

Energy drinks in the Gulf Cooperation Council states: A review

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Summary

Energy drinks have become a popular beverage worldwide. This review was carried out to have an overview among adolescents and emerging adults in the Gulf Co-operation Council states about energy drinks consumption rates and other related issues such as starting age and patterns of energy drink consumption.

The Medline and Embase databases were searched separately using different terms such as energy drinks, energy beverages, and caffeinated drinks. Data related to the rates of energy drinks use were entered in STATA for statistical analysis. Then, these data were used to conduct meta-analysis to estimate the rate of energy drink consumption. Overall, meta-analysis results showed that the estimated rates of energy drinks consumption is 46.9% (95% CIs, 33.2–66.1; nine studies) with I-square 3.7%. Findings indicated that individuals start to consume energy drinks at approximately 16 years old, and males were found to consume energy drinks more frequently than females. Results from this review carry several recommendations for policy and enforcement, public education and research that can help policy and decision makers to achieve the goal of safer use of energy drinks.

Keywords

energy drinks, energy beverages, Gulf Cooperation Council countries, consumption

Introduction

Energy drinks have become a popular beverage worldwide, used commonly by adolescents and young adults of 18–34 years old. In 2008, energy drinks comprised roughly 42.4% of the functional drinks market, with total revenue of \$11.8 billion USD.¹ At first, energy drink companies primarily targeted athletes; however, as the energy drink market grew and expanded vastly, it shifted its target to adolescents and young adults between the ages of 16 and 35 years.^{2,3}

The main active ingredient in the energy drinks is caffeine, and many other components are often added to prepare the “energy blend” such as sugar, taurine, glucuronolactone, guarana and B vitamins.⁴

Adolescents and young adults consume energy drinks because of their temporary benefits including increasing alertness, enhancing mental and physical energy, and improving mood.^{5,6} However, many studies identified side effects associated with excessive caffeine intake by adolescents such as irritability, sleep impairment, cardiovascular symptoms and nervousness.⁶ Researchers associated energy drink intake among youths with specific problem behaviours such as smoking and substance use.^{6,7} Arria et al. worryingly found that even after adjusting for confounders such as heavy alcohol drinking patterns, consuming energy drinks confer a risk for alcohol dependence.⁵ This might be attributed to two main reasons: (1) the popularity of mixing alcohol with energy drinks; and (2) the use of the high levels of caffeine available in some energy drinks to manage hangover effects from alcohol use.⁵

Researches and proactive steps to protect the health of the public have been carried out in the Western region in terms of energy drink consumption and related side effects. Yet, in the Gulf Co-operation Council states, there is dearth of studies focusing on the health and safety of energy drinks’ consumption. However, as a consequence of the few studies carried out in Saudi Arabia, the cabinet meeting approved number of actions to regulate energy drinks consumption and enhance its safety (see Appendix 1).

The aims of this study are:

- To have an overview among adolescents and emerging adults aged between 18 and 34 years in the Gulf Co-operation Council states of:
 - The starting age of energy drink consumption
 - The rough estimated prevalence rates of energy drink consumption
 - The patterns of energy drink consumption
 - Awareness of energy drink contents and associated side effects
- To identify differences between males and females in terms of energy drink prevalence and pattern of use

- To identify motivations for energy drink consumption
- To identify any association between energy drinks and substance use (e.g. smoking, alcohol and drugs)
- To provide recommendations that aim at reducing side effects associated with energy drink consumption, and promote their safe use among the public.

Method

Approval was not needed as this study was a review, with no primary data collection.

Review questions

A literature search was carried out to identify information relevant to the following review questions among adolescents and young adults in the Gulf Co-operation Council states:

- What is the starting age of energy drink consumption?
- Is there any gender differences in the consumption of energy drinks?
- What is the estimated rate of the prevalence of energy drink consumption?
- What are the patterns of energy drink consumption?
- What is the level of awareness of energy drink contents and associated side effects?
- What are the motivations for energy drink consumption?

The Medline and Embase databases (via Dialog and Ovid, respectively; 1950 to July 2014 (Medline), and 1947 to July 2014 (Embase)) were searched separately on 15 July 2014. The search was carried out using terms identified from PICOS deconstruction (population, intervention and outcomes) of the above review questions such as energy drinks, energy beverages, caffeinated drinks, side effects, motivation, and inspiration for use. Further relevant studies were identified by searching the reference lists of the database-derived papers, contacting expert investigators.

Measures

Rate of energy drink consumption. Any reported rate of energy drink consumption including: (1) ever consumed energy drinks; (2) consumed energy drinks once the past 12 months; (3) consumed energy

drinks the previous month; (4) consumed energy drinks the previous week; and (5) consume energy drinks on a daily basis.

Patterns of energy drink consumption. Any reported patterns of energy drink consumption among regular users who consume energy drinks on a daily basis and/or irregular users who might use 1–2 or 2–3 cans per week/month/year.

