Effect of energy drink intake before exercise on indices of physical performance in untrained females

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ABSTRACT

الأهداف: تحديد أثر مشروبات الطاقة قبل عمل أي تمرين على مؤشرات الأداء البدني للنساء الغير خاضعات للتدريب المستمر.

الطريقة: لقد تم إجراء هذه الدراسة باستخدام عنصر التجريب على مجموعتين تجريبية وضابطة في قسم وظائف الأعضاء في كلية الطب، جامعة الدمام، المملكة العربية السعودية خلال الفترة من سبتمبر 2011م إلى مايو 2012م. وقد تكونت عينة الدراسة من 32 طالبة سليمة بحيث تكون كل طالبة مسؤولة عن التحكم في مدى تناولها لمشروبات الطاقة طول فترة الدراسة. وقد تم إعطاء أفراد العينة مشروب طاقة فعلي وآخر وهمي قبل 45 دقيقة من عمل أي تمرين بدني. وتم ملاحظة عنصر التعب بعد استنفاذ الوقت بالإضافة إلى مراحل بروتوكول بروس. فيما تم تسجيل معدل ضربات القلب، وضغط الدم، ونسبة الأكسجين الموجودة في الدم قبل وبعد ممارسة الرياضة. وقد تم احتساب أعلى قيمة لنسبة الأكسجين باستخدام معادلات إحصائية معينة كاختبار t-test الذيلي.

النتائج: تراوح متوسط الأعمار لأفراد العينة 19.93±0.8 عاماً، وكان متوسط الطول 156.40±3.83 سم، بينما تراوح متوسط الوزن 51.73±3.65 كغم. وقد أظهرت النتائج أن معدل الوقت المستنفذ في المجموعة الضابطة وصل الى 11.67±1.51 دقيقة، بينما وصل في المجموعة التجريبية إلى 11.41±1.65 دقيقة (p<0.157). وقد كانت أعلى نسبة للأكسجين في المجموعة الضابطة 34.06±6.62، بينما وصلت الى 32.89±6.83 في المجموعة التجريبية بما يعني عدم وجود دلالة إحصائية (p<0.154). وقد لوحظ أيضاً عدم وجود فروق إحصائية دالة بين المجموعتين الضابطة والتجريبية فيما يخص معدل ضربات القلب، ومستوى ضغط الدم، ومستويات اللاكتات في الدم، وذلك قبل أو بعد ممارسة الرياضة. ومع ذلك فقد تم ملاحظة اختلافات كبيرة داخل كل مجموعة خصوصا بين الفترات ما قبل وبعد التمارين مباشرة بالإضافة إلى بعد أدائها بحوالي 30 دقيقة.

الخاتمة: أشارت الدراسة إلى عدم اختلاف آثار تناول مشروبات الطاقة على الأداء البدني أثناء ممارسة الرياضة في كلا المجموعتين التجريبية (النساء اللواتي تناولن مشروب الطاقة الفعلي) والضابطة والتي لم يتناول أفرادها مشروب الطاقة ذاته.

Objectives: To determine the effect of energy drink consumption before exercise on indices of physical performance in untrained females.

Methods: This single blind placebo controlled experimental study was carried out at the Physiology Department, University of Dammam, Dammam, Kingdom of Saudi Arabia from September 2011 to May 2012, on 32 healthy female students, in a crossover design. They were given either a standardized energy drink or the placebo 45 minutes before the exercise. Time to exhaustion and the stages of Bruce protocol achieved were noted. Heart rate, blood pressure, peripheral capillary oxygen saturation, and blood lactate were recorded before and after the exercise. Maximum oxygen consumption (VO_2max) was calculated by formula. Paired sample t-test was used for statistics.

Results: The mean age was 19.93±0.8 years, mean height 156.40±3.83 cm, and the mean weight 51.73±3.65 kg. Time to exhaustion in the placebo group was 11.67±1.51 minutes and 11.41±1.56 in the energy drink group (p<0.157). The VO_2max in the placebo group was 34.06±6.62, while it was 32.89±6.83 in the energy drink group (p<0.154). There were no significant differences between the placebo and the energy drinks groups in regards to heart rate, blood pressure, and blood lactate levels, before or after the exercise. However, there were significant differences before, immediately, and 30 minutes post exercise for all parameters between each group.

Conclusion: The effects of energy drinks intake on physical performance during the exercise in our small sample does not significantly differ from placebo.

