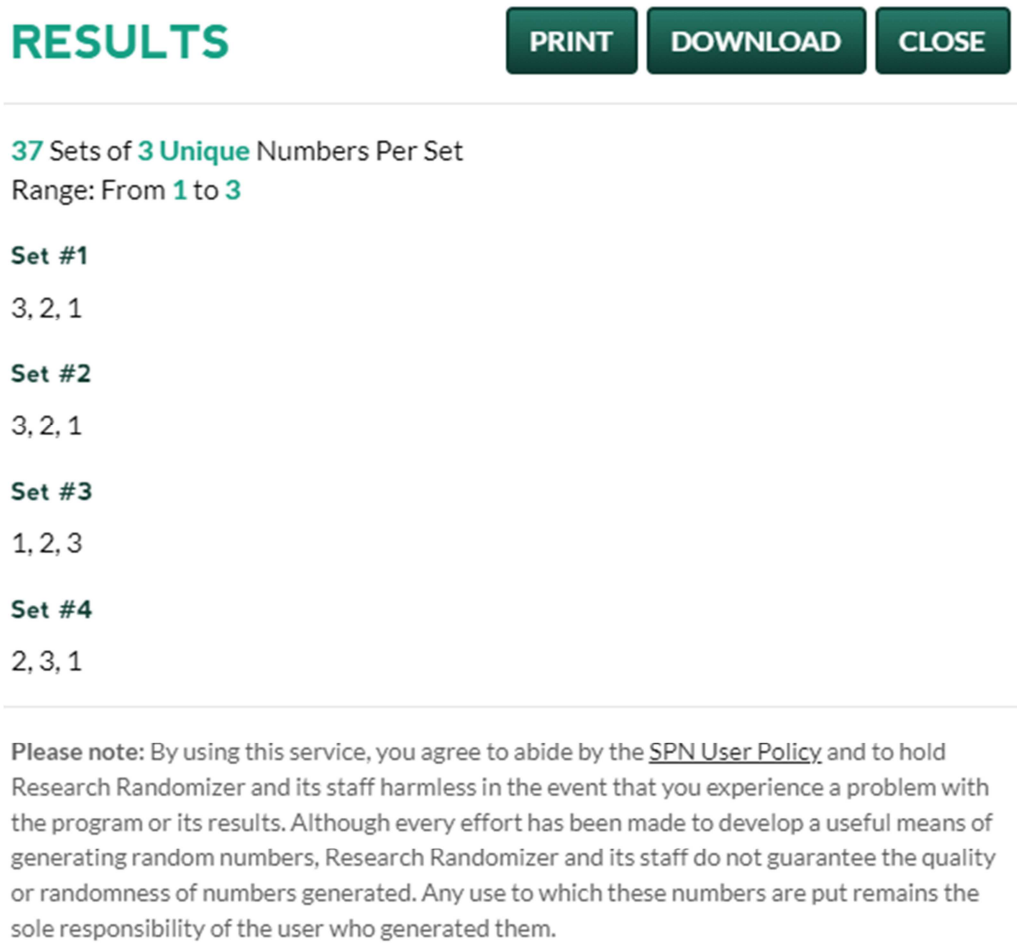

Figure 1. Shows randomization method used to randomize the volunteers into respective intervention groups.

Intervention

Three different types of drinks were provided by the researchers in order to standardize the intervention, which were *Revive Isotonic* drink (used for isotonic drink), *Power root energy* drink (used for hypertonic drink) and mineral water (used as controlled drink). The amount of the drink was kept constant which was 250ml. The cardiology parameters and alertness was measured 1 hour post-intervention. The nutritional value of Power root drink (Calories: 164kcal, Fat: 0g, Carbs: 39.5g, Protein: 1.5g, Sugar: 34.3g) and for Revive isotonic drink (Calories: 65kcal, Fat: 0g, Carbs: 16.6g, Protein: 0g, Sugar: 16.6g, Sodium: 0.11g) per serving of 250ml. A set of self-administered questionnaire was also distributed to assess their alertness. The questionnaire consisted of 4 sections (total of 24 components) addressing a variety of issues. Section A was socio-demographic profile of the participant, which consist of 7 components (age, gender, ethnicity, batch, smoking, alcohol consumption and exercise). Section B was a set of questions assessing the alertness of the participants that consist of 4 components with answers ranging from 1 to 10 (1-lowest, 10 –highest), which the participants were required to complete before drinking their respective drinks. Section C and D was filled by the researcher, which consist of 6 components (height, weight, BMI, systolic blood pressure, diastolic blood pressure and heart rate). Finally, the participants were required to complete another set of questions as a feedback after the intervention has been given that consist 7 components with answers ranging from 1 to 10 (1-lowest, 10-highest) and options (Yes or No).

Data Collection

On the day of data collection, the participants were called to the lecture hall and they were seated according to the group they belong in. At the beginning, the participants were briefed about the purpose and their role in the experiment. They were also informed that they are allowed to quit from the study anytime they want.

The participants were given the questionnaire to assess their mental alertness and the cardiology parameters (systolic BP, diastolic BP, heart rate) before and after the respective interventions were given. The blood pressure was measured using the OMRON automatic digital BP apparatus and was measured by two researchers to allow standardization. They were given the respective intervention allocated to them and after duration of 1 hour, the participants were reassembled at the same place and their height, weight, BMI, systolic blood pressure, diastolic blood pressure and heart rate were measured and calculated.