Selection

The titles and abstracts were evaluated by one reviewer to determine eligibility for full screening. Studies that utilised designs from a pre-determined list of acceptable methods – including randomised controlled trial and observational study (cross sectional, quasi-experimental and interventional) – were included. No limitations on publication type, publication status, study design or language of publication were imposed. However, we did not include secondary reports such as review articles without novel synthesis. The inclusion criteria demanded that the study population be adolescents and young adults from both genders and of a Gulf Co-operation Council states.

Ten studies were identified as suitable for full review, and were each considered by two reviewers. One study was excluded,⁸ by consensus, because data were not (fully) available.

Data extraction/quality assessment

The data captured for each study included data relating to (1) objective of the study; (2) methods (study design, sampling, participants' characteristics, and setting); and (3) outcomes.

Data synthesis

Data related to the prevalence of energy drink use were entered in STATA version 10 for statistical analysis. Then, these data were used to conduct meta-analysis to estimate the rate of energy drink consumption, and the degree of heterogeneity was assessed between the studies statistically using meta-analysis to obtain an I-square value. The majority of the studies included were observational; therefore, the value of I-square is expected to be high due to many factors including sampling, and methodological and statistical variation of the studies. Random effect method was used to account for the anticipated heterogeneity. Subgroup analysis was performed to assess the difference in consuming energy drinks between school and university

students. Also, the measures of uncertainty (95% confidence intervals) were calculated.

Results

Nine journal-published studies were identified for inclusion,^{7,9–16} of which four were carried out among school students, four among university students and one included samples from both school and university. A summary of these studies is provided in Table 1. Seven studies were conducted in the Kingdom of Saudi Arabia, one in the UAE and one in the Sultanate of Oman. Sample sizes ranged from 125 to 2908.

Age and gender of energy drinks users

Three studies^{9–11} reported the average age at first consumption as being roughly 16 years. However, in the study carried out in the UAE among medical students, the majority of participants (92%) declared that they started consuming energy drinks from 15 years.¹² Ibrahim et al. stated that males started drinking energy drinks at a younger age compared to females (16.1 ± 2.8 years vs. 18.3 ± 2.9 years, $p < 0.001$ respectively). On the contrary, Kilani et al. and Alsunni found that females started consuming energy drinks at an earlier age.^{10,11} For instance, based on the Kilani et al. findings, the average age at first consumption for females is 16.7 ± 1.3 compared to 17.1 ± 1.2 for males.¹¹

Musaiger et al. found that males consume energy drinks more frequently than females ($p < 0.001$).⁷ Alsunni et al. also found that male users were 4.5 times more numerous than female users.¹⁰

Prevalence rates and patterns of energy drink consumption

Overall, meta-analysis results showed that the estimated rate of energy drink consumption is 46.9% (95% CIs, 33.2–66.1; nine studies) with I-square = 3.7%. Subgroup analysis by setting shows that the highest estimate of energy drink consumption was found in schools, 65.3% (95% CIs, 41.6–102.3; four studies), followed by universities, 29.3% (95% CIs, 17.2–50.0; five studies). These differences in the summarised estimates of energy drink consumption between schools and universities are statistically significant ($p = 0.02$).

Four studies documented the pattern of energy drink consumption.^{7,9,10,13} The first study⁷ found that the majority of participants aged between 12 and 19 years who consume energy drinks (179

males (31.9%) and 123 females (24.7%)) use one to two cans per week. Worryingly, the study found also 125/562 (22.2%) of males and 20/499 (4%) of females consume >5 cans of energy drinks per week. The second study⁹ indicated that 4.6% of regular users of energy drinks consumed them more than once daily and about 20.3% consumed them on a daily basis, while 15.2% used energy drinks two to three times per week. The third study¹³ declared that 16.3% of males and 8.5% of females consume energy drinks more than three days per week. The final study carried out by Alsunni et al. showed that 107 of 153 (69.9%) males compared to 27 of 33 (38.4%) females consume energy drinks on an irregular routine ($p < 0.05$), and 19 of 134 (14.2%) males compared to 2 of 33 (6%) females consume energy drinks four to seven times per week.¹⁰ Additionally, 64 of 134 (47.8%) males compared to 10 of 26 (38.5%) females mentioned one can as the maximum number of energy drinks ever consumed in a single day, followed by 53 of 134 (39.6%) males compared to 9 of 26 (34.6%) females who maximally consume two cans daily.¹⁰

Interestingly, a statistically significant difference was found between smoking and energy drink consumption by one study.⁹ Energy drink consumption was much higher among smokers (59.6%) compared to non-smokers (27.1%) ($p < 0.001$).⁹ No studies identified the association between energy drink consumption and other substances including alcohol and drug use.

Awareness of the content of energy drinks and associated side effects

Consistently, in the four studies^{7,10,12,14} that assessed participants' awareness of the content of energy drinks, approximately half the number of the study sample were not aware of the active ingredients in the energy drinks. Regarding awareness of the caffeine content, in one of the studies, 53.2% of males and 48.3% of females knew that energy drinks contain caffeine ($p < 0.001$).⁷ In another study, 38.2% of males and 32.8% of females were not aware of the constituents of energy drinks, and 37.1% of males and 44.7% of females were not aware of the presence of caffeine in particular.¹⁰ The majority of medical students (95%) who participated in a cross-sectional study carried out in the UAE were ignorant of the caffeine and high calory content of energy drinks.¹² In the fourth study, it was illustrated that more than two-thirds (69.6%) of the study sample did not know the active ingredients ($p = 0.013$).¹⁴

Table 1. Summary of the studies included in the review.

