Are There Health Effects Related to the Consumption of Energy Drinks?

Findings From a Systematic Review

By

Marie Hood

BSN, University of Arizona, 1995

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Abstract

Energy drinks are beverages that contain high levels of caffeine and other stimulants and have become an increasingly popular choice of beverage, especially among adolescents and young adults. Energy drinks have similar nutritional value as sodas, only with a higher level of caffeine. Their popularity has led to concern about the potential health effects related to their consumption, especially with adolescents and young adults. A systematic review was conducted to determine if there are any potentially harmful health effects related to these highly caffeinated drinks. The data analysis included the design of the research, the main argument of the research article, the key concepts, the study sample size, and the results of the research articles. The results of this systematic review justifies the need for energy drinks to be regulated by the Food and Drug Administration and it is recommended that warning labels be placed on the beverages that are sold as an energy drink.
Introduction

Statement of the Problem

Energy drinks have become a popular beverage of choice when people want to quench their thirst and give a boost to their energy level. They are widely available to people of all ages and come in many flavors and brands. The ease of purchase with no health risks mentioned on the label may lead consumers to feel that these products are safe, but they contain high levels of caffeine and other stimulants. Within the United States, they are especially popular among adolescents and young adults with 30% to 50% of people within this age group reporting drinking them on a regular basis (Seifert, Schaechter, Hershorin, & Lipshultz, 2011). Since their introduction, the annual sales of energy drinks has skyrocketed within the United States immensely with over 8.9 billion dollars worth sold in 2011 (Johnson, Foster, & Mc Dowell, 2014). Red Bull © has dominated the market with 42% of the sales of energy drinks within the United States and in 2011, the company sold over four billion servings in over 160 countries (Burrows, Pursey, Neve, & Stanwell, 2013). As the popularity of these products increase, it is important to summarize the health effects that may be occurring to those who consume them. With the absence of any warning labels or negative nutritional values listed, energy drinks appear to be a safe choice of beverage, however they have been linked to some emergency department visits.

Purpose of the Study

To reduce the negative health effects of energy drinks, individuals need to be aware that along with the therapeutic benefits of energy and alertness, there may be negative health effects. The purpose of this paper was to summarize previous articles for
research that may indicate any harmful health effects to the people who consume energy
drinks. This can help determine if there is a public health need for education on potential
risks and to propose the use of warning labels on these products. While there has been
previous research on this topic in prior years, it is imperative to continue to monitor for
any health effects due to long-term energy drink consumption. Is there enough of a risk
to a person’s health that would require manufacturers to post a health risk statement on
the label?

The United States National Poison Data System (NPDS) tracks calls related to
different exposures. Upon examination of calls made to the NPDS related to toxic
exposures to high levels of caffeine, it was found that out of a total of 2.3 million calls,
4,854 (0.2%) were related to these beverages (Seifer, et al., 2013). After excluding 3,192
(65.8%) of these calls that included energy drinks combined with alcohol, 50.7% were
calls made on behalf of children <6 years old, 76.7% were unintentional energy drink
overdoses; and 60.8% were males (Seifer, et al., 2013). Energy drinks remain
unregulated in the United States and other countries around the world as they are labeled
as dietary supplements. If it is found that energy drinks have negative health effects that
outweigh any beneficial therapeutic effects, regulation by the United States Food and
Drug Administration (FDA) may reduce these risks.

**Potential Significance of the Study**

One average sized energy drink can have enough caffeine to equal five cups of
coffee. Health care providers need to be made aware of the potential health effects
related to energy drink consumption. To date, much of the research that has been
conducted on energy drink consumption has focused on children and young adults. Of
the calls to the NPDS related to energy drink consumption, 68.2% were for people <20 years old (Seifer, et al., 2013). Studies that were conducted from 1966 to 2011 that examined health impacts from high doses of caffeine intake have been incomplete (Burrows, Pursey, Neve, & Stanwell, 2013). As the population of energy drink consumers continues to age, it is imperative to continue to collect data to monitor for new and long-term health effects (Thorlton, Colby, & Devine, 2014). According to a Center for Disease Control and Prevention Morbidity and Mortality Weekly Report, the widespread consumption of these products has led to sleep deprivation and work impairment (Centers for Disease Control and Prevention, 2012). This data can allow for recommendations for medical treatment, public health education on the associated risks, and recommendations for regulation on the sales of these products. Currently, the consumption of energy drinks is socially acceptable as the risks are generally unknown.