Saudi Med J 2015; Vol. 36 (5): 580-586
doi: 10.15537/smj.2015.5.11141

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Received 14th January 2015. Accepted 16th March 2015.

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Energy drinks are functional beverages containing caffeine, taurine, glucose, and other additives. They have become very popular throughout the world since 1997 when "Red Bull" was introduced in the market. Companies are aggressively marketing the drinks through advertisements and sponsorship of sports events. The wide range of advertisements and campaigns of energy drinks have been successful in taking the annual consumption to approximately 5.8 billion liters (2013 estimate) in around 160 countries.[1] The popularity of energy drinks in Kingdom of Saudi Arabia (KSA) does not seem to be much different. In a study conducted at a Saudi University, 45.6% of the students who participated in the survey (n=412) admitted to be regular users of energy drinks.[2] Recently, low priced brands have been introduced to attract those who cannot afford the high priced market leaders. The reports of high potential associated risks led the Saudi Council of Ministers to ban the sale of energy drinks at government, health, and education institutes. All forms of advertising were also prohibited.[3] Energy drinks have been marketed with claims to give an 'energy boost' in the form of increased alertness, visual information processing, attention, and physical performance.[4] Therefore, energy drinks are very attractive to young adults and athletes with the age range of almost 65% of the consumers between 13-35 years.[5] Despite all of these claims, the effects of energy drinks on physical and cognitive performances remain controversial leaving a physiologist wondering if these drinks deliver what they claim.[2] A widely cited pioneer study[6] carried out on 36 subjects showed by name that a 'market leader' energy drink significantly improved aerobic endurance and anaerobic performance in cycle ergometers. In addition, mental performance including choice reaction time, concentration, and memory were also significantly improved. A specific energy drink was reported to result in a significant increase in upper body muscle endurance during repeated 'Wingate cycle performance' in young physically active adults. However, no effect was observed on anaerobic peak or average power.[7] Similarly, Hoffman et al[8] found that energy drinks caused a significant increase in reaction performance during exercise, but with no change on anaerobic power performance. A recent study[9] concluded that ingestion of around 3 mg/kg of caffeine in the form of energy drinks significantly enhanced the physical performance of female volleyball players. Although some studies have identified positive effects of energy drinks on exercise performance, yet other researchers reported no significant effects or even detrimental health consequences. Excessive caffeine in energy drinks has been reported to elevate mean arterial pressure[10] as well as heart rate.[11] In addition, it has been found that caffeine in energy drinks enhances diuresis and natriuresis,[12] while it decreases insulin sensitivity.[13] Chronic energy intake may lead to neural, cardiovascular, renal, and gastrointestinal dysfunctions.[14] Immediate serious adverse effects following energy drinks consumption have been reported. Four cases of death as well as 5 separate cases of convulsion associated with energy drinks ingestion were documented.[15] Moreover, psychiatric manifestations, like agitation, anxiety, and insomnia were reported in 4 patients with known psychiatric disorder.[16] Also, there is a case report of anaphylaxis following consumption of energy drink with vitamin B12 added to it.[17]

The use of energy drinks is increasing in KSA, yet there is a lack of local experimental studies on the effect of energy drinks so far. Sensing the need for local evidence with respect to energy drink use, our group has designed a number of experimental studies on different 'gender' and 'physical activity category' groups after an initial landmark survey.[2] This particular study was designed to determine the effects of energy drink consumption before exercise on indices of physical performance in untrained females subjected to standardized exercise and compare it with a placebo group.

Disclosure. Authors have no conflict of interests, and the work was not supported or funded by any drug company. This project in part was supported by a research grant from the University of Dammam, Dammam, Kingdom of Saudi Arabia.

Methods. This study was carried out at the Department of Physiology, College of Medicine, University of Dammam, Dammam, Kingdom of Saudi Arabia. The Research and Ethics Committee of the University of Dammam granted approval of the study after verifying that it fulfills the criteria laid out by the Helsinki Declaration and the University of Dammam. It was a placebo controlled experimental study with a crossover design. It was conducted on healthy Saudi female students of the University of Dammam who volunteered for this project from September 2011 to May 2012. A written informed consent was taken from all the volunteers. The study population was all female students of the university who volunteered for the project. The project was widely notified. Up to the last day, 113 volunteers reported. We numbered them on 'first come first numbered bases' from 001 to 113. We used first 3 columns of table of random numbers (and so on) for picking subjects (as calculated by sample size calculation). We generated 50 numbers initially; however after 41 subjects the sample size of 32 was achieved, 9 subjects were excluded based on the exclusion criteria.