Ref	Objective	Method	Key findings
7	To explore the knowledge of, attitudes to and intake of energy drinks among adolescents in Saudi Arabia	<ul style="list-style-type: none"> - Multi-stage stratified sampling - 1061 school children aged 12–19 years - Jeddah, Saudi Arabia 	<ul style="list-style-type: none"> - 31.9% of males and 24.7% of females drank energy drinks, 1–2 days per week, with a significant difference between the genders ($p < 0.001$). - The frequency of energy drink consumption was higher among males than females. For example, 22.2% (125) of males consumed more than five cans daily, compared to 4% (20) of females. - Advertisements were the main single source of information on energy drinks (51.6% and 33.9% in males and females, respectively). - The main reasons for consuming energy drinks were for their taste and flavour (58.4%), in order to 'try them' (51.8%) and to 'get energy' (43%), with significant differences between males and females ($p < 0.001$). - About half of adolescents (47% male; 52.3% female) did not know the ingredients of energy drinks ($p < 0.006$), and only 53.2% of males and 48.3% of females knew that these drinks contained caffeine ($p < 0.001$). - Only 53.2% of males and 48.3% of females knew that these drinks contained caffeine ($p < 0.001$). - Only 27.2% of males and 5.8% of females knew that energy drinks contain vitamins ($p < 0.001$).
9	To determine the prevalence, pattern and predictors of energy drink consumption among medical students and interns in three medical colleges, Jeddah, Saudi Arabia	<ul style="list-style-type: none"> - Cross sectional study was conducted at three medical colleges. - Multistage stratified random sample - 610 samples 	<ul style="list-style-type: none"> - Males started consuming energy drinks at younger age (16.10 ± 2.86 years) compared to females (18.31 ± 2.98 years). A highly statistical significant difference was present (Student's t-test = 4.76, $p < 0.001$). - 4.6% of regular users consumed energy drinks more than once daily, about one-fifth (20.3%) utilized them on a daily basis, while 15.2% used these drinks 2–3 times a week. - About one-third (31.6%) of regular users of energy drinks reported experiencing adverse effects after using such drinks. Heart palpitation was most commonly reported side effect (30.4%) followed by insomnia (29.5%), frequent micturition (19.1%), headache (16.2%) and jolt and crash episodes (4.8%). - The main inspirations of the first use of energy drinks, among 'ever consumed' users, were friends (50.2%), advertisement (31.4%) and curiosity (18.4%). - The prevalence rate of regular consumption of energy drinks during the two months preceding the study was 33.4%. - Enjoying leisure time with friends (57.5%), boosting energy for studying (56.4%), staying awake for a long time (50.5%), driving for long distances (33.8%) and better athletic performance (24.5%) were the most common reasons, from their opinions. - Prevalence rate of energy drink consumption was also much higher among smokers (59.6%) compared to non-smokers (27.1%), with a highly significant statistical difference ($X^2 = 42.15$, $p < 0.001$).

(continued)

Table 1. Continued.

Ref	Objective	Method	Key findings
10	To determine energy drinks consumption patterns among the students of University of Dammam To identify good and bad effects attributed to the use of energy drinks by consuming students	- Questionnaire based survey was carried out at the University of Dammam - October to December 2010, Saudi Arabia	- 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 numbered 154 (81.91%) and female users just 34 (18.08%). The male to female difference was statistically significant ($p < 0.05$). - 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. - The commonest reasons for using energy drinks in both genders was to give company (female (15) 24% vs. male (50) 24%; $P < 0.01$). - A total of 68 (42.2%) males and 15 (41.6%) females had no particular reason for using energy drinks for first time and 42 males (26%) and 8 females (22.2%) used it due to their friends. - The ability to stay awake longer was the commonest in females, 17 (22.6%), while in increased alertness was the commonest in males, 40 (14.6%). - Most of the students in both genders never consumed more than one: males 107 (69.9%) vs. females 27 (81.8%). - More than half of the students knew about one or more components of energy drinks but a large number did not know about the presence of caffeine.
11	To investigate lifestyle habits including physical activity, eating habits, and sleep duration	- A cross-sectional study - To investigate life style activity - 802 Omani (442 females and 360 males) - 15–18 years	- Average age 17.1 ± 1.2 for males and 16.7 ± 1.3 for females. - 65% of males and 47% of females consume energy drinks ≥ 3 times weekly.
12	To determine the preference, awareness, and frequency of consumption of health drinks and energy drinks among university students in Ajman, UAE.	- Cross-sectional study - 125 (85 females and 40 males) Gulf Medical University students - Ajman, United Arab Emirates	- 92% of the students consumed energy drinks but less than 8% took health drinks. - Around 85% of the respondents thought that energy drinks would enhance mental energy and brain development ($p < 0.05$). - More than 92% started drinking energy drinks from 15 years of age. - It was also observed that 72% of the students were influenced by advertisements on television and at retail outlets. - The majority of respondents (95%) were ignorant about the high calorie and caffeine content in these energy drinks. - Most of the consumers preferred to use a glassful per day as it was convenient in terms of amount and price.
13	To report on the prevalence of physical activity, sedentary behaviours and dietary	- Cross-sectional study - Saudi Arabi in three cities: al-Khobar, Jeddah and Riyadh	- Energy drinks intake ($>$ three days/week) 16.3% males and 8.5% females ($p < 0.001$)

(continued)

Table 1. Continued.

