ORIGINAL ARTICLE

ENERGY DRINKS CONSUMPTION PATTERN, PERCEIVED BENEFITS AND ASSOCIATED ADVERSE EFFECTS AMONGST STUDENTS OF UNIVERSITY OF DAMMAM, SAUDI ARABIA

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Background: There are safety concerns about energy drinks alongside marketing claims of physiological and behavioural benefits. There is no scientific data about usage of energy drinks in Saudi Arabia. This study determined consumption patterns of energy drinks as well as perceived benefits and side effects amongst students at a Saudi university. **Methods:** This study was carried out in students of University of Dammam from October to December 2010. A questionnaire about energy drink use, reasons for use, benefits and side effects experienced was distributed amongst the university students. Frequencies of responses and differences between male and female students were analysed. **Results:** A total of 412 students (282 males and 130 females) responded, out of whom 54.60% males and 26.15% female students were energy drink users. Mean age at first use was significantly ($p<0.05$) less in female students. Inspirations for first time use were friends (both genders) and curiosity (males mainly). Most students did not have a fixed frequency of use. The commonest reasons for use were company of friends, to keep awake, for more energy and for better performance in driving, sports or exams. Amongst many the commonest ($p<0.05$) benefit reported was ability to stay awake longer. The students reported a number of adverse effects. Increased urination and insomnia were the commonest in males and females respectively. Only 36.70% males and 14.28% females never experienced an adverse effect. **Conclusion:** A significant proportion of students at university of Dammam use energy drinks, they have reported a number of effects (perceived as benefits) along with a variety of adverse effects.

Keywords: Energy Drinks, Students, Saudi Arabia, Benefits, Adverse effects

INTRODUCTION

'Energy drinks' are fortified beverages with added dietary supplements. The marketing of these drinks mainly relies on the claims that the natural ingredients in energy drinks supply increased energy, increased alertness, and improved athletic performance. At the same time the health professionals are concerned about the negative health effects associated with these products.[1]

Energy drinks most often contain taurine, caffeine and glucose along with a variety of other substances like guarana and ginseng. These drinks vary widely in caffeine content. As much as 80 to 300 mg of caffeine and 35 grams of processed sugar per 8-ounce serving are commonly present in most energy drinks.[1] The effects of energy drink ingredients on physical and cognitive performances remain controversial.[2]

Caffeine in energy drinks provides increased alertness, improved memory, and enhanced mood. However, caffeine can have harmful physical consequences. When realistic doses are used caffeine improves performance by reducing reaction times and improving attentionalperformance.[3–6] Improvements are seen across psychomotor and vigilance tasks, particularly when responses are sustained over time. Caffeine is also consistently associated with modulation of mood, most notably increasing alertness and reducing fatigue.[6] Even low doses of caffeine (12.5 to 100 mg) improve cognitive performance and mood.[7]

On the other hand caffeine has been found to have detrimental health consequences. Riesenhuber and colleagues found that the caffeine (but not taurine) in energy drinks promotes diuresis and natriuresis.[8] Acute caffeine consumption reduces insulin sensitivity[9] and increases mean arterial blood pressure.[10] High caffeine consumption is associated with chronic daily headaches.[11] Neural, cardiovascular, gastrointestinal, and renal dysfunctions have been associated with chronic caffeine ingestion.[12] Adverse effects associated with caffeine consumption in amounts greater than 400 mg include nervousness, irritability, sleeplessness, increased urination, arrhythmia, and stomach upset. Consumption also has been known to cause pupil dilation when taken with certain antidepressants or SSRIs.[13]

Marketing of energy drinks never mentions glucose, however it is well documented that aspects of psychological performance can be enhanced following the administration of a drink containing 25–50 g of glucose that include but are not limited to memory,[14] reaction times,[15] driving simulator performance,[16] and serial subtraction mental arithmetic.[17] Some studies suggest that there is some degree of synergy between the cognition-modulating effects of glucose and caffeine when used together.[18]

Some researchers identified moderate positive effects of energy drinks on performances, whereas others found contrary results. The adverse effects of energy drink can be related either to the toxicity of ingredients or specific situations in which energy drinks are used such as ingestion in combination with alcohol. The consumption of energy drinks may increase the risk for caffeine overdose and toxicity in children and teenagers.[2] Caution is warranted even for healthy adults who choose to consume energy beverages. Consumption of a single energy beverage will not lead to excessive caffeine intake; however, consumption of two or more beverages in a single day can.[13]