For sample size calculation, (based upon a pilot study on 5 volunteers, the results of whom were not included in the final data) we assumed that mean (±SD) time to exhaustion in the placebo group (PG) will be 8.5 (±1.5) minutes and it will be 10 (±1.5) minutes in the energy drinks groups (EDG). At a power of 90% and at an alpha level (*p*-value) of 0.05 we calculated the sample size to be 30. We however, recruited 32 volunteers (after observing the inclusion and exclusion criteria) to cover up for 'no show'. Unexpectedly, all of our volunteers showed up for both sessions, therefore we based our results on 32 subjects. The inclusion criteria were age range 18-22 years, BMI 18-25 kg/m^2, and of Saudi nationality. The exclusion criteria were any physical disability, any diagnosed disease likely to interfere with exercise on treadmill, or safety of the subject (especially cardiac or respiratory disease), using any medication or herbal supplements, having any known sensitivity to taurine or caffeine, trained athletes or regularly exercising, regular users of energy drinks, pregnancy or lactation, and menstruating on the day of the exercise or one week prior to it.

A standardized 'Energy Drink' with a caloric value of 45 Kcal was bought from the market (2.0 g taurine, 1.2 g glucuronolactone, 160 mg caffeine, 54 g carbohydrate, 40 mg niacin, 10 mg pantothenic acid, 10 mg vitamin B6, and 10 µg vitamin B12). The placebo was an apple flavoured drink with protein 1 g, carbohydrates 42 g, cholesterol 0%, potassium 9%, vitamin C 173%, caloric value 53 Kcal. The placebo was diluted with bottled water by adding 15 ml per 100 (to make 115 ml) to match the calories with the energy drink. Blinding was assured by: A) Serving both the drinks in similar unmarked disposable cups, B) Matching the color and consistency of drinks, C) Giving the drinks at least 7 days apart from one another to minimize recall, D) Ensuring that the volunteers were not regular users of energy drinks and had no recall of taste. The volunteers picked up their choice of A (Placebo) or B (Energy Drink) on the first appointment, without knowing what it was, to randomize the selection. A dose of 4 ml/kg body weight was arbitrarily selected based upon the previous studies.[4,6-8] A measuring cylinder was used to prepare the serving for both the energy drink and placebo at 4ml/kg body weight, and the assigned drink was given 45 min before starting exercise. All the subjects served as their own controls in this crossover study as they were exercised after energy drink or placebo at least 7 days apart from each other. In order to minimize the effect of diurnal variation, each test was arranged at a similar time of the day from 9-10 am with a room temperature of 22±1⁰C and 60±5% relative humidity.

Before the day of the exercise, the subjects were briefed on the procedure in a familiarization session. Days were assigned for the exercise according to their convenience. They were asked to ensure avoiding use of coffee or any product containing caffeine from 3 days prior to the scheduled exercise. The subjects were asked not to eat or drink anything after 12 midnight prior to the assigned exercise day, get 6-8 hours sleep, and to wear comfortable dress for the exercise. On arrival to the exercise physiology laboratory, they were provided with 4 ml/kg body weight of either an energy drink or a placebo drink (based on randomization). Height and body weight were measured. Resting heart rate and blood pressure were recorded. Maximum heart rate was calculated by formula (220-age), 60% of this value was called the lower value of target zone, and the 80% as the upper value of target zone.[18] Exercise was conducted after 45 minutes of consuming the assigned drink. A treadmill (TEPA, TM-Pro 2000, Istanbul, Turkey) was used for a standardized exercise. The protocol was adjusted to 'Bruce protocol'.[19] The Bruce protocol was started at stage-1 with a speed of 2.74 km/h and a grade of 10%. Every 3 minutes the speed and grade is automatically adjusted. The subjects continued to exercise under direct supervision until the subject could no longer perform, heart rate exceeded the target heart rate zone, or peripheral capillary oxygen saturation (SpO_2) dropped to <80%. Either of these were marked as exhaustion, and time from start of Bruce protocol to exhaustion was called "time to exhaustion".[20] Maximum oxygen consumption (VO_2max) was calculated according to the formula $VO_2max=(4.38\times T-3.9)$, where 'T' is the recorded 'time to exhaustion'.[21]