Data Analysis

The data was entered in Microsoft Excel version 2013 and it was double checked to prevent any duplication and missing of data. From Microsoft excel, the informations were then used for statistical calculations using software known as GraphPad and Epinfo version 7.

For descriptive analysis, a table was drawn for the demographic details to describe the frequency and its percentage for each of the factors of the respective interventions. The analysis was done using a parametric test known as paired t test where t value and p value was calculated to find the significance between the energy drink, sports drink and mineral water on cardiology parameters and mental alertness, thus testing the hypothesis. The tests were also used to calculate the mean blood pressure and its standard deviation that we obtained before and after the interventions were given. Another parametric test was also included called ANOVA test, to find the association between isotonic drink, hypertonic drink and mineral water with the cardiology parameters and mental alertness. Multiple bar chart was used to represent the data calculated from categorical data (demographic data and feedback). Mean plot and box plot were used to represent the numerical data obtained from the BP and heart rate measurements.

The feedback analysis was done using a non-parametric test called Wilcoxon-Signed Rank test to find the mean, median and interquartile range for each of the components between the groups. For all the calculations and data analysis in this randomized controlled trial study, the level of significance (α) was fixed at 0.05. Bonferroni adjustment was applied to protect from type I error. Thus, the new p-value calculated was 0.0167 ($\alpha_{altered} = 0.05/3 = 0.0167$) was considered as statistically significant. Bonferroni adjustment was done for paired comparison between the:

1 Energy drink vs Sports drink

2 Sports drink vs Mineral water

3 Energy drink vs Mineral water

For measurement of association, relative risk between the intervention and control group was calculated alongside 95% confidence interval.

Ethical considerations

Prior to the study, participants were explained about the procedure of the experiment and their role in the study. All the participants participated voluntarily and incentives were given at the end of the study as a token of appreciation. A written informed consent was obtained from the participants. We obtained approval from the Ethical committee of MBBS, MMMC prior to commencement of this study. The participants were assured that all the data collected will be kept confidential, untraceable and kept solely for study purposes.

3. Results

Table 1. Baseline characteristics between isotonic (n=37), hypertonic (n=37) and mineral water (n=37).

Variables	Isotonic (n=37) n (%)	Hypertonic (n=37) n (%)	Mineral Water (n=37) n (%)	Total (n=111) n (%)
Age (years)[a]	22.4 (0.6)	22.4 (0.8)	22.5 (1.3)	22.4 (0.9)
Gender				
Male	15 (40.5)	24 (64.9)	17 (46.0)	56 (50.4)
Female	22 (59.5)	13 (35.1)	20 (54.0)	55 (49.6)
Ethnicity				
Chinese	12 (32.4)	18 (48.7)	17 (14.6)	47 (42.3)
Malay	8 (21.6)	7 (18.9)	5 (13.5)	20 (18.0)
Indian	17 (46.0)	11 (29.7)	9 (24.3)	37 (33.3)
Others	0 (0.0)	1 (2.7)	6 (16.4)	7 (6.4)
BMI (kg/m^2)[a]	23.3 (4.1)	23.9 (5.0)	24.2 (3.6)	23.8 (4.3)

[a]Mean (SD), BMI = Body Mass Index

A total sample size of 111 were randomized into three intervention groups, which were isotonic (n=37), hypertonic (n=37) and mineral water (n=37). Table 1 shows baseline characteristics between isotonic, hypertonic and mineral water. The mean age of the participants in isotonic was 22.4 (SD=0.6), hypertonic solution was 22.4 (SD=0.8), mineral water was 22.5 (SD=1.3). There were 40.5% male participants in isotonic solution, 64.9% in hypertonic solution and 46.0% in mineral water. There were 59.5% female participants in isotonic solution, 35.1% in hypertonic solution and 54.0% in mineral water. As for the ethnicity, there were 32.4% Chinese participants in isotonic, 48.7% in hypertonic solution and 14.6% in mineral water. There were 21.6% Malay participants in isotonic solution, 18.9% in hypertonic solution and 13.5% in mineral water. There were 46.0% Indian participants in isotonic solution, 29.7% in hypertonic solution and 24.3% in mineral water. There were 2.7% in hypertonic solution and 16.4% in mineral water for participants belonging to other ethnicity groups. The mean BMI of the participants was 23.3 (SD=4.1) in isotonic solution, 23.9 (SD=5.0) in hypertonic solution and 24.2 (SD=3.6) in mineral water.

Table 2. Comparison of change (after-before) in systolic blood pressure, diastolic blood pressure and heart rate between isotonic (n=37), hypertonic (n=37) and mineral water (n=37).