Energy drinks have similar nutrition value as soda, only with a higher level of caffeine and other energy boosters such as guarana, taurine, sugar, ginseng, and bitter orange. A 12-ounce serving of one popular brand of energy drink contains 160 calories, 42 grams of carbohydrates, and 41 grams of sugar with another having 210 calories, 46 grams of carbohydrates, and 46 grams of sugar (Sifferlin, 2013). Each listed energy ingredient has its own health risks. Guarana can cause “insomnia, nervousness, restlessness, rapid heart rate, tremors, anxiety, chest pain, and dysrhythmia” (Rath, 2012). The amount of sugar found in these drinks can cause dental erosions, cavities, diabetes, and obesity (Rath, 2012). Taurine, a non-essential amino acid can cause a negative nitrogen balance, which may lead to a decrease in a metabolic efficiency and can disrupt
a person’s kidney functions (Haas, 2015). Individually these ingredients have side effects so when combined in the amounts that are contained in energy drinks, they may have exponential negative health effects.

The Institute of Medicine states that “a wealth of unanswered questions remain about exposure to caffeine in food and dietary supplements and the consequences of that exposure especially in certain potentially vulnerable populations such as children and adolescents” (Pray, Yaktine, & Pankevich, 2014). Any negative health effects that are found to be related with energy drinks and society then begin to associate these products with danger to their health, people may support not drinking or limiting these products. At this time, society supports the drinking of highly caffeinated beverages and until the potential health risks outweigh the social norm, consuming these beverages should be considered a potential public health risk.

**Research Questions and Associated Hypothesis**

The research questions that were addressed in the systematic review were: 1) Are there any health effects associated from the consumption of energy drinks? 2) Should the FDA regulate the sales of energy drinks? This paper was based on the theory that there are health effects or health risks associated with the consumption of energy drinks. The hypothesis for this systematic review is: “If a subject consumes energy drinks, there is a potential for health effects.” The null hypothesis will be that there are not any health effects found related to the consumption of energy drinks. The independent variable will be the presence or absence of energy drink consumption and the dependent variable will be health effects.

\[ H_0: \mu_d = 0 \text{ (there are no health effects related to consuming energy drinks)} \]
H₁: μd <> 0 (there are health effects related to consuming energy drinks)

**Background Literature Review**

**Search Strategy**

The Academic Search Primer was used for the background literature review using the Boolean/Phrase operator with and “energy drink,” and “health,” and “effects,” and “public health,” and “caffeine,” not “alcohol,” not “animal study.” The search was limited to only English-language and scholarly or peer-reviewed articles. In order to have recent studies the article search was limited to the years of 2010 through 2015. Google and Google Scholar were similarly searched for articles and they were considered with similar inclusion and exclusion criteria as above.

**Theoretical Foundation**

Providing the structure and the rationale for research projects, theories are an important element in both qualitative and quantitative research. For this research on the health effects of energy drinks, two theories that were used were the Theory of Reasoned Action (TRA) and the Theory of Planned Behavior (TPB). Both of these theories follow the theory that an individual’s behavioral intention is based on the individual’s motivation (DiClemente, Salazar, & Crosby, 2013, pp. 67-72). Icek Ajzen and Martin Fishbein first introduced TRA in 1980 as a value-expectancy model of health behavior (Ajzen & Fishbein, 1980). In 1985 the TRA was updated to the TPB as Fishbein and Ajzen found that not all behavior is voluntary and under an individual’s control (University of Twente, 2010). TPB still follows the same ideals of TRA but adds that behavior can be planned and deliberate if the individual decides that this is the health behavior that they choose. These two health behavior theory models where chosen
because they both can be used to help understand the choice an individual makes to consume energy drinks. TPB is an extension of the TRA and can answer the question of why an individual will consume energy drinks even if it is found that they contain negative health effects or to make the choice to not consume them.

As a value-expectancy theory, TPB states, “an individual’s belief about a health behavior that is within their control and the behavioral intent, can predict their actual behavior” (Riverside Community Health Foundation, n.d.). The intention is determined by the individual’s attitude toward the behavior and the individual’s beliefs regarding other people’s support of this behavior and the individual’s desire to comply with others (DiClemente, Salazar, & Crosby, 2013, p. 66). People will elect to stop or limit drinking energy drinks if the health costs are outweighed by the benefits of personal beliefs. If an individual feels that others around them support the behavior it may be harder for them to make the decision to not consume them anymore. The main issue with energy drinks is that they are marketed as fun drinks that have beneficial therapeutic effects and are safe to drink.