Blood lactate was measured at 3 points, just before the exercise, 0 minutes after the exercise, and 30 minutes after the exercise' using the Lactate Scout device (EKF Diagnostics, Magdeburg, Germany). Heart rate, blood pressure, and SpO_2 were measured using Welch Allyn Spot Vital Signs monitor (Welch Allyn, Skaneateles Falls, NY, USA) at baseline, every 3 minutes during the exercise, immediately after the exercise, and 30 minutes after the exercise. After the exercise, breakfast, and souvenirs were given to each participant before leaving the lab. The data were entered into IBM SPSS Statistics for Windows version 19 (IBM Corp., Armonk, NY, USA), and a Chi-square test was used to compare the percentage of subjects in different stages of Bruce protocol, at the time of exhaustion, between the EDG and the PG groups. Descriptive statistics were used to calculate means and SD for all the variables. Paired sample 't' test was used to compare pre and post exercise heart rates, blood pressure, time to exhaustion, SpO_2, VO_2max, and blood lactate within the group and between the 2 groups. A *p*-value of <0.05 was taken as statistically significant.

Results. The mean (±SD) age of the subjects was 19.93±0.8 years, height 156.40±3.83 cm, weight 51.73±3.65 kgs, and target heart rate 200.06±0.8 beats/min. As this was a crossover study and the same volunteers were used for the PG and the EDG, therefore, these variables were the same for both groups. **Table 1** presents a comparison of the percentage of subjects achieving a Bruce protocol stage at the time of exhaustion between both groups. One (3.1%) subjects in each group got exhausted at stage-3. In the PG 13 (40.6%), and in the EDG 16 (50%) stopped at stage-4 (*p*=0.006). In the PG 17 (53.1%), while in the EDG 15 (46.9%) were exhausted at stage-5 (*p*=0.0034). The number of volunteers reaching stage-5 or above was significantly (*p*<0.001) more in the PG (17 in stage-5 and one in stage-6) as compared with the EDG (15 in stage-5 and 0 in stage-6). **Figure 1** shows a comparison of time to exhaustion, and VO_2max between the PG and the EDG. There was no significant difference between both groups in time to exhaustion (11.67±1.51 versus 11.41±1.56, *p*<0.157) or in VO_2max (34.06±6.62 versus 32.89±6.83, *p*<0.154). **Table 2** shows a comparison of systolic blood pressure (SBP) and diastolic blood pressure (DBP) before exercise, immediately after exercise, and 30 minutes after exercise between the 2 groups. Systolic blood pressure at 30 minutes after exercise, and DBP immediately after exercise was significantly (*p*<0.01) more in the energy drink group; however, both of these were within normal values. **Table 3** shows a comparison of heart rate before exercise, immediately after exercise,

Table 1 - Comparison of the percentage of subjects achieving a Bruce protocol stage at the time of exhaustion between the placebo group and the energy drink group in untrained Saudi female university students (n=32 for both groups).

Bruce protocol stage at the time of exhaustion	Placebo group	Energy drink group	*P*-value (Comparison of the 2 groups)
	n (%)		
1	0 (0)	0 (0)	---
2	0 (0)	0 (0)	---
3	1 (3.1)	1 (3.1)	---
4	13 (40.6)	16 (50)*	0.0006
5	17 (53.1)*	15 (46.9)	0.0034
6	1 (3.1)*	0 (0)	0.000
7	0 (0)	0 (0)	---

The test of significance for Bruce protocol stage was Chi-square test, **P*<0.05.

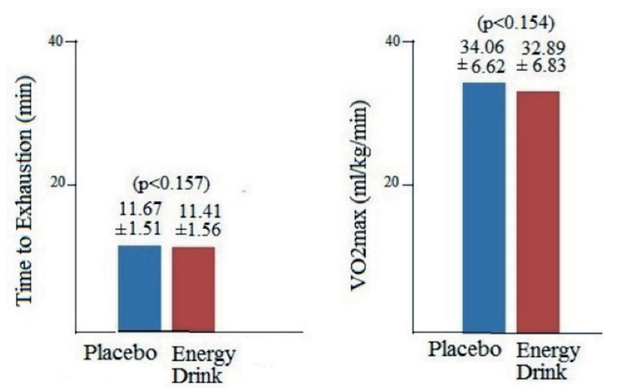

Figure 1 - Comparison of time to exhaustion, and maximum oxygen consumption (VO_2max) between the placebo group and the energy drink group in untrained Saudi female university students. (The unit of VO_2max is milliliters of oxygen/kilogram of body weight/minute [ml/kg/min], and the unit of time to exhaustion is minutes).

