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Acute Physiological Effects of Energy Drinks on Cardiovascular Endurance, Blood Pressure, and Heart Rate in Collegiate Athletes

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Abstract

Background: Energy drinks are commonly consumed by athletes due to their caffeine and stimulant content, which is believed to enhance performance. Previous research suggests benefits for anaerobic power and reaction time, but their effects on cardiovascular endurance and physiological responses remain inconclusive.
Aims: This study aimed to examine the acute effects of energy drink consumption on cardiovascular endurance, blood pressure, and heart rate among collegiate athletes in the Philippines.
Methods: Using a one-group pretest-washout-posttest design, 21 collegiate athletes (12 males, 9 females) participated. Cardiovascular endurance was assessed using the beep test. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured using a digital sphygmomanometer (Omron 10 Series BP7450), while heart rate (HR) and heart rate recovery (HRR) were monitored digitally. Participants underwent a pretest, consumed 330 ml of energy drink, completed a washout period, and then performed a post-test. The Shapiro-Wilk test was used to assess normality, and paired sample t-tests determined pre–and post-test differences.
Result: Energy drink intake did not significantly improve cardiovascular endurance ($p > .05$). However, significant increases in DBP ($p = .040$) and HR ($p = .029$) were observed in males. At the same time, females showed a significant rise in SBP ($p = .032$). HRR significantly improved in females ($p = .031$), indicating a possible short-term recovery benefit. Combined results showed a significant increase in DBP ($p = .021$), while HRR approached significance ($p = .055$).
Conclusion: Although no enhancement in cardiovascular endurance was observed, energy drinks acutely influenced cardiovascular markers, raising blood pressure and heart rate in males and enhancing HRR in females. The absence of a control group and uncontrolled variables, such as caffeine metabolism, hydration, and socioeconomic factors, limit causal conclusions. These findings suggest the need for sex-specific guidance when using energy drinks. Future randomized trials with larger samples are recommended.

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INTRODUCTION

Student-athletes are subjected to physical and cognitive demands requiring optimal performance in both academic and athletic settings (Lopes Dos Santos et al., 2020; Young et al., 2023). The role conflict between academics and sports has been associated with mental fatigue, stress, and impaired cognitive function (Sun et al., 2021; Wu et al., 2024). Sleep deprivation further exacerbates performance deficits by reducing reaction time, accuracy, and sprint capability (Charest & Grandner, 2020; Pradzynska et al., 2024). To counteract these challenges, athletes often resort to energy drinks, which are believed to enhance endurance and maintain alertness (Gutiérrez-Hellín & Varillas-Delgado, 2021; Tambalis, 2022). Similar to other ergogenic aids explored in sports science, such as

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calisthenics (Masagca, 2024b; Masagca, 2025d) and music tempo modulation (Masagca, 2025c), energy drinks are used with the intent to optimize physical performance under fatigue and stress.

Energy drinks typically contain caffeine (Alsunni, 2015), taurine, and sugar (Abu-Reidah, 2020), along with other bioactive compounds known to influence athletic and physiological performance (Erdmann et al., 2021). Furthermore, previously conducted studies have observed that the ergogenic benefits of caffeine include improved endurance, increased power output, and enhanced neuromuscular response (Ferreira et al., 2022; Giráldez-Costas et al., 2023). Moreover, studies have demonstrated significant increases in anaerobic capacity, grip strength, and sprint performance following energy drink consumption in sports such as soccer (Del Coso et al., 2012), basketball (Abian-Vicen et al., 2014), and rugby (Del Coso et al., 2013). Additionally, improvements in running economy and agility have also been observed in intermittent sports such as hockey (Del Coso et al., 2016) and soccer (Gruska et al., 2024). These performance-related outcomes are in line with emerging findings on alternative ergogenic aids such as jump squats and high-intensity interval training, which have demonstrated measurable enhancements in physical fitness and explosiveness among collegiate students (Masagca, 2024a; Masagca, 2025b).