Situation of energy drink popularity does not seem to be much different in Saudi Arabia. Companies are aggressively marketing it through advertisement, sponsorship of sports events and huge subsidies to outlets who sell them. Low priced brands have mushroomed to attract those who do not want to purchase high priced market leaders. Although energy drinks target young adult consumers, there has been no research regarding energy drink consumption patterns among college students in Saudi Arabia. The only Saudi study about energy drinks available on internet, dealt with determination of caffeine in stimulant herbal products and energy drinks available in the kingdom.[19] We carried out this study to determine energy drink consumption patterns among the students of University of Dammam and identify good and bad effects attributed to the use of energy drinks by consuming students.

MATERIAL AND METHODS

This questionnaire based survey was carried out at the University of Dammam from October to December 2010 after approval of Research & Ethical Committee. The study population was all the male and female students in the main campus of the university. Participation was purely voluntary and no names or IDs were asked for. Questionnaires were distributed through class leaders who subsequently collected them from the students who volunteered to respond.

The questions asked were in Arabic with an English language translation available if required. First set of questions was to classify students according to the year of study, gender and age. The next set addressed the users only to determine age at first use, stimulus for first time use, type of energy drink preferred, reasons for use and frequency of use.

The next set of two questions asked about the physiological or psychological benefits that the student attributed to energy drink and any physical or psychological problems linked to the use of energy drink.

The last set of questions addressed knowledge of the student about constituents of energy drinks and WHO recommendations about use of energy drinks. In addition the students were indirectly asked about their feelings about potential benefits of the energy drink by asking if they would recommended energy drink use to near and dear ones.

The data were entered into statistical package SPSS-IBM (version-19). Descriptive statistics were used to calculate frequencies for all the responses.

RESULTS

A total of 412 students (282 males and 130 females) responded to the questionnaire. Out of them 188 (45.63%) were using energy drinks regularly. The male users were 154 (81.91%) and female users just 34 (18.08%). The male to female difference was statistically significant ($p<0.05$). However female users were 26.15% of all the female responders (n=130), while the male users were 54.6% of all male responders (n=282). The responders belonged to different colleges on the main campus however most of the responders did not mention their college and year of study.

Table-1 shows class and gender wise distribution of the responders as well as users of energy drinks amongst them.

Table-2 summarises mean age of all responders, mean age of energy drink users and age at the first use. The mean age at first use was significantly less in the female users.

Table-3 gives inspiration for the first time use. 'No particular reason' was the response of the majority in both males and females. Motivation by friends was the second commonest in both genders.

Table-4 shows frequency of energy drink use. Most of the students of both the genders had no set routine.

Table-1: Distribution of all users of energy drinks according to the year of study

Year of study (n=412)	Males		Female	
	Total responses (n=282)	Energy Drink users 154 (54.6%)	Total responses (n=130)	Energy Drink users 34 (26.15%)
I (n=86)	77	47 (61.03%)	9	9 (100%)
II (n=25)	12	5 (41.66%)	13	7 (53.84%)
III (n=35)	18	12 (66.66%)	17	9 (52.94%)
IV (n=37)	31	16 (51.61%)	6	4 (66.66%)
V (n=19)	16	6 (37.5%)	3	3 (100%)
VI (n=20)	17	2 (11.76%)	3	0 (0%)
No response (n=190)	111	66 (59.45%)	79	2 (2.53%)

Table-2: Mean age of responders and age at first time use of energy drinks in the users

Age (Years)	Males	Females
Age of all responders	21.43±2.03 (235)	21.24±2.12 (79)
Age of users	21.36±2.19 (129)	21.17±1.49 (23)
Age at first use	16.15±2.96 (136)	15.81±3.2* (31)

*Difference significant (p<0.05) when compared with males.
The number of responders is given in parenthesis

Table- 3: Inspiration for first time use

Inspiration	Males (n=161)	Females (n=36)
For no particular reasons	68 (42.23%)*	15 (41.66%)*
Friends/peers	42 (26.08%)	8 (22.22%)
Promotion (Advertisement)	15 (9.31%)	7 (19.44%)**
Curiosity	36(22.36%)**	6 (16.66%)

*Significant (p<0.05) within the group
**Significant (p<0.05 when compared with the other gender.
Some responders gave more than one answers).