Outcomes	Mean (SD)			$F(df_1, df_2)$	P_{value}[b]
	Isotonic	Hypertonic	Mineral water		
Systolic blood pressure (mmHg)	0.1 (13.2)	6.1 (8.3)	3.8 (13.7)	2.4 (2, 108)	0.096
Diastolic blood pressure (mmHg)	0.2 (9.5)	2.2 (8.6)	1.2 (9.7)	0.4 (2, 108)	0.645
Heart rate (beats/min)	-2.3 (8.7)	0.2 (10.2)	-4.9 (8.4)	2.9 (2, 108)	0.057

[b]One-way ANOVA test

Table 2 shows comparison of systolic blood pressure, diastolic blood pressure and heart rate between the three intervention groups, which were isotonic (n=37), hypertonic (n=37) and mineral water (n=37). One-way ANOVA test was done with level of significance set at 0.05. The mean (SD) of the participants' systolic blood pressure who drank isotonic drink was 0.1 (13.2), hypertonic drink was 6.1 (8.3) and mineral water was 3.8 (13.7). F-statistics calculated was 2.4 with df1 was 2 and df2 was 108. The P value computed was 0.096. Hence, there was no significant difference in the systolic blood pressure of the participants who drank isotonic drink, hypertonic drink and mineral water. The mean (SD) of the participants' diastolic blood pressure who drank isotonic drink was 0.2 (9.5), hypertonic drink was 2.2 (8.6) and mineral water was 1.2 (9.7). F-statistics calculated was 0.4 with df1 was 2 and df2 was 108. The P value computed was 0.645. Hence, there is no significant difference in the diastolic blood pressure of the participants who drank isotonic drink, hypertonic drink and mineral water. The mean (SD) of the participants' heart rate who drank isotonic drink was -2.3 (8.7), hypertonic drink 0.2 (10.2) and mineral water -4.9 (8.4). F-statistics calculated was 2.9 with df1 was 2 and df2 was 108. The P value computed is 0.057. Hence, there was no significant difference in the heart rate of the participants who drank isotonic drink, hypertonic drink and mineral water.

Table 3. Comparison of change (after-before) in systolic blood pressure, diastolic blood pressure and heart rate between hypertonic (n=37) and isotonic solution (n=37).

Outcomes	Mean (SD)		P_{value}[c]
	Hypertonic	Isotonic	
Systolic blood pressure (mmHg)	6.1 (8.3)	0.1 (13.2)	0.021[d]
Diastolic blood pressure (mmHg)	2.2 (8.6)	0.2 (9.5)	0.340[d]
Heart rate (beats/min)	0.2 (10.2)	-2.3 (8.7)	0.257[d]

[c]Unpaired t-test, [d]Post-hoc analysis with Bonferroni correction (P_{value} < 0.0167 is statistically significant)

Table 3 shows comparison systolic blood pressure, diastolic blood pressure and heart rate between hypertonic and isotonic solution. The post-hoc analysis with Bonferroni correction was done with level of significance set at <0.0167. The mean (SD) of the participants' systolic blood pressure who drank hypertonic drink was 6.1 (8.3) whereas those who drank isotonic drink was 0.1 (13.2). The P value computed for the systolic blood pressure was 0.021. Hence, there was no significant difference in the systolic blood pressure of the participants who drank hypertonic and isotonic solution. The mean (SD) of the participants' diastolic blood pressure who drank hypertonic drink was 2.2 (8.6) and isotonic drink was 0.2 (9.5). The P value computed for diastolic blood pressure was 0.340. Hence, there was no significant difference in the diastolic blood pressure of the participants who drank hypertonic and isotonic solution. The mean (SD) of the participants' heart rate who drank hypertonic drink was 0.2 (10.2) and isotonic drink was -2.3 (8.7). The P value computed for heart rate was 0.257. Hence, there was no significant difference in the heart rate of the participants who drank hypertonic and isotonic solution.

Table 4. Comparison of change (after-before) in systolic blood pressure, diastolic blood pressure and heart rate between mineral water (n=37) and isotonic solution (n=37).

Outcomes	Mean (SD)		P_{value}[c]
	Mineral water	Isotonic	
Systolic blood pressure (mmHg)	3.8 (13.7)	0.1 (13.2)	0.233[d]
Diastolic blood pressure (mmHg)	1.2 (9.7)	0.2 (9.5)	0.673[d]
Heart rate (beats/min)	-4.9 (8.4)	-2.3 (8.7)	0.191[d]

[c]Unpaired t-test, [d]Post-hoc analysis with Bonferroni correction (P_{value} < 0.0167 is statistically significant)

Table 4 shows comparison systolic blood pressure, diastolic blood pressure and heart rate between mineral water and isotonic solution. The post-hoc analysis with Bonferroni correction was done with level of significance set at <0.0167. The mean (SD) of the participants' systolic blood pressure who drank mineral water was 3.8 (13.7) whereas those who drank isotonic drink was 0.1 (13.2). The P value computed for the systolic blood pressure was 0.233. Hence, there was no significant difference in the systolic blood pressure of the participants who drank mineral water and isotonic solution. The mean (SD) of the participants' diastolic blood pressure who drank mineral water was 1.2 (9.7) and isotonic drink was 0.2 (9.5). The P value computed for diastolic blood pressure was 0.673. Hence, there was no significant difference in the diastolic blood pressure of the participants who drank mineral water and isotonic solution. The mean (SD) of the participants' heart rate who drank mineral water was -4.9 (8.4) and isotonic drink was -2.3 (8.7). The P value computed for heart rate was 0.191. Hence, there was no significant difference in the heart rate of the participants who drank mineral water and isotonic solution.

Table 5. Comparison of change (after-before) in systolic blood pressure, diastolic blood pressure and heart rate between mineral water (n=37) and hypertonic solution (n=37).