However, despite the potential benefits of energy drinks on athletic performance, their effects on cardiovascular function remain controversial. Several studies have documented significant elevations in both systolic and diastolic blood pressure following energy drink consumption (Shah et al., 2019; Xu et al., 2021), with some individuals exhibiting sustained hypertension for hours post-ingestion (Oberhoffer et al., 2023). Others, however, have reported negligible or transient effects, particularly in young, healthy athletes (Hajsadeghi et al., 2015). Heart rate responses also vary, with some studies showing marked increases post-exercise, while others report no significant change in peak or mean heart rate (Astorino et al., 2012; Duncan & Hankey, 2013).

Cardiovascular endurance is a critical component of athletic performance, yet research on how energy drinks influence this domain—especially in intermittent sports—remains limited. While the effects of energy drinks on anaerobic output are well documented, their impact on aerobic capacity and sustained cardiovascular function is underexplored. This gap is especially evident in developing countries like the Philippines, where climate, socioeconomic conditions, and lifestyle practices significantly shape physiological responses. Despite widespread energy drink use among student-athletes, few studies have examined their cardiovascular effects within this context.

Recent works (post-2020), including those by Masagca (2024a; 2025a; 2025b; 2025c; 2025d), emphasize the importance of context- and sex-specific research, noting how physiological and cultural variables may alter the impact of ergogenic aids. Addressing this gap, the present study is novel in its integration of cardiovascular endurance testing (via the beep test) with real-time monitoring of systolic and diastolic blood pressure and heart rate at five-minute intervals over 50 minutes. It also highlights sex-based differences in response and explores implications in a tropical, low-resource athletic environment. This research not only expands the literature on the acute cardiovascular effects of energy drinks but also provides empirical data essential for localized policy and coaching recommendations, especially in nations like the Philippines, where affordable, accessible interventions are crucial.

METHOD

Research Design

This study employed a one-group pretest-washout-posttest design (Adila et al., 2023) to examine the acute effects of energy drink consumption on cardiovascular endurance, blood pressure, and heart rate in collegiate athletes. This quasi-experimental design allowed for comparing pretest and post-test measures within the same group, eliminating inter-individual variability while assessing changes before and after energy drink ingestion. The washout period between tests minimized potential carryover effects, ensuring that the post-test results reflected the impact of the intervention rather than residual fatigue or prior exertion.

Since the study did not include a control group, each participant served as their baseline, allowing for a direct comparison of cardiovascular responses before and after consuming an energy drink. This design was chosen due to practical constraints and the real-world applicability of evaluating energy drink effects in a field-based setting. While this approach provides insight into individual physiological changes, it does not control for external influences, which could impact the results. Despite these limitations, the design effectively captured immediate physiological responses to energy drink consumption, making it suitable for exploring short-term effects on athletic performance.

Participants

The study involved 21 collegiate athletes (12 males and 9 females) from a public tertiary institution in the Philippines, representing sports such as basketball, futsal, volleyball, and sepak takraw. Purposive sampling was used to select participants who met the inclusion criteria: aged 17–20, currently enrolled student-athletes with at least one year of competitive experience in the State Colleges and Universities Athletic Association (SCUAA). Exclusion criteria included a history of cardiovascular conditions, caffeine sensitivity, hypertension, or current use of medications or supplements affecting cardiovascular function. Although the sample size was limited to 21 due to the availability of eligible participants and the logistical demands of physiological monitoring, it allowed for focused observation within a real-world athletic setting. While this number may limit generalizability, the study provides valuable preliminary data, particularly within the Philippine collegiate sports context. Participants were not monetarily compensated but received individual feedback on performance and cardiovascular responses, serving as a potential benefit for their athletic development. Demographically, most participants were 18 years old, with a few aged 17, 19, or 20. Males generally had higher BMI, greater lean body mass, and taller stature, while females had higher fat mass.