Ref	Objective	Method	Key findings
	habits among Saudi adolescents and to examine the interrelationships among these factors	- 2908 secondary school (males 1401 and females 1507) - Age: 14–19 years	
14	To explore the prevalence of consumption, pattern of use and knowledge about energy drinks among female secondary school students in Almadinah, Saudi	- Cross sectional survey - 600 females, Secondary school - Mean age 17 - Saudi Arabia	<ul style="list-style-type: none"> - 72% knew about the effects of energy drinks on blood pressure, 77.3% about effects on blood sugar level, 69.2% about effects on heart rate and only 47% about effect on menstruation. - 52.2% consumed energy drinks. - 25.6% used energy drinks to increase vitality and 20.8% to be alert. - 69.9% didn't know the active ingredients of energy drinks. - Less than one-fourth of users (22.4%) developed mood changes: 60.1% stated that they became more energetic; 29.1% developed body changes, such as menstrual changes and change in voice tone. - More than one third (35.0%) attributed the popularity of energy drinks use to advertising, and 47.0% recommended coffee as an alternative. - More than two thirds (69.6%) of the students did not know the active ingredients of energy drinks ($p = 0.013$). - One-fourth (27.5%) had tried stopping use, and 34.9% of them had had withdrawal symptoms. - Less than two-thirds of current energy drinks users (61.0%) stated that they would quit if they had side-effects. - Most students at each level had close friends who consumed energy drinks (87.8% at level I, 90.9% at level II and 84.9% at level III), and more than two-thirds had family members who consumed them (71.8% at level I, 82.5% at level II and 80.8% at level III) ($p = 0.036$). Current consumption was correlated with consumption by a family member or close friend.
15	To explore the use of over the counter (OTC) medicines including energy drinks among students during exams in Riyadh City, Kingdom of Saudi Arabia	A cross-sectional study using a self-administered 22-item online questionnaire	<ul style="list-style-type: none"> - A total of 1596 students participated in this survey, of whom 829 (51.9%) were university students and 767 (48.1%) were high school students. - A total of 621 (38.9%) high school students and 182 (11.4%) university students consume energy drinks during exams.
16	To estimate the prevalence of energy drink consumption among Umm Al-qura University students	Cross-sectional survey using a self-administered questionnaire for 257 (78 males, 179 females) medical students from Umm Al-	<ul style="list-style-type: none"> - 27.7% of students were using energy drinks of whom a significantly higher proportion of male students (61.5% of all male students, $n = 48$) consumed energy drinks when compared to females (12.3% of all female students, $n = 22$, $p = 0.0001$).

(continued)

Table 1. Continued.

Ref	Objective	Method	Key findings
		Qura University Age ranged between 21 and 25 years	<ul style="list-style-type: none"> - 32.8% consumed energy drinks to have energy, 31.4% to study for exams and finish projects, 8.5% to drive for long distances, and 11.4% to be like friends and show off. - 20% of people consuming energy drinks experienced heart palpitation, 6% experienced headache, 3% reported nervousness and 4% reported nausea and vomiting.

Table 2. Summary of the motivations for consuming energy drinks.

School students	University students
Taste	Enjoying leisure with friends
Getting or increasing vitality	Boosting energy for studying
Curiosity	Staying awake for long time
Being alert	Driving for long distances
Being with peers who consume energy drinks	Having better athletic performance
Having family members who consume energy drinks	Enhancing mental energy and brain development
	Giving company
	Taste and flavour

One study assessed the participants' awareness of the side effects associated with the consumption of energy drinks.¹⁴ It indicated that 72% of the participants knew about the effect of energy drinks on blood pressure, 77% knew the effect on blood sugar level, and 69.2% knew the effect on heart rate.¹⁴

Three studies reported^{9,14,16} that side effects resulted from energy drink use among school and university students. Ibrahim et al. reported that 31.6% of regular energy drink users experienced adverse effects after energy drink consumption.⁹ Of these adverse effects, 30.4% of users reported having heart palpitation, 29.5% having insomnia, 19.1% having frequent micturition, 16.2% having headache and 4.8% having jolt and crash episodes.⁹ A jolt and crash episode is known as the experience of sudden burst, or jolt of energy, which only lasts a few hours before the consumer experiences a debilitating crash.⁹ Aluqmany et al. found that 22.4% of energy drink consumers developed mood changes, 60% stated that they became more energetic, and 29.1% stated developing body changes such as change in the voice tone, and menstrual changes.¹⁴ Similar side effects were reported by Bawazeer et al., in which 20% of university students consuming energy drinks experienced heart palpitation, 6% experienced headache, 3% reported nervousness, and 4% reported nausea and vomiting.¹⁶

Motivations for energy drink consumption

Six studies^{7,9,10,12,14,16} identified the motivation for consuming energy drinks among school and university students. A summary of the frequently mentioned reasons for use is listed in Table 2. Peer pressure, taste and flavour and being alert were the commonly mentioned reasons for energy drink intake by both school and university students. Curiosity was the reason for consuming energy drinks mentioned only by school students, while university students attributed the consumption of energy drinks among themselves to many reasons, but exclusively boosting energy for study, driving for long distances, and enhancing athletic performance were stated.