Outcomes	Mean (SD)		P_{value}[c]
	Mineral water	Hypertonic	
Systolic blood pressure (mmHg)	3.8 (13.7)	6.1 (8.3)	0.391[d]
Diastolic blood pressure (mmHg)	2.2 (8.6)	1.2 (9.7)	0.615[d]
Heart rate (beats/min)	0.2 (10.2)	-4.9 (8.4)	0.021[d]

[c]Unpaired t-test [d]Post-hoc analysis with Bonferroni correction (P_{value} < 0.0167 is statistically significant)

Table 5 shows comparison systolic blood pressure, diastolic blood pressure and heart rate between mineral water and hypertonic solution. The post-hoc analysis with Bonferroni correction was done with level of significance set at <0.0167. The mean (SD) of the participants' systolic blood pressure who drank mineral water was 3.8 (13.7) whereas those who drank hypertonic drink was 6.1 (8.3). The P value computed for the systolic blood pressure was 0.391. Hence, there was no significant difference in the systolic blood pressure of the participants who drank mineral water and hypertonic

solution. The mean (SD) of the participants' diastolic blood pressure who drank mineral water was 2.2 (8.6) and hypertonic drink was 1.2 (9.7). The P value computed for diastolic blood pressure was 0.615. Hence, there was no significant difference in the diastolic blood pressure of the participants who drank mineral water and hypertonic solution. The mean (SD) of the participants' heart rate who drank mineral water was 0.2 (10.2) and hypertonic drink was -4.9 (8.4). The P value computed for heart rate was 0.021. Hence, there no was significant difference in the heart rate of the participants who drank mineral water and hypertonic solution.

Table 6. Comparing systolic blood pressure, diastolic blood pressure and heart rate between before and after drinking isotonic solution (n=37).

Variables	Mean (SD)		Mean difference (95% CI)	t (df)	P_{value}[e]
	Before	After			
Systolic blood pressure (mmHg)	116.3 (15.9)	116.4 (14.7)	0.1 (-4.3, 4.5)	0.03 (36)	0.980
Diastolic blood pressure (mmHg)	74.4 (8.6)	74.6 (9.3)	0.2 (-3.0, 3.4)	0.14 (36)	0.891
Heart rate (beats/min)	77.7 (12.4)	75.4 (11.6)	-2.3 (-5.2, 0.6)	1.59 (36)	0.121

[e]Paired t-test

Table 6 shows comparison of systolic blood pressure, diastolic blood pressure and heart rate between before and after drinking isotonic solution. A paired t-test was done with level of significance set at 0.05. The degree of freedom (df) was 36. The mean (SD) of the participants' systolic blood pressure before and after drinking was 116.3 (15.9) and 116.4 (14.7) respectively. The mean difference (95% CI) and t-statistics of systolic blood pressure calculated before and after drinking was 0.1 (-4.3, 4.5) and 0.03 respectively. There was an increase of systolic blood pressure after drinking isotonic solution with the magnitude of 0.1 mean difference. The P value of systolic blood pressure computed was 0.980. Hence, there is no significant difference in the systolic blood pressure of the participants before and after drinking isotonic solution. The mean (SD) of the participants' diastolic blood pressure before and after drinking was 74.4 (8.6) and 74.6 (9.3) respectively. The mean difference (95% CI) and t-statistics of diastolic blood pressure calculated before and after drinking was 0.2 (-3.0, 3.4) and 0.14 respectively. There was increase of diastolic blood pressure after drinking isotonic solution with the magnitude of 0.14 mean difference. The P value of diastolic blood pressure computed was 0.891. Hence, there is no significant difference in the diastolic blood pressure of the participants before and after drinking isotonic solution. The mean (SD) of the participants' heart rate before and after drinking was 77.7 (12.4) and 75.4 (11.6) respectively. The mean difference (95% CI) and t-statistics of heart rate calculated before and after drinking was -2.3 (-5.2, 0.6) and 1.59 respectively. There was a decrease in the heart rate of the participants' after drinking isotonic solution with the magnitude of 2.3 mean difference. The P value of heart rate computed was 0.121. Hence, there is no significant difference in the heart rate of the participants before and after drinking isotonic solution.

Table 7. Comparing systolic blood pressure, diastolic blood pressure and heart rate between before and after drinking hypertonic solution (n=37).

Variables	Mean (SD)		Mean difference (95% CI)	t (df)	P_{value}[e]
	Before	After			
Systolic blood pressure (mmHg)	120.5 (15.4)	126.6 (16.9)	6.1 (3.3, 8.8)	4.48 (36)	0.001
Diastolic blood pressure (mmHg)	78.4 (8.7)	80.7 (9.2)	2.2 (-0.6, 5.1)	1.58 (36)	0.122
Heart rate (beats/min)	78.2 (15.6)	78.5 (14.4)	0.2 (-3.2, 3.6)	0.15 (36)	0.885