Table 2 - Comparison of systolic blood pressure before exercise, immediately after exercise, and 30 minutes after exercise between the placebo group and the energy drink group in untrained Saudi female university students (values are expressed as mean ±SD).

Variable	Placebo group (n=32)	Energy drink group (n=32)	*P*-value (Comparison of the 2 groups)
Systolic blood pressure (mm Hg)			
Before exercise	115.28±11.05	119.18±13.02	0.062
Immediately after exercise	135.71±14.06#	136.53±13.86#	0.649
30 minutes after exercise	108±9.71	111.84±11.43	0.024*
Diastolic blood pressure (mm Hg)			
Before exercise	72.28±8.16	74.06±7.86	0.171
Immediately after exercise	71.59±8.92#	74.09±7.22	0.022*
30 minutes after exercise	70.68±6.99#	71.96±8.77#	0.407

The test of significance applied was paired sample 't' test, **p*-value significant, #*p*<0.05 when compared with the baseline of the same group and 30 minutes after the exercise between the 2 groups. Although the rise and subsequent fall within the group were significantly different from the preceding values, none of the values were significantly different between the 2 groups. **Table 4** shows a comparison of blood lactate and SpO_2 before exercise, immediately after exercise, and 30 minutes after exercise between the 2 groups. There was a significant rise followed by significant drop (at 30 minutes) in blood lactate of both the groups. None of the values were significantly different between both groups. Peripheral capillary oxygen saturation on the other hand, dropped significantly with exercise in both groups and remained significantly less than the baseline value at 30 minutes. However, at 30 minutes post exercise, it recovered significantly more in the energy drink group compared with the placebo group. There was no adverse effect noted in any of the subjects in both the groups

Discussion. The results of our study indicate that a pre-exercise intake of energy drink did not significantly improve the markers of physical performance namely 'time to exhaustion', VO_2max , blood pressure, heart rate, or SpO_2 in untrained Saudi females. In addition, there was no significant change in lactate clearance between the 2 groups. Our finding is in agreement with Nelson et al[22] who conducted time to exhaustion tests using a double-blind, randomized, placebo controlled, crossover design for 15 physically active subjects. The study showed no differences in ride time to exhaustion between the PG and the EDG. In addition, rating of perceived exertion using the 10-point Borg category scale did not reveal any significant change. Although the resting heart rate was increased in energy drink consumers group, yet the peak heart rate did not show a significant change. A recent study[23] determined the acute effect of an energy drink on physical performance in professional female volleyball players. Nineteen players participated in a randomized, crossover, double-blind study to measure grip strength, vertical jump, and anaerobic power in 3 different sessions. The results revealed no significant within-session and measurement time interactions for each performance test. The authors concluded that acute ingestion of an Energy drink did not improve physical performance of professional female volleyball players. However, our subjects were untrained females as compared with this study. Another study conducted on 17 physically active university students using a double-blind, crossover, repeated measurement design found no significant difference in run time to exhaustion between both groups.[24] Furthermore, another double-blind, randomized, crossover study[25]

Table 3 - Comparison of heart rate before exercise, immediately after exercise, and 30 minutes after exercise between and within the placebo group and the energy drink group in untrained Saudi female university students (values are expressed as mean ±SD).

Heart rate (bpm)	Placebo group	Energy drink group	*P*-value (Comparison of placebo and energy drink group)
Before exercise	91.78±14.86	92.81±16.28	0.759
Immediately after exercise	139.62±11.66#	140.46±13.57#	0.728
30 minutes after exercise	108.03±11.26#	107.12±12.69#	0.713

The test of significance applied was paired sample 't' test, #p<0.05 when compared with the baseline of the same group, bpm - beats per minute

Table 4 - Comparison of blood lactate levels and peripheral capillary oxygen saturation (SpO_2) (%) before exercise, immediately after exercise, and 30 minutes after exercise between and within the placebo group and the energy drink group in untrained Saudi female university students (values are expressed as mean ±SD).