Table 1. Demographic Distribution of the Participants (n = 21)

	Male (n = 10)	**Female (n = 11)**	**Both (n = 21)**
Age			
17 years old	3	3	6
18 years old	4	5	9
19 years old	1	2	3
20 years old	2	1	3
Grand mean	18.20 ± .944	18.09 ± .944	18.14 ± 1.01
Sports Event			
Basketball	3	3	6
Futsal	2	5	7
Sepak Takraw	4	3	7
Volleyball	1	0	1
Anthropometric measurements			
Height (m)	2.00 ± .00	1.73 ± .47	1.86 ± .359
Fat mass (kg)	10.40 ± 1.84	14.64 ± 2.46	12.62 ± 3.04
Lean Body Mass (kg)	50.50 ± 11.67	39.18 ± 3.46	44.57 ± 10.06
Body Mass Index	25.10 ± 2.77	21.91 ± 1.04	23.43 ± 2.58

Instrument

The beep test, also known as the multistage fitness test, was selected as the primary evaluation tool for cardiovascular endurance due to its well-documented validity and reliability in measuring aerobic capacity in both athletic and non-athletic populations (Léger & Boucher, 1980). The test requires participants to run back and forth between two markers in synchronization with auditory beeps, which progressively shorten in duration, necessitating an increase in running speed. This method provides a standardized assessment of VO_2 max and endurance capacity, making it widely applicable in sports performance testing. Multiple studies have confirmed the test's strong test-retest reliability and criterion-related validity, including its correlation with laboratory-based VO_2 max measures, particularly in college students (Dimarucot & Macapagal, 2021) and youth athletes (Brito et al., 2022). Given the lack of advanced laboratory equipment, the beep test served as a cost-effective and field-appropriate alternative for assessing endurance performance in university athletes. Furthermore, blood pressure was measured using a digital sphygmomanometer, the Omron 10 Series BP7450 (HEM-7342T-Z), which has been validated for accuracy and reliability in clinical and research settings (Peprah et al., 2023). A digital BP monitor was preferred over a manual sphygmomanometer to reduce potential measurement errors and ensure consistency across trials.

Procedures

The data collection process consisted of three phases: pretest, washout period, and post-test. To minimize external influences, participants were instructed to abstain from consuming energy drinks, caffeinated beverages, and other stimulants for three days before the pretest. Additionally, they were required to maintain a minimum of eight hours of sleep per night to control for potential fatigue-related effects on cardiovascular endurance and recovery. The pretest was conducted in a gymnasium setting to ensure uniform testing conditions. Participants remained seated for 50 minutes before testing to standardize their resting physiological state. Blood pressure and heart rate were continuously monitored and recorded every five minutes, generating ten data points per session. Before endurance testing, all athletes completed a structured warm-up and stretching routine to ensure optimal physiological preparedness and minimize the risk of injury. Cardiovascular endurance was assessed using the beep test, a field-based measure widely used for evaluating aerobic fitness and VO_2 max estimation. HR was recorded at the point of exhaustion, and HRR was assessed two minutes post-exercise, indicating the heart's ability to return to baseline following maximal exertion (Qiu et al., 2017; Römer & Wolfarth, 2022). The beep test was selected due to its validity and practicality, particularly given the university's lack of advanced laboratory equipment such as metabolic gas analyzers or cycle ergometers. Additionally, the test aligns with the physiological demands of intermittent sports like basketball, futsal, and sepak takraw, which involve repeated bouts of high-intensity effort followed by short recovery periods (Magee et al., 2021).