[e]Paired t-test

Table 7 shows comparison of systolic blood pressure, diastolic blood pressure and heart rate between before and after drinking hypertonic solution. A paired t-test was done with level of significance set at 0.05. The degree of freedom (df) was 36. The mean (SD) of the participants' systolic blood pressure before and after drinking was 120.5 (15.4) and 126.6 (16.9) respectively. The mean difference (95% CI) and t-statistics of systolic blood pressure calculated before and after drinking was 6.1 (3.3, 8.8) and 4.48 respectively. There was an increase of systolic blood pressure after drinking hypertonic solution with the magnitude of 6.1 mean difference. The P value of systolic blood pressure computed was 0.001. Hence, there is significant difference in the systolic blood pressure of the participants before and after drinking hypertonic solution. The mean (SD) of the participants' diastolic blood pressure before and after drinking was 78.4 (8.7) and 80.7 (9.2) respectively. The mean difference (95% CI) and t-statistics of diastolic blood pressure calculated before and after drinking was 2.2 (-0.6, 5.1) and 1.58 respectively. There was increase of diastolic blood pressure after drinking hypertonic solution with the magnitude of 2.2 mean difference. The P value of diastolic blood pressure computed was 0.122. Hence, there is no significant difference in the diastolic blood pressure of the participants before and after drinking hypertonic solution. The mean (SD) of the participants' heart rate before and after drinking was 78.2 (15.6) and 78.5 (14.4) respectively. The mean difference (95% CI) and t-statistics of heart rate

calculated before and after drinking was 0.2 (-3.2, 3.6) and 0.15 respectively. There was an increase in the heart rate of the participants' after drinking hypertonic solution with the magnitude of 0.2 mean difference. The P value of heart rate computed was 0.885. Hence, there is no significance difference in the heart rate of the participants before and after drinking hypertonic solution.

Table 8. Comparing systolic blood pressure, diastolic blood pressure and heart rate between before and after drinking mineral water (n=37).

Variables	Mean (SD)		Mean difference (95% CI)	t (df)	P_{value}[e]
	Before	After			
Systolic blood pressure (mmHg)	115.4 (14.5)	119.2 (14.0)	3.8 (-0.8, 8.4)	1.69 (36)	0.099
Diastolic blood pressure (mmHg)	75.7 (10.2)	76.9 (8.3)	1.2 (-2.1, 4.4)	0.73 (36)	0.472
Heart rate (beats/min)	81.2 (12.1)	76.3 (11.7)	-4.9 (-7.7, -2.1)	3.56 (36)	0.001

[e]Paired t-test

Table 8 shows comparison of systolic blood pressure, diastolic blood pressure and heart rate between before and after drinking mineral water. A paired t-test was done with level of significance set at 0.05. The degree of freedom (df) was 36. The mean (SD) of the participants' systolic blood pressure before and after drinking was 115.4 (14.5) and 119.2 (14.0) respectively. The mean difference (95% CI) and t-statistics of systolic blood pressure calculated before and after drinking was 3.8 (-0.8, 8.4) and 1.69 respectively. There was an increase of systolic blood pressure after drinking mineral water with the magnitude of 3.8 mean difference. The P value of systolic blood pressure computed was 0.099. Hence, there is no significant difference in the systolic blood pressure of the participants before and after drinking mineral water. The mean (SD) of the participants' diastolic blood pressure before and after drinking was 75.7 (10.2) and 76.9 (8.3) respectively. The mean difference (95% CI) and t-statistics of diastolic blood pressure calculated before and after drinking was 1.2 (-2.1, 4.4) and 0.73 respectively. There was increase of diastolic blood pressure after drinking mineral water with the magnitude of 1.2 mean difference. The P value of diastolic blood pressure computed was 0.472. Hence, there is no significant difference in the diastolic blood pressure of the participants before and after drinking mineral water. The mean (SD) of the participants' heart rate before and after drinking was 81.2 (12.1) and 76.3 (11.7) respectively. The mean difference (95% CI) and t-statistics of heart rate calculated before and after drinking was -4.9 (-7.7, -2.1) and 3.56 respectively. There was a decrease in the heart rate of the participants' after drinking mineral water with the magnitude of 4.9 mean difference. The P value of heart rate computed was 0.001. Hence, there is significant difference in the heart rate of the participants before and after drinking mineral water.

Table 9. Comparison of alertness before and after drinking hypertonic solution (n=37).

Questions	Median (Q_1, Q_3)		P_{value}[f]
	Before	After	
How energetic do you feel currently?	6.0 (5.0, 7.0)	8.0 (7.0, 9.0)	<0.001
How alert do you feel currently?	7.0 (5.0, 7.0)	8.0 (8.0, 9.0)	<0.001
How awake do you feel currently?	6.0 (6.0, 7.0)	9.0 (8.0, 9.0)	0.002

[f]Wilcoxon Signed Rank test

Table 9 shows comparison of alertness before and after drinking hypertonic solution. There were significant differences of how the participants felt energetic, alert and awake before and after drinking hypertonic solution. The median value of how energetic the participant felt before was 6.0 (Q_1=5.0, Q_3= 7.0) which was increased to 8.0 (Q_1= 7.0, Q_3= 9.0) with P value of <0.001. Hence, there was significant difference of how the participant felt energetic before and after drinking hypertonic solution. The median value of how alert the participant felt before was 7.0 (Q_1= 5.0, Q_3= 7.0) that had increased to 8.0 (Q_1= 8.0, Q_3=9.0) with P value of <0.001. Hence, there was significant difference of how the participant felt alert before and after drinking hypertonic solution. The median value of how awake did the participants felt before was 6.0 (Q_1= 6.0, Q_3= 7.0) that had increased to 9.0 (Q_1= 8.0, Q_3= 9.0) with P value of 0.002. Hence, there was significant difference of awake did the participants felt before and after drinking hypertonic solution.