Discussion

Demographics of energy drink users

Findings from the reviewed studies indicated that individuals start to consume energy drinks at approximately 16 years old, yet some researches, for instance Kilani et al., found that females started consuming energy drinks earlier than 16 years.¹¹ Jacob et al. reported that the majority of energy

drink users started drinking them from 15 years of age.¹² In the same line, it was reported in a study carried out in Canada that the average age of consuming energy drinks among secondary school students is 15.2 years.⁶ However, Ballard et al. reported the consumption of energy drinks at younger ages, starting from 11 years.¹⁵

Results from the review demonstrated that males consume energy drinks more than females. Similarly, many studies reported that males are more likely to consume energy drinks than females.^{5,17–19} This might be attributed to the extensive marketing that promises to increase physical performance for males. Furthermore, Alsunni et al. explained the greater consumption of energy drinks among males in Saudi Arabia by the higher amount of physical activity males carry out compared to females.¹⁰ Unlike the findings from these studies, Malinauskas et al. reported higher prevalence rate of consuming energy drink among female college students in the USA.²⁰ This might be due to the tactics followed by the energy drink companies such as using attractive feminine names like “Go GIRL”, and introducing the sugar-free and diet versions to reduce the gap between gender in the consumption of energy drinks.

Estimated rates of energy drink consumption

Meta-analysis results showed that the estimated rate of energy drink consumption is 46.9% with I-square=3.7%, and the estimated rates of energy drink consumption among school students tend to be higher (65.3%) than university students (29.3%). However, this finding could be limited by the sampling issues such as sample size and method followed in the reviewed studies. Using different cut-off points for defining the prevalence of energy drink use such as: (1) ever consumed energy drinks; (2) consumed energy drinks once in the past 12 months; (3) consumed energy drinks the previous month; (4) consumed energy drinks the previous week; and (5) consume the energy drinks on a daily basis also might lead to the vast variation in the findings.

Similar findings on the consumption rate of energy drinks among school students were reported in a study in Atlantic, Canada where 62% of 7th, 9th, 10th and 12th school students were found to have consumed energy drinks at least once in the previous year in 2012.⁶ While findings on the consumption rate of energy drinks among university students reported from some studies carried out elsewhere^{20,21} are higher than the prevalence in this review.

The common use of energy drinks among school students is alarming, and calls for policy, preventive

and research response in order to tackle this issue and ensure the safety of this population.

Patterns of energy drink use

Findings on the patterns of consuming energy drinks vary between the studies due to the differences occurring between regular users who consume energy drinks on a daily basis and irregular users who might use 1–2 or 2–3 cans per week/month/year. For instance, some researchers found that 4.6% of regular users of energy drinks consume them more than once daily and about 20.3% consumed them on a daily basis, while 15.2% used energy drinks 2–3 times per week. Worryingly, Musiger et al. reported higher frequency of energy drink consumption (>5 cans weekly) among 22% of schoolchildren aged from 12 to 19 years compared to 52% of college students with the average age of 21 who consume >1 can monthly.⁷ A noteworthy finding by Alsunni et al. stated that 53 (39.5%) males and 9 (34.61%) females consume maximally two cans in a single day.¹⁰ This calls for raising awareness among school and university students on the safe daily allowance for consuming energy drinks per day, and consequences of excessive consumption of energy drinks on health.

Awareness on the content and potential associated side effects

It was worrying that a large number of the included study sample in the review were not aware of the active ingredients, particularly caffeine, in the energy drinks. Even more worrisome, the majority of the adolescents who participated in the study carried out by Musiger et al. considered energy drinks to be soft drinks.⁷ Similar results were found in a study carried out elsewhere, and 69.6% did not know the exact definition of energy drinks and their composition.²² In addressing the issue of energy drinks with students, parents should play a role in educating their children on the content of energy drinks and potential associated side effects. In the school, sport teachers and schools’ nurses should take the responsibility of educating the students on the main ingredients of energy drinks, the safe daily allowance of energy drinks (500 ml or one can/per day), and the potential associated side effects. Coaches and athletic departments also should take the lead in educating athletes on the differences between sport and energy drinks and the main active ingredients used in energy drinks.