Following the pretest phase, a washout period of 2–3 days was implemented to allow for adequate physiological recovery and minimize residual fatigue that could affect post-test performance. This duration is consistent with standard recovery windows in exercise research, particularly for submaximal aerobic exertion, and was deemed sufficient to reduce potential carryover effects from the pretest while maintaining participant readiness. During the washout period, participants were instructed to maintain consistent dietary habits and avoid any food or beverage containing caffeine or other stimulants. Water intake was permitted, and meals were recorded to monitor compliance with dietary controls. The post-test followed the same protocol as the pretest but included ingesting an energy drink 50 minutes before testing. BP and HR were monitored at 5-minute intervals during this period, maintaining consistency with the pretest measurements. The beep test was administered under identical conditions, with HR recorded at exhaustion and during the two-minute post-exercise recovery phase. This standardized testing approach ensured that the study could effectively evaluate the acute effects of energy drink consumption on cardiovascular endurance, BP, HR, and HRR while controlling for external physiological and environmental factors (Romero et al., 2017).

Analysis Plan

Descriptive statistics, including mean and standard deviation, were used to summarize demographic data such as age, height, weight, body fat mass, and lean body mass. To assess the effect of energy drink consumption on cardiovascular endurance, a paired t-test was conducted to compare pretest and post-test values. The analysis was performed using IBM SPSS Statistics version 29 of MacOS, with statistical significance set at $p < 0.05$. A result was considered statistically significant if the probability of occurrence by chance was below 5%, following standard statistical conventions.

Furthermore, the Shapiro-Wilk test was used to assess normality (Amirah et al., 2023; Wahyuningsih et al., 2023), as it is appropriate for small sample sizes ($n < 50$). A p-value ≥ 0.05 indicated that a variable did not significantly deviate from a normal distribution. Most variables met this assumption, except for height, body mass index (BMI), and beep-test post-scores, which showed slight deviations. However, since parametric tests are generally robust to minor violations of normality, the *paired t-test* was deemed appropriate for further analysis.

Table 2. Normality Test Using Shapiro-Wilk Test (*n* < 50)

Variables	Shapiro-Wilk test (*n* < 50)		
	Statistics	*df*	Sig.
Height (m)	.422	21	<.001
Fat mass (kg)	.968	21	.687
Lean Body Mass (kg)	.923	21	.101
Body Mass Index	.907	21	.047
Beep-test^{pre}	.944	21	.258
Beep-test^{post}	.896	21	.029
SBP^{pre}	.910	21	.054
DBP^{pre}	.960	21	.513
HR (bpm)^{pre}	.945	21	.271
HRR (bpm)^{pre}	.944	21	.265
SBP^{post}	.929	21	.131
DBP^{post}	.967	21	.664
HR (bpm)^{post}	.914	21	.065
HRR (bpm)^{post}	.941	21	.227

Ethical Considerations

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki (1975), ensuring the safety, rights, and well-being of all participants. Prior to data collection, participants were fully informed about the study's purpose, procedures, potential risks, and benefits. Written informed consent was obtained, and participants were explicitly informed of their right to withdraw from the study at any point without penalty. Furthermore, confidentiality was strictly maintained, with all data anonymized and used exclusively for research purposes. The study took place in a controlled university setting, where standardized protocols were implemented to minimize risks associated with cardiovascular testing. Participants were screened prior to involvement to confirm that they were in good health, had no history of cardiovascular conditions, and were not under any medication that could interfere with heart rate or blood pressure. During testing, trained research personnel closely monitored the participants throughout all phases of the study. A first aid kit and medical support staff were on standby during each testing session, and participants were allowed rest periods as needed to ensure safety and comfort.

Although this was a self-funded study, it received ethical clearance and was officially reported through the College of Sports, Exercise and Recreation, with Control No. CSER-CRDU-2025-011. The procedures adhered to international standards for human research ethics to protect the dignity, rights, and welfare of all participants involved.

RESULTS AND DISCUSSION

Result

The paired t-test results indicate that energy drink consumption did not produce a statistically significant change in cardiovascular endurance, as measured by the beep test, in males ($t(9) = 1.203$, $p = .260$, Cohen's $d = 1.578$), females ($t(10) = -1.444$, $p = .179$, Cohen's $d = 2.714$), or the combined sample ($t(20) = -.644$, $p = .530$, Cohen's $d = 2.373$). While statistical significance was not achieved, the effect size was more significant in females, suggesting a possible difference in response between the sexes. However, these findings do not account for other influential factors, such as individual caffeine sensitivity, hydration levels, nutritional intake, sleep quality, and psychological factors, all of which could affect cardiovascular endurance. Additionally, external variables such as training history, fitness level, and variations in energy drink composition may have influenced the results, underscoring the complexity of physiological responses to supplementation.