Table 10. Comparison of alertness before and after drinking isotonic solution (n=37).

Questions	Median (Q_1, Q_3)		P_{value}[f]
	Before	After	
How energetic do you feel currently?	7.0 (6.0, 8.0)	8.0 (7.0, 9.0)	<0.001
How alert do you feel currently?	7.0 (5.0, 8.0)	8.0 (7.0, 9.0)	<0.001
How awake do you feel currently?	7.0 (6.0, 8.0)	8.0 (7.0, 9.0)	0.001

[f]Wilcoxon Signed Rank test

Table 10 shows comparison of alertness before and after drinking isotonic solution. There were significant differences of how the participants felt energetic, alert and awake before and after drinking isotonic solution. The median value of how energetic the participant felt before was 7.0 (Q_1= 6.0, Q_3= 8.0) which was increased to 8.0 (Q_1= 7.0, Q_3= 9.0) with P value of <0.001. Hence, there was significant difference of how the participant felt energetic before and after drinking isotonic solution. The median value of how alert the participant felt before was 7.0 (Q_1= 5.0, Q_3= 8.0) that had increased to 8.0 (Q_1= 7.0, Q_3=9.0) with P value of <0.001. Hence, there was significant difference of how the participant felt alert before and after drinking isotonic solution. The median value of how awake did the participants felt before was 7.0 (Q_1= 6.0, Q_3= 8.0) that had increased to 8.0 (Q_1= 7.0, Q_3= 9.0) with P value of 0.001. Hence, there was significant difference of awake did the participants felt before and after drinking isotonic solution.

Table 11. Comparison of alertness before and after drinking mineral water (n=37).

Questions	Median (Q_1, Q_3)		P_{value} [f]
	Before	After	
How energetic do you feel currently?	6.0 (5.0, 7.0)	7.0 (6.0, 8.0)	0.039
How alert do you feel currently?	6.0 (5.0, 7.0)	7.0 (6.0, 7.0)	0.019
How awake do you feel currently?	6.0 (5.0, 7.0)	6.0 (6.0, 7.0)	0.019

[f]Wilcoxon Signed Rank test

Table 11 shows comparison of alertness before and after drinking mineral water. There were significant differences of how the participants felt energetic, alert and awake before and after drinking mineral water. The median value of how energetic the participant felt before was 6.0 (Q_1= 5.0, Q_3= 7.0) which was increased to 7.0 (Q_1= 6.0, Q_3= 8.0) with P value of 0.039. Hence, there was significant difference of how the participant felt energetic before and after drinking mineral water. The median value of how alert the participant felt before was 6.0 (Q_1= 5.0, Q_3= 7.0) that had increased to 7.0 (Q_1= 6.0, Q_3=7.0) with P value of 0.019. Hence, there was significant difference of how the participant felt alert before and after drinking mineral water. The median value of how awake did the participants felt before was 6.0 (Q_1= 5.0, Q_3= 7.0) that remained constant to 6.0 (Q_1= 6.0, Q_3= 7.0) with P value of 0.019. Hence, there was significant difference of awake did the participants felt before and after drinking mineral water.

Table 12. Comparison of negative outcomes between hypertonic (n=37) and mineral water (n=37).

Question	Hypertonic n (%)		Mineral Water n (%)		RR (95% CI)	x^2	P_{value} [g]
	Yes	No	Yes	No			
Do you feel any headache currently?	3 (8.1)	34 (91.9)	2 (5.4)	35 (94.6)	1.5 (0.3, 8.5)	0.2	0.643
Do you feel anxious currently?	7 (18.9)	30 (81.1)	3 (8.1)	34 (91.9)	2.3 (0.7, 8.3)	1.9	0.174
Do you experience palpitation currently?	11 (29.7)	26 (70.1)	2 (5.4)	35 (94.6)	5.5 (1.3, 23.1)	7.6	0.006
Do you experience any allergic reaction currently?	5 (13.5)	32 (86.5)	0 (0.0)	37 (100.0)	Undefined	5.4	0.021

[g]Chi-square test

Table 12 shows the negative outcomes such as headache, anxious, palpitation and allergic reaction that were felt by the participant drinking hypertonic drink in comparison to mineral water. Participants who drank hypertonic solution are 1.5 times more likely to have headache than participants who drank mineral water. The computed P value was 0.643. Hence, there was no significant difference of the participants having headache after drinking hypertonic solution compared to mineral water. According to Chi-square test, there was not enough evidence to reject the null hypothesis. So, there was no statistically significant difference of participants getting headache after drinking hypertonic solution compared to mineral water.

Participants who drank hypertonic solution are 2.3 times more likely to feel anxious than participants who drank mineral water. The computed P value was 0.174. Hence, there was no significant difference of the participants feeling anxious after drinking hypertonic solution compared to mineral water. According to Chi-square test, there was not enough evidence to reject the null hypothesis. So, there was no statistically significant difference of participants feeling anxious after drinking hypertonic solution compared to mineral water.