Table-4: Frequency of energy drinks use

Frequency of use	Males (n=153)	Females (n=33)
Irregular routine	107 (69.93%)*	27(81.81%)*
>1 per day	8(5.22%)	3(9.09%)**
2–3 times/week	19 (12.41%)**	1(3.03%)
4–7 times/week	19 (12.41%)**	2(6.06%)

*Significant (p<0.05) within the group
** Significant (p<0.05 when compared with the other gender)

Table-5: Maximum energy drink cans ever consumed in a single day

Maximum consumption ever in a day	Males (n=134)	Females (n=26)
1	64 (47.76%)*	10 (38.46%)*
2	53 (39.55%)	9 (34.61%)
3	9 (6.71%)	6 (23.07%)**
4	6 (4.47%)	1 (3.84%)
5 or >5	2 (1.49%)**	0 (0%)

*Significant (p<0.05) within the group
**Significant (p<0.05 when compared with the other gender)

Table-5 gives maximum cans of energy drinks ever consumed in a single day. Most of the students in both the genders never consumed more than one.

Table-6 gives reasons for energy drink use. The commonest in both genders was to give company to friends, however it was closely followed by 'to keep awake' in both male and female students.

Table-7 outlines the benefits of energy drinks experienced. 'Ability to stay away longer' was the commonest in females, while along with this 'increased alertness' was joint first in the males. Out of the numerous others identified by the students, 'increased power', 'improved mood', 'increased concentration' and 'improved memory' were significantly (p<0.05) more in the males, while increased reaction speed, improved digestion and improved emotional status were reported by significantly (p<0.05) more females.

Table-6: Reason for using energy drinks

Reasons	Males (=207)	Females (n=62)
To give company to friends	50 (24.15%)*	15 (24.19%)*
To keep awake	44 (21.25%)	14 (22.58%)
For more energy	28 (13.52%)	9 (14.51%)
Nice taste	19 (9.17%)	6 (9.67%)
For better performance in driving	18 (8.69%)**	0 (0%)
For better performance in sports/Gym	16 (7.72%)**	3 (4.83%)
For better performance in examinations	15 (7.24%)	9 (14.51%)**
No reason	8 (3.86%)**	1 (1.61%)
Favourite Drink	3 (1.44%)	1 (1.61%)
Experiment	2 (0.96%)	1 (1.61%)
For thirst/need after sport	2 (0.96%)	0 (0%)
Fun	1 (0.48%)	2 (3.22%)
Design project	1 (0.48%)	0 (0%)
Ease in Digestion	0 (0%)	1 (1.61%)

*Significant (p<0.05) within the group
** Significant (p<0.05 when compared with the other gender)
Some responders gave multiple answers

Table-7: Benefits of energy drinks experienced

Benefits	Males (n=273)	Females (n=75)
Ability to stay awake longer	40 (14.65%)*	17 (22.66%)*
Improvements in physical performances	37 (13.55%)	9 (12%)
Increased alertness	40 (14.65%)*	10 (13.33%)
Improvements in mental performances	31 (11.35%)	8 (10.66%)
Increased power in exercise/sport	28 (10.25%)**	4 (5.33%)
Improves mood (Euphoria)	27 (9.89%)**	5 (6.66%)
Increase concentration	20 (7.32%)**	2 (2.66%)
Improved memory	16 (5.86%)**	1 (1.33%)
None	16 (5.86%)	4 (5.33%)
Improve digestion	10 (3.66%)	5 (6.66%)**
Increase in reaction speed	8 (2.93%)	3 (3.99%)**
Improve vigilance	6 (2.19%)	2 (2.66%)
Improve emotional status	4 (1.46%)	3 (3.99%)**
Improved driving	4 (1.46%)	1 (1.33%)
Tasty	2 (0.73%)	0 (0%)
Less Tiredness	1 (0.36%)	0 (0%)
Cool down	1 (0.36%)	0 (0%)
Provide electrolytes	1 (0.36%)	0 (0%)
Fun	0 (0%)	1 (1.33%)

*Significant (p<0.05) within the group
** Significant (p<0.05 when compared with the other gender)
Some responders gave multiple answers

Table-8 enlists different adverse effects that the students associate with energy drinks. Only 36.70% males and 14.28% females never experienced a problem, while the rest reported a number of adverse effects.