Table 3. Beep Test Scores for Pre-Test and Post-Test

Test	Group	Mean ± SD	SE	*df*	*t*	Sig.	95% CI [LL, UP]	Cohen's *d*	95% CI [LL, UP]
Beep-test (Male)	Pre	7.00 ± 1.33	.422	9	1.203	.260	[-.529, 1.729]	1.578	[-.273, 1.014]
	Post	6.40 ± .97	.306						

Test	Group	Mean ± SD	SE	*df*	*t*	Sig.	95% CI [LL, UP]	Cohen's *d*	95% CI [LL, UP]
Beep-test (Female)	Pre	2.91 ± 1.45	.436	10	-1.444	.179	[-3.005, .641]	2.714	[-1.046, .194]
	Post	4.09 ± 2.34	.707						
Beep-test (Both)	Pre	4.86 ± 2.50	.545	20	-.644	.527	[-1.414, .747]	2.373	[-.569, .291]
	Post	5.19 ± 2.14	.466						

The paired t-test results indicate varying effects of energy drink consumption on systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), and heart rate recovery (HRR) in both male and female athletes. In males, DBP increased significantly post-consumption ($t(9) = -2.397$, $p = .040$, Cohen's $d = 8.048$), along with a significant increase in HR ($t(9) = -2.598$, $p = .029$, Cohen's $d = 8.399$), while SBP and HRR did not show significant changes. Among females, SBP increased significantly post-consumption ($t(10) = -2.496$, $p = .032$, Cohen's $d = 9.181$), while DBP and HR remained statistically unchanged. However, HRR showed a significant improvement ($t(10) = -2.500$, $p = .031$, Cohen's $d = 3.859$), indicating a possible benefit for cardiovascular recovery. When analyzing both sexes combined, DBP showed a significant increase ($t(20) = -2.516$, $p = .021$, Cohen's $d = 10.407$), while SBP, HR, and HRR did not reach statistical significance, though HRR approached significance ($p = .055$). These findings suggest that energy drink consumption may contribute to increased blood pressure and heart rate, particularly in males, while potentially aiding cardiovascular recovery in females, highlighting the need for further research on sex-specific physiological responses.

Table 4. 50-minute Blood Pressure, Heart Rate, and Heart Rate Recovery Monitoring of the Participants

Test	Group	Mean ± SD	SE	*df*	*t*	Sig.	95% CI [LL, UP]	Cohen's *d*	95% CI [LL, UP]
SBP (male)	Pre	124.00 ± 4.00	1.27	9	1.344	.212	[-1.162, 4.562]	4.001	[-.529, 1.729]
	Post	122.30 ± 3.65	1.16						
DBP (male)	Pre	60.10 ± 6.03	1.91	9	-2.397	.040	[-11.857, -.343]	8.048	[-.529, 1.729]
	Post	66.20 ± 5.07	1.60						
HR (bpm_male)	Pre	71.20 ± 3.71	1.17	9	-2.598	.029	[-12.908, -.892]	8.399	[-.529, 1.729]
	Post	78.10 ± 8.16	2.58						
HRR (bpm_male)	Pre	31.20 ± 7.89	2.49	9	-1.122	.291	[-10.560, 3.560]	9.869	[-.529, 1.729]
	Post	34.70 ± 7.68	2.43						
SBP (female)	Pre	100.55 ± 5.28	1.59	10	-2.496	.032	[-13.077, -.741]	9.181	[-1.413, -.064]
	Post	107.45 ± 7.56	2.28						
DBP (female)	Pre	66.18 ± 4.90	1.48	10	-1.415	.187	[-13.810, 3.082]	12.572	[-1.306, .202]
	Post	71.55 ± 10.25	3.10						
HR (bpm_female)	Pre	76.73 ± 6.17	1.86	10	.455	.659	[-3.900, 5.900]	7.294	[-.460, .728]
	Post	75.73 ± 6.37	1.92						