Variable	Placebo group	Energy drink group	*P*-value
Blood lactate (mmol/l)			
Before exercise	2.38±0.77	2.55±0.8	0.062
Immediately after exercise	10.64±2.41#	10.75±2.93#	0.859
30 minutes after exercise	4.2±1.48#	4.88±1.97#	0.156
SpO_2 (%)			
Before exercise	99.06±1.10	99.46±0.97	0.076
Immediately after exercise	98.46±1.01#	98.71±0.95#	0.088
30 minutes after exercise	97.96±1.40#	98.46±1.07#	0.044*

The test of significance applied was paired sample 't' test, *p-value significant, #p<0.05 when compared with the baseline of the same group conducted on 11 male athletes showed no improvement in the mean racing time following energy drink intake. The findings revealed no improvement in both physical and psychological performance.

On the other hand, Ivy et al[26] demonstrated that pre-exercise ingestion of an energy drink did improve endurance performance on 12 professional cyclists from both genders. Although the study was a double-blind, randomized, crossover study, the participants were athletes with a higher VO_2max and a time-trial format had been used. It is worth noting that the study categorically spelled out the name of a specific energy drink, while we did not mention any brand. In addition, a study conducted among 10 male university athlete students found significant enhancement in time to exhaustion and VO_2max in EDG compared with PG. However, heart rate and blood lactate showed no significant differences between the 2 groups.[27] A similar observation was also seen in another study,[20] which examined 17 female athlete students, but in this study the heart rate was increased post exercise in the EDG. Although both studies used similar protocols to our study, the subjects were athletes and the doses for energy drinks were greater than we used, which might influence the results.

Surprisingly, very few studies have examined the effects of energy drinks on the cardiovascular system. The results showed inconsistency with big variations. We found no differences in the heart rate, systolic, and DBP before, immediately, and 30 minutes after exercise. Our finding is in agreement with Alford et al[6] who showed that energy drink intake had no significant effect on heart rate, systolic, and DBP. Similarly, Rahnama and Kazemic[27] revealed no differences in heart rate pre and post exercise following energy drink ingestion. In addition, Willoughby et al[28] demonstrated no change in heart rate one hour after energy drink consumption. Nelson et al,[22] found no significant change in peak heart rate during exercise; however, resting heart rate was increased in the EDG compared with the PG. Steinke et al[11] however, observed that heart rate increased 5-7 beats/min and SBP increased 10 mm Hg following energy drink ingestion. Marczinski et al[29] recently found that both systolic and DBP were increased significantly a few hours after energy drink intake, while the heart rate was reduced.

Although exercise has been reported to enhance lactate clearance,[30] especially in trained people,[31] yet several studies have found that energy drink ingestion has no effect on blood lactate, which is in parallel with our finding. Forbes et al[7] showed no change in blood lactate before and after repeated Wingate cycling tests in 15 young healthy subjects. Similarly, Rahnama and Kazemic[27] found that energy drink intake had no effect on blood lactate before and 2 minutes after Bruce treadmill test. Furthermore, Candow et al[24] demonstrated that blood lactate levels did not change before and after exercise between both groups. Although Philips et al[32] showed an increase in blood lactate levels during exercise in the EDG compared with the PG, yet no changes were observed before, immediately, and 30 minute after the exercise between the groups. In contrast to the previous studies, our study was conducted on untrained females rather than athletes or physically active individuals, which may explain the variability in results. Conducting the study on young females may have a reflection on the results as stated in Temple et al's[33] study in 2010 that recruited 26 boys and 26 girls with an age range 12-17 years. They suggested that caffeine intake has a broad range of effects and that the magnitude of these effects is moderated by gender. In addition, methodological differences including the dose of caffeine, and the amount of active ingredients may attribute to the inconsistency of the results. For instance, Rahnama and Kazemic[27] provided 6 ml/kg, whereas Alford et al[6] gave a can of energy drink to each subject with no known ml per kg body weight. This is of particular importance as different brands of energy drinks with variable contents of caffeine are available in the market. We suggest that these different concentrations of caffeine will have different effects on physiological variables. Likewise there is no 'recommended' or 'prescribed dose' suggested for the users. This means that consumption of different amount might also have variable effects.