Three studies reported side effects that resulted from consuming energy drinks on a regular basis such as heart palpitations, insomnia, nausea,

Table 3. Possible side effects of energy drink ingredients.^{24–29}

Main ingredients	Possible side effects
Caffeine	Nausea, heart palpitations, ventricular and atrial tachycardias, headache, insomnia, anxiety, irritability, seizure, hallucinations, hypokalemia, rhabdomyolysis
Guarana	Insomnia, nervousness, restlessness, tachycardia, tremors, anxiety, chest pain, dysrhythmias
Taurine	There is insufficient evidence to prove that adverse effects can occur with taurine use. Although the issue of taurine-induced toxic encephalopathy has been addressed, it is likely that the risk of taurine toxicity after energy drink consumption remains low. However, there is a need to carry out research examining the prolonged use of energy drinks providing >3 g taurine ²⁷
Sugar	Dental erosions, cavities, diabetes, obesity, ginseng insomnia, breast tenderness, vaginal bleedings, amenorrhea, tachycardia, heart palpitations, hypertension, edema, headaches, vertigo, euphoria, mania
Bitter orange	Myocardial infarction, stroke, seizure, hypertension, photosensitivity, dysrhythmias, migraine, headache
Ginseng	Based on available studies on animals and humans ginseng is considered safe. Yet, at very high doses it can cause hypertension, diarrhoea and sleep disturbance ²⁵
B vitamins	The consumption of large amount of B vitamins does not cause any adverse health effects
Yerba mate	Concerns regarding association between yerba mate and the occurrence of certain types of cancer such as lung, bladder and oral cancer. Yet, there is not conclusive evidence as many other factors such as lifestyle choices (e.g. smoking) might participate in the appearance of these types of cancer ²⁵

vomiting and frequent micturition. Research indicated that the effects of low to moderate (20 to 200 mgs) doses of caffeine produce energy and alertness, yet high doses can cause anxiety, jitteriness and upset stomach.²³ A summary of the major potential side effects associated with the common components in the energy drinks are listed in Table 3.

As a consequence of the adverse effects linked to the consumption of energy drinks in the USA, the American Academy of Pediatrics in 2011 recommended against energy drink intake among the young.²⁵ See Appendix 2 for the recommendations of the American Academy of Pediatrics.²⁶

Many factors are believed to increase caffeine overdose among youth including: inadequate labelling, massive marketing and advertising, and the ingestion of multiple cans daily as a result of the claim of enhancing performance: “more is better”.²⁷ Therefore, improving the labelling of the energy drink contents and regulating the marketing are needed.

Energy drink consumption and associated behavioural problems

Many studies focused on the possible association of energy drink consumption and several risky behaviours such as substance use and smoking. A positive association was found between frequent consumption of energy drinks and behavioural problems.^{3,6} Findings from this review for instance showed that

smokers consume energy drinks more commonly than non-smokers.⁹

More research in the Gulf Co-operation Council states should examine the association of energy drink consumption with risky behaviours such as smoking, substance use and mixing energy drinks with non-medical prescription drugs.

Reasons for energy drinks' use

Several drives for using energy drinks have been identified from the reviewed studies. Taste and flavour of the energy drinks were commonly cited by school and university students to motivate the use of energy drinks. These subjects might be attracted by the taste of the high level of sugar that many energy drinks contain, also some brands use “diet-sweeteners”, which are preferred by some people. University students frequently mentioned using energy drinks to boost their energy for studying especially during exams, and to promote athletic performance. Similar findings were reported by many studies (e.g. Aslam et al.²²). Energy drinks are designed to boost the energy of users through using stimulants (mainly caffeine), vitamins and herbal supplements. Many studies associated the consumption of energy drinks with moderate improvement in physical endurance, alertness and psychomotor performance.³ Unlike the findings by these studies, other studies did not find significant associations between energy drink

consumption and physical or cognitive outcome.^{2,3} Although energy drinks are able to enhance physical endurance temporarily, prolonged and excessive use has many side effects on the health of the individuals.²²

Peer pressure was another common reason for purchasing energy drinks by school and university students. This finding is in line with findings from other studies that confirm the influence of peers on purchasing and consuming energy drinks.²⁷

Implications of this review

The results of this review suggest a number of recommendations that will further enhance the safety of energy drink consumption among people in the Gulf Co-operation Council states. These recommendations include the following:

Policy and enforcement might include^{28–30}

- Prohibiting advertising energy drinks through all media sources
- Prohibiting the promotion of energy drinks in campaigns, and prohibiting energy drink companies from sponsoring sport or social cultural events
- Prohibiting free distribution of energy drinks to consumers of all age groups
- Emphasising writing a label in Arabic language that contains:
 - The main ingredients
 - Health warning on the harmful effects associated with consuming more than the recommended daily allowance by adolescents (one can/day).
 - Special warnings on the consumption for pregnant and breastfeeding women, people with diabetes, hypertension and cardiovascular diseases, people with caffeine allergy and for people aged <16 years old.
- Banning the sale of energy drinks from corner shops, cafeterias, restaurants, public and private gyms
- Training paediatricians and general practitioners on counselling and screening for energy drinks among children and young adults.

Public education might include

- Motivating health care providers such as general practitioners and school nurses to counsel adolescents on the active contents of energy drinks and possible risks associated with consuming energy drinks.
- Carrying out educational campaigns designed to raise awareness among adolescents and young

adults of energy drink contents and side effects associated with excessive consumption.