Another issue with energy drinks is that they are highly marketed, easily accessible, and socially accepted. They are promoted as products that increase performance, focus, concentration, and speed (Substance Abuse and Mental Health Services Administration, Center for Behavioral Health Statistics and Quality, 2013). However, the health benefits and safety of these products have been under question and the Institute of Medicine (IOM) states that “a wealth of unanswered questions remain about exposure to caffeine in food and dietary supplements and the health consequences of that exposure especially in certain potentially vulnerable populations such as children.
and adolescents” (Pray, Yaktine, & Pankevich, 2014). A hypothesis regarding the consumption of these highly caffeinated drinks is that there are negative health effects related to their consumption. If individuals become aware of the negative health effects, it will be necessary for them to realize that the risks of consuming energy drinks outweigh the benefits and make a decision to quit.

The TRA and TPB have been used in previous studies of human behavior. When TPB was applied to risky alcohol usage among college students it found that “self-efficacy, attitudes, and subjective norms significantly predicted baseline intention, which in turn predicted future heavy episodic drinking” (Collins, Witkiewitz, & Larimer, 2011). The participants in this study were 837 randomly selected college students at two U.S. universities on the West coast. Of the participants, 64.2% were female. In this three-month study, the authors tested the TPB as a predictor of growth in risky college drinking. They found that TPB is a true predictor of risky college drinking of alcohol.

Performing this research project was justified by the fact that if there are any negative health effects identified through this systematic review that are caused by drinking energy drinks may encourage people to stop drinking them. If there are negative health effects found with consuming energy drinks and society begins to associate these products as a danger to health, people will support not drinking these products. As it stands, these drinks have a social reputation of being hip, delicious, and energy boosting. Currently society supports the drinking of caffeinated beverages. As long as it is socially acceptable, it is the theory that an individual will not stop drinking energy drinks until the health costs are known. Given the current culture that we are living in, this may take a long time.
Literature Review Related to Key Variables or Concepts

Many of the studies that were found on energy drink consumption focused their studies on certain a population such as children, adolescents, young adults, military members, or college students. Based on the research question of “What are the health effects of energy drinks?” and using the search strategy listed above, there were twenty-two articles that can be used for a systematic review. This systematic review was limited to quantitative studies. During the search, there was only one article that was found that described a qualitative study on the health effects of energy drinks. After completing a literature review, most of the articles that were found relating to this topic discussed statistics from medical reports of diagnoses after consuming an energy drink, not peer-reviewed articles on qualitative findings. To address the research question of the health effects of energy drinks, quantitative research allowed for testing the hypothesis that energy drinks cause health effects. The cause and effect statistics of drinking energy drinks that was found in the literature review were summarized and those generalized findings have been applied to other populations in their research.

While other researchers have focused their study to a population (i.e. college students), one of the studies was a quantitative study on all ages that have consumed energy drinks and sought medical attention for either acute or chronic health disorders. This study by Seifer et al., found that energy drinks have been associated with serious adverse effects such as seizures, diabetes, cardiac abnormalities, mood disorders, and behavior disorders (Seifer, et al., 2013). Energy drinks have also been associated with increased anxiety but not depression or stress in young adult males (Trapp, Allen, O'Sullivan, Robinson, Jacoby, & Oddy, 2014). Energy drink consumption was found to
be associated with abuse of other substances such as tobacco and alcohol (Gallimberti, et al., 2013). Further research into the possible contribution of energy drink consumption and the long-term risk of developing mental health problems should be examined. The impact of energy drinks on mental and physical health remains unknown and the therapeutic benefits that energy drink manufacturer’s claim need to be also examined.

The popularity of energy drinks continues to increase, especially with teenagers and young adults. Prior to 2012, the sales of energy drinks to this population alone accounted for $2.3 billion in sales (Rath, 2012). Greater frequency of energy drink use was associated with poorer sleep quality, longer sleep latency, shorter sleep duration, and lower habitual sleep efficacy (Stasio, Curry, Wagener, & Glassman, 2011). According to the National Sleep Foundation, sleep is essential for a person’s health and wellbeing (American Psychological Association, 2015). Particularly with this age group, it is imperative to obtain adequate sleep while the human brain develops. More research into the effects of energy drink use on the developing brain appears to be warranted.