Table-9 reflects knowledge about constituents of energy drinks in the students. More than half of the students knew about one or more component of energy drinks but a large number did not know about presence of caffeine.

Table-10 reflects knowledge about recommendations of health authorities for use of energy drinks after sports/exercise related dehydration and in athletes taking other medicines. Significant majority of students did not know about these recommendations.

Table-8: Any adverse effects associated with energy drink use

Problems	Males (n=188)	Females (n=70)
Never	69 (36.70%)*	10 (14.28%)
Increased urination	28 (14.89%)**	8 (11.42%)
Abnormal heart beat	17 (9.04%)	8 (11.42%)**
Insomnia	9 (4.78%)	12 (17.14%*,**
Irritability	10 (5.31%)	4 (5.71%)
Stomach pain	9 (4.78%)	4 (5.71%)
Seizures	10 (5.31%)**	1 (1.42%)
Crashafter energy high	8 (4.25%)	6 (8.57%)**
Decreases performance	8 (4.25%)	3 (4.28%)
Dehydration	7 (3.72%)	2 (2.85%)
Problem with vision	8 (4.25%)**	1 (1.42%)
Nervousness	7 (3.72%)	5 (7.14%)**
Nausea	4 (2.12%)	4 (5.71%)**
Emergency room visits	4 (2.12%)**	0 (0%)
Headache	2 (1.06%)	0 (0%)
Kidney Pain	1 (0.53%)	1 (1.42%)
Allergy	1 (0.53%)	0 (0%)
Abdominal Pain	1 (0.53%)	0 (0%)
Muscle Pain	0 (0%)	1 (1.42%)

**Significant (P<0.05) within the group*
*** Significant (P<0.05 when compared with the other gender*
Some responders gave multiple answers

Table-9: Knowledge about constituents of energy drinks

Constituents	Males (n=175*)	Female (n=67*)
Caffeine	65 (37.14%)	30(44.77%)*,**
Do not Know	67 (38.28%)*,**	22(32.83%)
Taurine	23 (13.14%)**	6(8.95%)
Alcohol	6 (3.42%)	5(7.46%)**
Ginseng	8 (4.57%)	4(5.97%)
Guarana	6 (3.42%)	0(0%)

*Significant (p<0.05) within the group
**Significant (p<0.05 when compared with the other gender).
Some responders gave multiple answers

Table-10: Knowledge about recommendations of health authorities for use of energy drinks in specific sports related scenarios

Responses (n=255)	Condition	
	Dehydration after sports/exercise	Athletes taking other medicines
Can use	27 (10.58%)	12 (4.70%)
Cannot use	54 (21.17%)	56 (21.96%)
Do not know	174 (68.23%)	187 (73.33%)

To the question about recommending use of energy drinks to friends only 2% of the female users (n=34) answered in yes while 38% of male users (n=154) thought that they would recommend energy drinks to others.

DISCUSSION

Age and Gender of Energy drink users

In our study the male energy drink users were 4.5 times more than the female users. The use of energy drinks might be less in females as typical Saudi girls are less physically active than the typical Saudi males and energy drinks are mostly marketed for increasing physical performance.

Mean age of respondents as well as users in our study was around 21 years. A worth noting finding not reported in other studies was that the age at first use was around 16 years, with age at first use in the female users being significantly younger than the male counterparts.