Contrary to most of the contemporary studies, our study is unique in using an undeclared brand of energy drink on untrained females. In our opinion, the first has eliminated the chance of any bias, while the later has successfully highlighted the true effect of energy drink in a population that is not fitness trained or regularly exercising. The major limitation of our study was the absence of a 'blank' (non active) control. Our argument was that we wanted to identify the pure effect of energy drinks by using an active standardized control with the same caloric value, but ingredients not claimant of being an 'energy drink'. We agree that there is chance of some chemical in the 'active control drink' being as active as the energy drink; however, this control was identical for all the participants. In view of the above findings and the limitations highlighted, we suggest future researchers to work on similar projects with both active, and non active controls, energy drinks with different caffeine content, as well as, different doses of the same energy drink. This spectrum of studies is necessary to once and for all determine the true potential, if any, of the effect of energy drinks on physiological parameters of exercise and fitness.

In conclusion, the effects of energy drink intake before exercise on indices of physical performance during exercise in our small sample of non-active females did not significantly differ from placebo.

References

1 Global: Energy drink sales hindered by Thai decline - reseach. [Updated 2009 October 13, Accessed 2014 November 27]. Available from: http://www.just-drinks.com/analysis/energy-drink-sales-hinderedby-thai-decline-research_id98736.aspx
2. Alsunni AA, Badar A. Energy drinks consumption pattern, perceived benefits and associated adverse effects amongst students of University of Dammam, Saudi Arabia. ***J Ayub Med Coll Abbottabad*** 2011; 23: 3-9.
3. Al-Misbahi A. Ad ban on energy drinks takes effect. The Saudi Gazette. [Updated 2014 July 1, Accessed 2014 November 27]. Available from URL: http://www.saudigazette.com.sa/index.cfm?method=home.regcon&contentid=20140701210137
4. Ishak WW, Ugochukwu C, Bagot K, Khalili D, Zaky C. Energy Drinks: Psychological Effects and Impact on Well-being and Quality of Life—A Literature Review. ***Innov Clin Neurosci*** 2012; 9: 25-34.
5. Alsunni AA. Are energy drinks Physiological? ***Pakistan Journal of Physiology*** 2011; 7: 44-49.
6. Alford C, Cox H, Wescott R. The effects of red bull energy drink on human performance and mood. ***Amino Acids*** 2001; 21: 139-150.
7. Forbes SC, Candow DG, Little JP, Magnus C, Chilibeck PD. Effect of Red Bull energy drink on repeated Wingate cycle performance and bench-press muscle endurance. ***Int J Sport Nutr Exerc Metab*** 2007; 17: 433-444.
8. Hoffman JR, Kang J, Ratamess NA, Hoffman MW, Tranchina CP, Faigenbaum AD. Examination of a pre exercise high energy drink on exercise performance. ***J lnt Soc Sports Nutr*** 2009; 6: 2.
9. Pérez-López A, Salinero JJ, Abian-Vicen J, Valadés D, Lara B, Hernandez C, et al. Caffeinated energy drinks improve volleyball performance in elite female players. ***Med Sci Sports Exerc*** 2015; 47: 850-856.
10. Marczinski CA, Stamates AL, Ossege J, Maloney SF, Bardgett ME, Brown CJ. Subjective State, Blood Pressure, and Behavioral Control Changes Produced by an "Energy Shot." ***J Caffeine Res*** 2014; 4: 57-63.
11. Steinke L, Lanfear DE, Dhanapal V, Kalus JS. Effect of "energy drink" consumption on hemodynamic and electrocardiographic parameters in healthy young adults. ***Ann Pharmacother*** 2009; 43: 596-602.
12. Riesenhuber A, Boehm M, Posch M, Aufricht C. Diuretic potential of energy drinks. ***Amino Acids*** 2006; 31: 81-83.
13. Kolnes AJ, Ingvaldsen A, Bolling A, Stuenaes JT, Kreft M, Zorec R, et al. Caffeine and theophylline block insulin-stimulated glucose uptake and PKB phosphorylation in rat skeletal muscles. ***Acta Physiol (Oxf)*** 2010; 200: 65-74.