Test	Group	Mean ± SD	SE	*df*	*t*	Sig.	95% CI [LL, UP]	Cohen's *d*	95% CI [LL, UP]
HRR (bpm_female)	Pre	25.18 ± 4.22	1.27	10	-2.500	.031	[-5.502, -.317]	3.859	[-1.415, -.065]
	Post	28.09 ± 3.81	1.15						
SBP (both)	Pre	111.71 ± 12.85	2.81	20	-1.553	.136	[-6.584, .965]	8.292	[-.775, .105]
	Post	114.52 ± 9.61	2.10						
DBP (both)	Pre	63.29 ± 6.17	1.35	20	-2.516	.021	[-10.452, -.977]	10.407	[-1.003. -.083]
	Post	69.00 ± .846	1.85						
HR (bpm_both)	Pre	74.10 ± 5.76	1.26	20	-1.464	.159	[-6.696, 1.172]	8.642	[-.755. .123]
	Post	76.86 ± 7.19	1.57						
HRR (bpm_both)	Pre	28.05 ± 6.81	1.49	20	-2.040	.055	[-6.453, .072]	7.167	[-.889. .009]
	Post	31.24 ± 6.72	1.47						

A closer examination of Table 4 reveals distinct cardiovascular responses to energy drink consumption between male and female athletes. In males, the significant increase in diastolic blood pressure (DBP) from 60.10 to 66.20 mmHg (p = .040) and heart rate (HR) from 71.20 to 78.10 bpm (p = .029) suggests heightened sympathetic nervous system activity post-consumption. This aligns with the known vasoconstrictive and stimulatory effects of caffeine and other compounds in energy drinks, potentially predisposing male athletes to acute cardiovascular strain, especially when compounded by physical exertion. For females, while diastolic pressure and heart rate did not change significantly, the systolic blood pressure (SBP) increased markedly from 100.55 to 107.45 mmHg (p = .032), indicating a possible rise in cardiac output or peripheral resistance. Interestingly, females also demonstrated a significant improvement in heart rate recovery (HRR), from 25.18 to 28.09 bpm (p = .031), a response that could be attributed to either improved autonomic regulation post-exercise or better vagal reactivation. This HRR improvement suggests a potential short-term recovery benefit, though it should be interpreted cautiously, given the stimulant nature of energy drinks.

In summary, the findings highlight that energy drinks exert differential effects on cardiovascular markers, with males being more susceptible to elevations in pressure and HR. At the same time, females may derive limited recovery advantages. These nuanced physiological shifts emphasize the need for sex-specific guidelines in energy drink consumption, particularly in athletic populations where cardiovascular efficiency is critical.

Discussion

The findings of this study indicate that energy drink consumption did not produce a statistically significant improvement in cardiovascular endurance, as measured by the beep test. This aligns with Gutiérrez-Hellín and Varillas-Delgado (2021), who suggested that caffeine and other stimulants mainly enhance anaerobic performance rather than sustained aerobic capacity. While Kazemi et al. (2009) reported endurance improvements, other studies, such as Alford et al. (2001) and Peveler et al. (2017), support the conclusion that energy drinks do not consistently improve endurance performance. Variability in these findings may stem from individual differences in caffeine metabolism, habitual caffeine use, and genetic predisposition, as noted by Grinberg et al. (2022).