Energy drinks are typically attractive to young people. A study on students of University of Buffalo reported that 48% of energy drinks users were females and the mean age was around 20 years.[20] In a study on physical education students in Argentine 54 % users were males and the mean age of users was 22 years 6 months.[21] Mean age in a study on students at a university in the Central Atlantic region of the United States was 21.5±3.7 years and they had significantly more female (53%) energy drink users.[22] Similarly the mean age in a study of university students in Turkey was 22.8±2.09 years.[23]

Inspiration for first use

Most of the students did not have any specific reason as inspiration for the first time use of energy drinks. However 'friends' as inspiration was the commonest reason in both male and female students. Similarly 'curiosity' was significantly more common inspiration for first use in males than in the females. Companies spend a lot of money on promotion of energy drinks. Surprisingly this did not have much effect in the male students, although in female students it was one of the main inspirations. On the contrary in the only study reporting inspiration for the first time use reported that many students in a Turkish university who had 'ever' tried an energy drink did so the first time because they wondered about its taste.[23]

Frequency of energy drinks use

Most of the students did not have any specific frequency of energy drink use. Very few reported a regular routine of use. More females than males committed to use of more than one can per day. Most of the males reporting a set routine either used 2–3 times in a week or 4–7 times in a week. Majority of the students had experienced use of more than one can in a day. Most of the users restricted themselves to maximum two cans in a day however a significant proportion used more than two cans in a day. Surprisingly the proportion of girls using 3 or more cans in a day was significantly more than the male students. This could be a reason for the higher prevalence of insomnia seen in the females.

A study of Physical education students in Argentine reported mean consumption of energy drinks being once in their lives in 2.2%, at least once in the last 12 months in 9.5% and at least once in the last month in 38%, while 39.4% consumed six times or more in the last month and 10.9% consumed 20 times or more in the last month.[21] In a study on university students in the

Central Atlantic region of the United States 51% of participants reported consuming greater than one energy drink each month. The majority of users consumed one energy drink to treat most situations although using three or more was a common practice to drink with alcohol while partying (49%).[22]

Reasons for use

One of the most important achievements of our study was to understand the reasons that make Saudi students use energy drinks. Not surprisingly the commonest reason in both boys and girls was 'to give company to friends'. Surprisingly the proportion of boys and girls committing to this reason was not much different. The next commonest reason in both males and females, again with almost identical frequency, was 'to keep awake'. Likewise 'for more energy' was also seen in almost same proportion of males and females. As expected, the other reasons given by males were the typical male activities like 'for better driving' and 'for better performance in sports'. In the girls 'for better performance in examinations' was more frequent than in the boys. Quite a significant number in both males and females gave the reason 'nice taste', while very few mentioned interesting things like 'experiment', fun and 'to quench thirst' etc.

Justifications for consumption appear to differ based on race, culture and social norms. In the study of Argentine students 54% used energy drinks to improve the taste of alcoholic drinks, 27.7% to extend their evening leisure periods, 13.9% to improve sports performance, 9.5% for stimulation, 8.8% to enjoy the taste, 6.6% for curiosity and 4.4% to studybetter.[21] A study on university students in the Central Atlantic region of the United States reported that the majority of users consumed energy drinks for insufficient sleep (67%), to increase energy (65%) or to drink with alcohol while partying (54%).[22] A study on Turkish students reported that reasons for using energy drinks included getting energy, staying awake, boosting performance in sports, or mixing with alcoholic beverages.[23] A 2008 statewide Patient Poll conducted by the Pennsylvania Medical Society's Institute for Good Medicine found that 20% of respondents had used energy drinks in high school or college to stay awake longer, to study or write a paper.[24]

Perceived Benefits

The commonest benefit noticed by both male and female students was 'ability to stay awake for longer time'. In addition 'increased alertness' was a joint first in males while it was second commonest in the females. Another common benefit reported in both males and females was improved physical as well as mental performance. Many students reported improved performance in sports and improved mood, concentration and memory.

Alford *et al* compared energy drinks with control drinks. They found that the studied energy drink significantly improved aerobic endurance and anaerobic performance on cycle ergometers. Significant improvements in mental performance included choice reaction time, concentration and memory.[25] During repeated cycling tests in young healthy adults an energy drink significantly increased upper body muscle endurance.[26] A glucose-based energy drink given to eleven tired participants being tested in a driving simulator improved lane drifting and reaction times.[27]

Chronic ingestion of a once-daily low-calorie energy drink appears ineffective at improving body composition, cardiorespiratory fitness, or strength in sedentary males. However, when combined with exercise, preworkout energy drink consumption may significantly improve some physiological adaptations to combined aerobic and resistance training.[28]

Associated adverse effects

Reporting the presence of adverse effects in 63.30% male users and in 85.72% females was the most alarming finding of our study. The adverse effects reported were all reversible in nature, and most of them reflected increased neuronal activity. Increased urination was commonest in males, while insomnia was commonest in the females. Abnormal heart beats, irritability, stomach pain, crash after energy high, problems with vision, nervousness and emergency room visits were also reported.