Participants who drank hypertonic solution are 5.5 times more likely to experience palpitation than participants who drank mineral water. The computed P value was 0.006. Hence, there was significant difference of the participants experiencing palpitation after drinking hypertonic solution compared to mineral water. According to Chi-square test, there was enough evidence to reject the null hypothesis. So, there was statistically significant difference of participants experiencing palpitation after drinking hypertonic solution

compared to mineral water.

13.5% participants who drank hypertonic solution had developed allergic reaction whereas 0% participants who drank mineral water had developed any allergic reaction. According to Chi-square test, there was enough evidence to reject null hypothesis. So, there was statistically significant difference of participants developing allergic reaction after drinking hypertonic solution compared to mineral water.

Table 13. Comparison of negative outcomes between isotonic (n=37) and mineral water (n=37).

Question	Isotonic n (%)		Mineral Water n (%)		RR (95% Cl)	x^2	P_{value} [g]
	Yes	No	Yes	No			
Do you feel any headache currently?	1 (2.7)	36 (97.3)	2 (5.4)	35 (94.6)	0.5 (0.0, 5.3)	0.3	0.556
Do you feel anxious currently?	3 (8.1)	34 (91.9)	3 (8.1)	34 (91.9)	1.0 (0.2, 4.6)	0.0	0.999
Do you experience palpitation currently?	2 (5.4)	35 (94.6)	2 (5.4)	35 (94.6)	1.0 (0.1, 6.7)	0.0	0.999
Do you experience any allergic reaction currently?	0 (0.0)	37 (100.0)	0 (0.0)	37 (100.0)	Undefined	2.1	0.152

[g]Chi-square test

Table 13 shows the negative outcomes such as headache, anxious, palpitation and allergic reaction that were felt by the participant drinking isotonic drink in comparison to mineral water. Participants who drank isotonic solution are 0.5 times less likely to have headache than participants who drank mineral water. The computed P value was 0.556. Hence, there was no significant difference of the participants having headache after drinking isotonic solution compared to mineral water. According to Chi-square test, there was not enough evidence to reject the null hypothesis. So, there was no statistically significant difference of participants getting headache after drinking isotonic solution compared to mineral water.

Participants who drank isotonic solution are equally exposed to feel anxious compared to participants who drank mineral water. Hence, there no is association between drinking isotonic solution and mineral water towards feeling anxious. The computed P value was 0.999. Hence, there was no significant difference of the participants feeling anxious after drinking isotonic solution compared to mineral water. According to Chi-square test, there was not enough evidence to reject the null hypothesis. So, there was no statistically significant difference of participants feeling anxious after drinking isotonic solution compared to mineral water.

Participants who drank isotonic solution are equally exposed to experience palpitation compared to participants who drank mineral water. Hence, there is no association between drinking isotonic solution and mineral water towards experiencing palpitations. The computed P value was 0.999. Hence, there was no significant difference of the participants experiencing palpitation after drinking isotonic solution compared to mineral water. According to Chi-square test, there was not enough evidence to reject the null hypothesis. So, there was no statistically significant difference of participants experiencing palpitation after drinking isotonic solution compared to mineral water.

100% participants who drank isotonic solution did not develop any allergic reaction similar as participants who drank mineral water who also did not develop any allergic reaction. According to Chi-square test, there was not enough evidence to reject null hypothesis. So, there was no statistically significant difference of participants developing allergic reaction after drinking isotonic solution compared to mineral water.

4. Discussion

The objective of this study was to measure the effects of energy drinks and sports drink on systolic blood pressure, diastolic blood pressure, heart rate and alertness in comparison with mineral water amongst young healthy adults in MMMC.

The changes in cardiology parameters were not significantly different between interventions of isotonic, hypertonic and mineral water. No significant differences were found in physiological measurements of mean change in systolic blood pressure, diastolic blood pressure and heart rate between drink interventions. A comparison study regarding different tonicity of carbohydrate-electrolyte sports drinks on performance and physiological function done by Jack Hornsby showed that no significant differences were found in physiological measurements of mean change in systolic and diastolic blood pressure between the different tonicity of carbohydrate-electrolyte sports drink. [8]

There are no significant changes in systolic, diastolic blood pressure and heart rate after taking isotonic drinks. This result is supported by a similar study of effects of isotonic beverage on autonomic regulation during and after exercise. Results in this study showed that hydration with isotonic solution did not significantly influence heart rate during exercise but promote faster recovery. [9] However, it was said that isotonic drink will increases blood pressure due to the sodium content in the isotonic sports drink [10]. On the other hand, potassium, calcium and magnesium contain in isotonic sports drink can leads to lowering in blood pressure. [11]

Systolic blood pressure was significantly increased after taking hypertonic drink in this study however mean changes in diastolic blood pressure and heart rate after taking hypertonic drink were not statistically significant. A recent analysis of 15 studies, involving over a thousand healthy people found that consuming an energy drink caused systolic blood pressure to rise by 4.44/2.73 mmHg. [14] A validation study regarding energy drinks and their impact on the cardiovascular system done by Erik Konrad showed that ingestion of an amount of caffeine equivalent to 1-3 cups coffee appears to result in an increase in systolic blood pressure of 4-9mmHg. [12] Researchers of a study according to Henry Ford Hospital has also found that both the caffeine and taurine contain in energy drinks have direct effect on cardiac function and responsible for the increase in blood pressure [13]. Increased in blood pressure and heart rate were insignificant for healthy adults [13, 15] however healthy adults who consumed energy drink two cans a day experienced an increase in their blood pressure and heart rate [13]. Be that as it may, study regarding the effect of acute consumption of energy drinks on blood pressure and heart rate in the group of young adults showed results which are not withstanding with ours. There was statistically significant increase in diastolic blood pressure but significant effect on systolic blood pressure and heart rate were not detected [16].