As with other substances, as the human body acclimates to higher levels of caffeine, it will require more consumption of to have any perceived therapeutic benefit. This is also known as caffeine tolerance, which is a common term associate with the body’s response to caffeine intake (Zar, n.d.). This tolerance is acquired over time and as the body becomes accustomed to these products, it requires more caffeine for alertness (Rath, 2012). Health care practitioners need to be aware of the increasing popularity of these drinks and they should be prepared to educate the public on their health effects. As has been demonstrated with other caffeinated beverages, as people build up a tolerance to energy drinks the intake may gradually increase over time.
Methodology

In this study, a systematic review research design was used in order to summarize the health effects of energy drinks on those who consume them. Utilizing a systematic review allowed for a collection and review of existing literature on energy drinks and synthesized their findings to answer the research questions. This literature review of quantitative peer-reviewed research articles allowed the hypothesis for this systematic review of: If a subject consumes energy drinks, there is a potential for health effects to be answered. The null hypothesis was that there are not any health effects found related to the consumption of energy drinks. The independent variable was the presence or absence of energy drink consumption and the dependent variable was health effects. The results of this systematic review allowed for a recommendation regarding the need for warning labels on energy drinks since there was a finding of negative health effects.

Inclusion and Exclusion Criteria

Please refer to Table 1 for a list of inclusion and exclusion criteria.

Table 1

Inclusion/Exclusion Criteria

<table>
<thead>
<tr>
<th>Inclusion Criteria</th>
<th>Exclusion Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy drink articles</td>
<td>Not animal testing studies</td>
</tr>
<tr>
<td>Population: All ages</td>
<td>Non-English language articles</td>
</tr>
<tr>
<td>Health effects from consumption</td>
<td>Study articles written prior to 2010</td>
</tr>
<tr>
<td>English language articles</td>
<td>Energy drink studies when mixed with alcohol</td>
</tr>
<tr>
<td>Full text available</td>
<td>Qualitative studies</td>
</tr>
<tr>
<td>Peer reviewed study articles</td>
<td>Commentary articles</td>
</tr>
<tr>
<td>All study types including randomized control trials (RCT)</td>
<td></td>
</tr>
<tr>
<td>Articles written in years 2010-2015</td>
<td></td>
</tr>
<tr>
<td>Quantitative studies</td>
<td></td>
</tr>
</tbody>
</table>

Please refer to Table 2 for the results of the electronic search
Table 2

Electronic Search Results

<table>
<thead>
<tr>
<th>Search Engine Used</th>
<th>Search Terms</th>
<th>Number of Studies identified</th>
<th>Number of Studies Excluded</th>
<th>Exclusion Criteria Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Search Premier Boolen/Phrase</td>
<td>Energy Drinks And Health And Effects And Caffeine And Public Health Not Animal Not Alcohol Peer-Reviewed Full Text</td>
<td>23</td>
<td>8</td>
<td>Not Animal English Only Alcohol Commentary Prior to 2010</td>
</tr>
<tr>
<td>CINAHL Boolen/Phrase</td>
<td>Energy drinks And Health And Effects Not Animal Not Alcohol Peer-Reviewed Full Text</td>
<td>11</td>
<td>5</td>
<td>Not Animal English Only Alcohol Commentary Prior to 2010</td>
</tr>
</tbody>
</table>

Number of duplicate articles: 7

Full Text Articles excluded after review due to being commentary: 3

Data Analysis Plan

After performing a literature review, there were thirty-four articles using the electronic search using two different search engines. After removing seven articles that were duplications between the two search engines, there were twenty-seven articles left to screen. Of these articles, twelve were excluded, as they were commentary articles such as an article that discussed the need for a ban on energy drinks in school vending
machines or on the role of marketing on the sales of energy drinks. These qualitative articles did not fit the criteria of quantitative research articles and were excluded. This left fifteen full-text articles for reviewing. Upon further examination, even though “not alcohol” was used during the initial search there were three articles that were excluded for the reason that they discussed the practice of mixing energy drinks with alcohol in their results. After the inclusion and exclusion criteria were met, twelve quantitative articles remained to continue the systematic review on the topic of health effects of energy drinks.

Data analysis included the design of the research, the main argument of the research article, the key concepts, the study sample size, and the results of the research, which is listed in Table 3. Examples of the key concepts and results that were analyzed in this paper were 1) the number of subjects that reported to emergency departments with complaints of health effects after consuming energy drinks, 2) the number of subjects that visited their health care provider with complaints of symptoms with a history of energy drink consumption, 3) the different types of diagnoses related to energy drink consumption, and 4) the characteristics of the population that consumes energy drinks.