Seizures were reported by a significant proportion of energy drink users in our study, reflecting extreme neuronal irritability. As physiologists we are very much concerned about a high number of adult onset seizures reported by students and we intend to work more on the link of seizures with energy drinks. A case report from USA has reported a series of four patients who had discrete seizures on multiple occasions, following heavy consumption of energy drinks. These finished altogether after abstaining from the energy drinks.[29]

Amongst the other studies on students, the findings of University of Buffalo study suggest that energy drink consumption is closely associated with a problem behavior syndrome, particularly among whites.[20] A study in the US reported that almost one-quarter of college students reported mixing alcohol with energy drinks.[30] Another US study on college students found that jolt and crash episodes were experienced by 29% of users, 22% reported ever having headaches, and 19% heart palpitations.[22]

The consumption of energy drinks may increase the risk for caffeine overdose and toxicity in

children and teenagers.[2] Excess consumption of energy drinks may induce mild to moderate euphoria primarily caused by stimulant properties of caffeine and may also induce agitation, anxiety, irritability and insomnia.[25]

A study that analysed benefits and adverse effects associated with the consumption of energy drinks reported by various studies reported that no reports were identified of negative effects associated with taurine, ginseng, and guarana used in the amounts found in most energy drinks while commonly reported adverse effects seen with caffeine in the quantities present in most energy drinks are insomnia, nervousness, headache, and tachycardia.[1] A study in 2010 assessed the effects of 10 weeks of once-daily energy drink consumption or energy drink consumption with exercise. This study did not find any change in clinical markers for hepatic, renal, cardiovascular, and immune function.[28]

A number of studies conducted to compare cardiovascular parameters and electrocardiograms of students before and after consumption of an energy drink found no difference between any of the measured cardiovascular parameters.[31–32]

The synthetic taurine that is present in energy drinks is found in very large concentrations.[33] However there is no scientific evidence about adverse health effects of taurine.[34–36] However so far no research has been conducted on the effects of large quantities of taurine in combination with other common ingredients of energy drinks.

Knowledge about composition and about health regulations for use of energy drinks

Very few of the students knew about the composition of what they were using, similarly very few were aware of the restrictions on usage of these drinks during dehydration following exercise or sports as well as when using other medications. Energy drinks do not provide electrolytes, and have a higher likelihood of an energy 'crash-and-burn' effect. Caffeine in energy drinks can excrete water from the body to dilute high concentrations of sugar entering the blood stream, leading to dehydration.

Similar were the results of the Turkey university students where most students could not correctly define the ingredients of energy drinks or their potential hazardous health effects.[23]

A question in our questionnaire that gave an opportunity to the users to weigh good points versus bad points was recommending to others. It is worth noting that only 38% males and just 2% of female users wanted to recommend energy drinks use to others, this reflects that the confidence of users in these drinks is low.

In Saudi Arabia like other parts of the world the market is now flooded with new brands, with claims of 'energy highs' and 'extraordinary performances'. While the so called market leaders rely on aggressive marketing, these new brands rely on their comparatively low prices. There is a need to study energy drinks in the kingdom on government level to develop regulations about composition, production, truthful marketing and safe consumption. It is important to educate community in general and adolescents in particular about the hazards from energy drinks. In addition research needs to continue regarding the potential benefits and associated risks.

We have now got a clear picture about the usage, reasons for usage, benefits and side effects attributed to energy drinks amongst the students of University of Dammam. This will serve as a baseline for a number of other studies in the gulf region in general and in Saudi Arabia in particular, addressing safety issues, real need, maximum dose and restrictions on use of these bioactive drinks.

CONCLUSION

A significant proportion of students at University of Dammam uses energy drinks. The commonest reason for use is 'to give company to friends'. They report a number of perceived benefits, the commonest being 'ability to stay awake longer'. The students associate a variety of adverse effects with energy drinks, the commonest is 'diuresis' in males and 'insomnia' in females.

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