As for mineral water, there was no significant difference in the systolic and diastolic blood pressure before and after drinking in our study however heart rate was significantly decreased. The results were supported by a pilot study on the effect of functional water (mineral water) on heart rate in healthy humans. The results showed drinking 100ml of mineral water did not alter the arterial blood pressure in the 60 minutes post-drinking [17]. Drinking mineral water led to a significant fall in the heart rate [17]. Proper body hydration affects heart rate [19]. A study published in the Journal of Strength and Conditioning Research 2014 confirmed that lack of water in the body leads to more viscous blood and decrease the volume of the plasma which accelerated the heart rate [18, 19]. Hence, rehydration could lower the heart rate. Magnesium content in the mineral water helps in regulate blood pressure [11, 20, 21]. One study found that people whose drinking water was low in magnesium were able to lower their blood pressure by drinking a liter of mineral water every day [20].

In this research, the mental alertness of the participant was compared before and after drinking all three interventions which were isotonic, hypertonic and mineral water. Those who drank hypertonic solution showed statistically significant difference as the participants felt more energetic, alert and awake after drinking the solution. This result is in consistent with a research carried out by a university in Bristol, United Kingdom, which shows that consuming energy drink (hypertonic solution) have significant improvements in mental performance included choice reaction time, concentration and memory, which reflected increased subjective alertness. [22] However, another study carried out by a research laboratory in United States shows that there is no significant difference on how energetic the test subject felt and the test subjects' feelings of sleepiness after taking energy drink (hypertonic solution). [23]

The comparison of alertness before and after drinking isotonic solution shows statistically significant difference in which the participants felt more energetic, alert and awake after drinking isotonic solution. One of the previous study carried out among university athletes in Singapore shows that the use of sports drinks (isotonic solution) was significantly higher during the training/competition season than off-season as a source of fluid, energy and to reduce fatigue. [27] This shows that consumption of isotonic solution might have help improve mental alertness and reduce fatigability.

When comparing the mental alertness before and after drinking mineral water, the results showed that there were statistically significant difference of how energetic, alert and awake the participants felt before and after drinking mineral water. This goes along with a study carried out by a few researchers from a university in United Kingdom, where there was significant positive effects of objectively measured water ingestion on self-assessed alertness. [24]

In this research, negative outcomes such as headache, anxious, palpitation and allergic reaction such as stomach ache, vomiting and others, that were felt by the participants after drinking hypertonic drank was compared with mineral water. The results showed that there was no significant difference of the participants having headache after drinking hypertonic solution compared to mineral water, consistent with a study carried out by a university in Saudi Arabia. [25]

This research shows that there was no significant difference of the participants feeling anxious after drinking hypertonic solution compared to mineral water. It goes along with a study carried out by a research laboratory in United States, where the average change in visual analogue scale values from baseline for feeling anxious after consuming energy drink did not show any level of statistical difference. [23]

In this research, participants who drank hypertonic solution are more likely to experience palpitation than participants who drank mineral water and the result showed statistically significant difference, which is consistent with a study carried out among students attending a state university in the Central Atlantic region of the United States, where students experienced heart palpitations from consuming energy

drinks. [26]

The results showed that there was statistically significant difference of participants developing allergic reaction after drinking hypertonic solution compared to mineral water, which is in contrary with the study carried out by a university in Saudi Arabia, where allergic reaction development after drinking energy drink shows insignificant result. [25]

In this study, the negative outcomes such as headache, anxious, palpitation and allergic reaction that were felt by the participant after drinking isotonic drink in comparison to mineral water showed no significant results. Previous study did not show negative outcome of consuming isotonic solution but a case report on "Thiamine-deficient encephalopathy due to excessive intake of isotonic drink or over strict diet therapy in Japanese children" shows that excessive intake of isotonic solution can be harmful. [28]

5. Conclusion

Consumption of energy drinks and sports drink, despite the variation in the reason for choosing such drinks, is quite common in college students as it is easily accessible. Energy drinks have no therapeutic benefit, and many ingredients are understudied and not regulated whereas when sports drinks were initially created, the whole point was to provide athletes the replacement fluid, electrolytes, and macronutrients to replenish the loss electrolytes in the body that leads to increase plasma volume and better circulation. Proper body hydration affects your heart rate and performance. Namely, the lack of water in the body leads to more viscous blood and decreases the volume of the plasma, which leads to a circulation of the blood and accelerated the heart rate. Therefore, this study has demonstrated that energy drink could contribute to the enhancement of the participants' mental alertness, therefore, proving the hypothesis for this study true given that the result revealed such a significant difference. However, part of the hypothesis also mentions that sports drink will decrease the cardiac parameters (systolic and diastolic blood pressure and heart rate), this was unfortunately not proven true as there was a slight increase in cardiac parameters post-consumption.

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