- Motivating sport coaches to raise awareness among the young of the contents of energy drinks, and possible associated side effects.

Research might include

- Carrying out further systematic research among adolescents and young adults in the Gulf Co-operation Council states to assess awareness of the contents of energy drinks and associated side effects, and awareness of the safe daily allowance.
- Carrying out research that examines the relationship between energy drink consumption and other problem behaviours including substance use and mixing specific medications/alcohol with energy drinks.

Limitations of the review

The heterogeneity of the reviewed studies, and variable availability of sub-group data, was a major limitation in our review process. As a result, our outcomes are necessarily of only a generalised nature, and could not be given with measures of confidence. All of our reviewed studies were published in English. Nevertheless, this review has several important implications for policymakers and public health planners as discussed above. It provides evidence on the need to carry out educational campaigns in schools and universities to raise awareness of energy drinks' use and the health risks associated with their use.

Conclusion

Enhancing the safety of energy drink consumption among all subjects in society, especially the young, is essential, and to achieve this goal integrated efforts between different stakeholders should be ensured. The results of this review lead to several recommendations for policy and enforcement, public education and research that can help policy and decision-makers to achieve the goal of safer use of energy drinks.

Declarations

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References

1. Datamonitor. Global functional drinks, www.data monitor.com (2008a, accessed 12 July 2014).
2. Heckman MA, Sherry K, Mejia D, et al. Energy drinks: an assessment of their market size, consumer demographics, ingredient profile, functionality, and regulations in the United States. *Compr Rev Food Sci Food Safe* 2010; 9: 303–317.
3. Miller KE. Energy drinks, race, and problem behaviors among college students. *J Adolesc Health* 2008; 43: 490–497.
4. Higgins J, Tuttle T and Higgins C. Energy beverages: content and safety. *Mayo Clin Proc* 2010; 85: 1033–1041.
5. Arria AM and O'Brien MC. The “high” risk of energy drinks. *JAMA* 2011; 305: 600–601.
6. Azgaba S, Langille D and Asbridge M. An emerging adolescent health risk: caffeinated energy drink consumption patterns among high school students. *Prevent Med* 2014; 62: 54–59.
7. Musaiger A, Zagzoog N. Knowledge, attitudes and practices toward energy drinks among adolescents in Saudi Arabia. *Global J Health Sci* 2014; 6: 42–46.
8. Kabbash A. *Drug and substance abuse among medical students*. Department of Family and Community Medicine: King Saud University, 2006.
9. Ibrahim N, Iftikhar R, Murad M, Fida H and Abalkaeil B. Energy drinks consumption amongst medical students and interns from three colleges in Jeddah, Saudi Arabia. *J Food Nutr Res* 2014; 1: 174–179.
10. Alsunni A and Badar A. Energy consumption pattern, perceived benefits and associated adverse effects amongst students of University of Dammam, Saudi Arabia. *J Ayub Coll Abbottabad* 2011; 23: 3–9.
11. Kilani H, Al-Hazza H, Waly M and Musaiger A. Diet, physical activity and sleep duration among Omani adolescents. *Sultan Qaboos Univ Med J* 2013; 13: 510–519.
12. Jacob S, Tambawel J, Trooshi F and Alkhoury Y. Consumption pattern of nutritional health drinks and energy drinks among university students in Ajman, UAE. *Gulf Med J* 2013; 2: 22–26.
13. Al-Hazza H, Abahussain N, Al-Sobayel H, Qahwaji D and Musaiger A. Physical activity, sedentary behaviors and dietary habits among Saudi adolescents relative to age, gender and region. *Int J Behav Nutr Phys Act* 2011; 8:140. DOI:10.1186/1479-5868-8-140.
14. Aluqmany R, Mansoor R, Saad U, Abdullah R and Ahmad A. Consumption of energy drinks among female secondary school students, Almadinah Almunawwarah, Kingdom of Saudi Arabia, 2011. *J Taibah Univ Med Sci* 2013; 8: 60–65.
15. Almalak H, Albluwi A, Alkheib D, Alsaleh H, Khan T, et al. Students' attitudes toward use of over the counter medications during exams in Saudi Arabia. *Saudi Pharmaceut J* 2014; 22: 107–112.
16. Bawazeer N and Alsobahi N. Prevalence and side effects of energy drinks consumption among medical students at Umm Al-Qura university, Saudi Arabia. *Int J Med Student* 2013; 1: 104–108.
17. Ballard SL, Wellborn-Kim JJ and Clauson KA. Effects of commercial energy drink consumption on athletic performance and body composition. *Phys Sportsmed* 2010; 38: 107–117.
18. Azagba S, Langille D and Asbridge M. An emerging adolescent health risk: Caffeinated energy drink consumption patterns among high school students. *Prev Med* 2014; 62: 54–59.
19. Hoyte CO, Albert D and Heard KJ. The use of energy drinks, dietary supplements, and prescription medications by United States college students to enhance athletic performance. *J. Community Health* 2013; 38: 575–580.
20. Malinauskas BM, Aeby VG, Overton RF, Carpenter-Aeby T and Barber-Heidal K. A survey of energy drink consumption patterns among college students. *Nutr J* 2007; 6: 35–41.
21. Bulut B, Beyhun N, Topbas M and Can G. Energy drink use in university students and associated factors. *J Commun Health* 2014; 39: 1004–1011.
22. Aslam H, Mugal A, Edhi M, Saleem S and Rao M. Assessment of pattern for consumption and awareness regarding energy drinks among medical students. *Archive Public Health* 2013; 71: 31.
23. Arria AM, Caldeira KM, Kasperski SJ, O'Grady KE, Vincent KB, et al. Increased alcohol consumption, nonmedical prescription drug use, and illicit drug use are associated with energy drink consumption among college students. *J Addict Med* 2010; 4: 74–80.
24. Heckman MA, Sherry K and Mejia G. Energy drinks: An assessment of their market size, consumer demographics, ingredient profile, functionality and regulations in the United States. *Instit Food Technol* 2010; 9: 303–315.
25. Coon J and Ernst E. Panax ginseng: a systematic review of adverse effects and drug interactions. *Drug Safe* 2002; 25: 323–344.
26. American Academy of Pediatrics. Energy drinks: exploring concerns about marketing to youth. 2013.
27. Rath M. Energy drinks: what is all the hype? The dangers of energy drink consumption. *J Am Acad Nurse Practitioners* 2012; 24: 70–76. Available at: https://www.aap.org/en-us/advocacy-and-policy/federal-advocacy/documents/schneidersenatecommercecommitteeenergydrinkstestimony_7_31_13.pdf.
28. Heck CI and de Mejia EG. Yerba mate tea (*Ilex paraguensis*): a comprehensive review on chemistry, health implications, and technological considerations. *J Food Sci* 2007; 72: 138–151.