14. Seifert SM, Schaechter JL, Hershorin ER, Lipshultz SE. Health Effects of Energy Drinks on Children, Adolescents, and Young Adults. ***Pediatrics*** 2011; 127: 511-528.
15. Clauson KA, Shields KM, McQueen CE, Persad N. Safety issues associated with commercially available energy drinks. ***J Am Pharm Assoc (2003)*** 2008; 48: e55-e63; quiz e64-e67.
16. Ballard SL, Wellborn-Kim JJ, Clauson KA. Effects of commercial energy drink consumption on athletic performance and body composition. ***Phys Sports Med*** 2010; 38: 107-117.
17. Masuda K, Katoh N, Mizutani H, Kishimoto S. Anaphylaxis to vitamin B2 added to an energy drink. ***Clin Exp Dermatol*** 2009; 34: e263-e264.
18. Fox SM 3rd, Naughton JP, Haskell WL. Physical activity and the prevention of coronary heart disease. ***Ann Clin Res*** 1971; 3: 404-432.
19. Pollock ML, Bohannon RL, Cooper KH, Ayres JJ, Ward A, White SR, et al. A comparative analysis of four protocols for maximal treadmill stress testing. ***Am Heart J*** 1976; 92: 39-46.
20. Kazemi F, Gaeini AA, Kordi MR, Rahnama N. The acute effects of two energy drinks on endurance performance in female athlete students. ***Sport Sciences for Health*** 2009; 5: 55-60.
21. Rahnama N, Nouri R, Rahmaninia F, Damirchi A, Emami H. The effects of exercise training on maximum aerobic capacity, resting heart rate, blood pressure and anthropometric variables of postmenopausal women with breast cancer. ***J Res Med Sci*** 2010; 15: 78-83.
22. Nelson MT, Biltz GR, Dengel DR. Cardiovascular and ride time-to-exhaustion effects of an energy drink. ***J Int Soc Sports Nutr*** 2014; 11: 2.
23. Fernández-Campos C, Dengo AL, Moncada-Jiménez J. Acute Consumption of an Energy Drink Does Not Improve Physical Performance of Female Volleyball Players. ***Int J Sport Nutr Exerc Metab*** 2014 Nov 11. [Epub ahead of print]
24. Candow DG, Grenier S, Dorsch KD. Effect of sugar-free Red Bull energy drink on high-intensity run time-to-exhaustion in young adults. ***J Strength Cond Res*** 2009; 23: 1271-1275.
25. Umaña-Alvarado M, Moncada-Jiménez J. Consumption of an 'Energy Drink' does not Improve Aerobic Performance in Male Athletes. ***International Journal of Applied Sports Sciences*** 2005; 17: 26-34.
26. Ivy JL, Kammer L, Ding Z, Wang B, Bernard JR, Liao YH, et al. Improved cycling time-trial performance after ingestion of a caffeine energy drink. ***Int J Sport Nutr Exerc Metab*** 2009; 19: 61-78.
27. Rahnama N, Kazemic F. The effectiveness of two energy drinks on selected indices of maximal cardiorespiratory fitness and blood lactate levels in male athletes. ***J Res Med Sci*** 2010; 15: 127-132.
28. Willoughby SR, De Sciscio P, Prabhu A, Roberts-Thomson R, Schultz C, Sanders P, et al. Energy drink effects platelet aggregation and endothelial function: A possible link to increased cardiovascular risk. ***Heart Lung and Circulation*** 2009; 18 Suppl 3: S265.
29. Marczinski CA, Stamates AL, Ossege J, Maloney SF, Bardgett ME, Brown CJ. Subjective State, Blood Pressure, and Behavioral Control Changes Produced by an "Energy Shot". ***J Caffeine Res*** 2014; 4: 57-63.
30. Andersen LW, Mackenhauer J, Roberts JC, Berg KM, Cocchi MN, Donnino MW. Etiology and therapeutic approach to elevated lactate. ***Mayo Clin Proc*** 2013; 88: 1127-1140.
31. Siegel AJ, Januzzi J, Sluss P, Lee-Lewandrowski E, Wood M, Shirey T, et al. Cardiac biomarkers, electrolytes, and other analytes in collapsed marathon runners: implications for the evaluation of runners following competition. ***Am J Clin Pathol*** 2008; 129: 948-951.
32. Phillips MD, Rola KS, Christensen KV, Ross JW, Mitchell JB. Preexercise energy drink consumption does not improve endurance cycling performance but increases lactate, monocyte, and interleukin-6 response. ***J Strength Cond Res*** 2014; 28: 1443-1453.
33. Temple JL, Dewey AM, Briatico LN. Effects of acute caffeine administration on adolescents. ***Exp Clin Psychopharmacol*** 2010; 18: 510-520.