In contrast, this study found significant acute changes in cardiovascular parameters. Diastolic blood pressure (DBP) significantly increased in males, consistent with previous findings on the hypertensive effects of caffeine due to vasoconstriction and sympathetic stimulation (Hajsadeghi et al., 2015; Wassef et al., 2017). Female participants experienced a significant increase in systolic blood pressure (SBP), echoing the sex-specific responses reported by Somers and Svatikova (2020), potentially driven by hormonal and autonomic factors. Male heart rate (HR) also increased significantly, supporting research by Banks et al. (2024) on caffeine's role in increasing cardiac output through beta-adrenergic activation. Interestingly, females showed a significant improvement in heart rate recovery (HRR), suggesting enhanced parasympathetic reactivation post-exercise—consistent with findings by An et al. (2014) and Rahnama et al. (2010) on sex-related differences in recovery dynamics and stimulant sensitivity.

Implications

From a practical standpoint, findings suggest that collegiate athletes, especially in the Philippine context, should exercise caution when consuming energy drinks before endurance activities. The observed elevations in heart rate and blood pressure, particularly among males, indicate potential cardiovascular risks even in young, healthy individuals. Although female athletes may benefit from improved HRR, this must be weighed against individual variability and overall health. Coaches, athletic trainers, and sports science practitioners should monitor stimulant intake and consider sex-specific responses when advising athletes, especially in settings with limited medical oversight.

Research Contributions

This study contributes novel insights into the sex-specific acute cardiovascular effects of energy drinks within a Southeast Asian collegiate athlete population. By focusing on both performance (beep test) and cardiovascular health markers (BP, HR, HRR), this study addresses an important gap in localized, real-world sports science literature. It adds field-based evidence to an area often limited to laboratory-based anaerobic studies and highlights the need for gender-sensitive ergogenic evaluations.

Limitations

The use of a one-group pretest-washout-posttest design without a control group limits the study's internal validity and causal inference. Performance fluctuations, placebo effects, and test familiarity may have influenced the outcomes. Additionally, confounding variables such as hydration status, dietary intake, sleep, and psychological stress were not controlled. Variability in caffeine metabolism and prior caffeine exposure may have further affected individual responses. The energy drink formulation used may differ in caffeine, sugar, or taurine levels from other commercial brands, limiting generalizability. Lastly, environmental conditions and socioeconomic status, which can influence nutrition and training, were not accounted for.

Suggestion

Future research should employ randomized controlled trials (RCTs) with placebo and double-blind procedures to enhance validity and control expectancy effects. Studies should standardize diet, hydration, sleep, and training load during the testing period. Larger, more diverse athletic populations are needed to generalize findings across different sports and demographics. Advanced statistical techniques such as repeated-measures ANOVA, mixed-effects models, and multivariate regression should be used to explore predictors of cardiovascular response. Additionally, future studies should examine long-term energy drink use, compare formulations, and isolate the effects of key ingredients such as caffeine, taurine, sugar, and guarana on cardiovascular function and performance.

CONCLUSION

This study aimed to evaluate the acute effects of energy drink consumption on cardiovascular endurance, blood pressure, heart rate, and heart rate recovery among collegiate athletes. Results indicated no significant improvement in cardiovascular endurance but demonstrated notable acute changes in cardiovascular parameters—specifically elevated diastolic pressure and heart rate in males and improved heart rate recovery in females. These findings suggest that energy drinks may not enhance aerobic performance but do exert significant sex-specific physiological effects. Therefore, caution is warranted when using energy drinks in sports settings, and individualized, sex-sensitive guidance should be considered when recommending such supplements to athletes.

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AUTHOR CONTRIBUTION STATEMENT

RR, JL, AA, SP, and HC carried out conceptualization. JL and AA were responsible for the investigation, while RR, JL, and AA developed the methodology. The original draft of the manuscript was written collaboratively by RR, JL, AA, SP, and HC, who also participated in the review and editing process. JL handled software development, and JL and AA conducted data curation. RR, JL, and AA undertook visualization efforts, while JL and AA performed formal analysis. Funding acquisition was a joint effort by RR, JL, AA, SP, and HC.

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