29. Bigard AX. Risks of energy drinks in youths. *Arch Pediatr* 2010; 17: 1625–1631.
30. Naeem Z. Health hazards of energy drinks and positive actions by Saudi government. *Int J Health Sci* 2014; 8: v–vi.
31. Reid S, Ramsarran J, Brathwaite R, Lyman S and Barker A. Energy drinks usage among university students in a Caribbean country: Patterns of use and adverse effects. *J Epidemiol Global Health* 2014 (in press).

Appendix 1. Saudi Arabia regulations for energy drinks³⁰

The Cabinet meeting of Saudi Arabia approved a number of actions according to the Saudi press agency, including:

- To prohibit advertising of any energy drinks or advertising or promotional campaigns for any energy drink via any readable, audible or visible media or by any other means.
- To prohibit energy drink companies, their agents, distributors and marketing associations from sponsoring any sporting, social or cultural event, or taking any measure leading to promotion.
- To prohibit the free distribution of energy drinks to consumers of all age groups.
- To prohibit the sale of energy drinks in restaurants and canteens in government facilities; education and health facilities; halls and public and private sport clubs.

Appendix 2. Recommendations by the American Academy of Pediatrics to regulate energy drinks consumption²⁶

- **Caffeine and energy drinks should be actively and strongly discouraged for young people.** Due to the potentially harmful health effects of caffeine, dietary intake should be discouraged for all children. Because the actual stimulant content of energy drinks is hard to determine, energy drinks pose an even greater health risk than simple caffeine. Therefore, energy drinks are not appropriate for children and adolescents and should never be consumed.

- **Public education is necessary.** Parents should be advised on nutrition and sleep needs of children and adolescents to reduce the need for stimulant seeking behaviours. Also, parents and adolescents should understand the risks of consumption and overconsumption of caffeinated beverages and energy drinks as well as the dangers of consuming alcohol with energy drinks. The health risks of these products also reinforce the need for increased media literacy as recommended by the American Academy of Pediatrics.
- **Voluntary consumer product labelling would benefit the public.** Energy drink packaging should provide information on the cumulative total of all caffeine and other stimulants, and it should be per package for non-resaleable packaging. In the absence of strong voluntary standards, mandatory requirements would help consumers make informed choices and better protect public health and safety.
- **More research is needed.** Given the health effects of energy drinks due to the high doses of caffeine, often in combination with other stimulant ingredients with unknown safety profiles, research on energy drinks and the ingredients they contain is urgently needed. Additional poison control data would certainly be helpful in identifying areas of concern.
- **Stronger federal guidance is necessary.** The American Academy of Pediatrics is pleased that the Food and Drug Administration took action to protect public health and safety in response to concerns and adverse incidences regarding caffeinated alcoholic beverages, inhalable caffeine products, and the introduction of caffeinated gum and processed foods. The Food and Drug Administration should finalize its 2009 guidance for industry to ensure that beverage products are classified appropriately based on their composition and intended use. Furthermore, additional efforts are needed to examine potential safety standards for GRAS ingredients that are generally regarded as safe but with demonstrated health and safety risks for children or other vulnerable populations or when consumed in excess amounts. Finally, Congress should eliminate all unnecessary requirements that delay or inhibit the work of the Interagency Working Group on food marketed to children.