Please refer to Figure 1 for the results of inclusion and exclusion criteria.
Figure 1. Results of Inclusion and Exclusion Criteria.

Table 3

Included Studies and Effects

<table>
<thead>
<tr>
<th>Author(s) and Year</th>
<th>Research Design</th>
<th>Main Argument/Hypothesis</th>
<th>Key concepts/assumptions</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seifert, et al. (2011)</td>
<td>Literature review</td>
<td>1) To determine what energy drinks are. 2) Compile consumption data of energy drinks</td>
<td>Wide use of energy drinks by this age group. Caffeine can be tolerated in</td>
<td>1) Energy drinks are consumed by 30-50% of adolescents and young adults. 2) The amount of caffeine in energy drinks is not regulated. 3) Energy drinks have been</td>
</tr>
</tbody>
</table>
There is a danger of health effects associated with consuming energy drinks. There is a high rate of energy drink consumption among adolescents and young adults. 

Energy drinks have become popular among adolescents and young adults. There are health effects associated with consumption of these beverages. 

1) Teens and young adults account for nearly $2.3 billion in energy drink sales. 
2) Popularity of energy drinks among adolescents and young adults continues to increase. 
3) This age group is attracted to energy drinks due to the perceived benefits yet are unaware of their adverse health effects. 
4) The body becomes accustomed to these products and requires more caffeine for alertness. 
5) Side effects include: headache, anxiety, irritability, agitation, lightheadedness, tremors, confusion, psychosis, seizures, and altered mental status, heart palpitations, chest pain, tachycardia, dysrhythmias, hypertension, 

Rath, M (2012) Literature review 

There is a high rate of energy drink consumption among adolescents and young adults. 

Energy drinks contain high amounts of caffeine, taurine, sugars and sweeteners, herbal supplements, and other ingredients that may not be healthy for children. 

4) Adverse effects are associated with seizures, diabetes, cardiac abnormalities, mood and behavioral disorders. 
5) Of the 5448 US caffeine overdoses reported in 2007, 46% were under 19 years old. 
6) Several counties and states have debated or restricted the sales and advertising of energy drinks. 
7) No therapeutic benefit. 

There are health effects associated with consumption of these beverages. 

4) Compile caffeine and energy drink overdose data. 
4) Examine the physiologic effects of the ingredients in energy drinks. 
5) Identify potential problems of energy drinks among children and adolescents. 
6) Assess the marketing of energy drinks. 
7) Report current regulation of energy drinks. 
8) Propose educational, research, and regulatory recommendations. 

There is a danger of health effects associated with consuming energy drinks. There is a high rate of energy drink consumption among adolescents and young adults.
Seifert, et al. (2013) | Meta-Analysis
---|---
Examination of calls to the US National Poison Data System (NPDS) to assess the incidence and outcomes of toxic exposures to caffeine-containing energy drinks.
To evaluate the effect of regulatory actions and educational initiatives on the rates of energy drink exposures.

Beverages containing high levels of caffeine and other stimulants will result in calls to the NPDS.
There will be health effects related to the consumption of energy drinks that resulted in calls to the NPDS.

1) Of 2.3 million calls to the NPDS, 4854 (0.2%) were energy drink related.
2) 3192 (65.8%) cases involving energy drinks with unknown additives (i.e. alcohol) were excluded.
3) Of 1480 non-alcoholic energy drink cases, 50.7% were children <6 years old; 76.7% were unintentional; and 60.8% were males.
4) Major adverse health effects consisted of three seizures, two non-ventricular dysrhythmias, one ventricular dysrhythmia, and one tachypnea.
5) 68.2% were <20 years old. 50% of the calls of energy drink toxicity involved unintentional exposure by children <6 years old.

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**Results**

**Data collection**

A quantitative systematic review was conducted to examine the health effects of energy drinks to determine if there are any potentially harmful health effects related to the consumption of these drinks. A Boolean/Phrase search was completed using the search engines: Academic Search Primer and the Cumulative Index to Nursing and Allied Health Literature (CINAHL). Studies that were included in this systematic review had to meet the following criteria: English-language and scholarly or peer-reviewed articles that were published in a journal within the last five years that contained hyper-stimulation of the gastrointestinal tract, and gastro-esophageal reflux.
quantifiable information on the health effects or therapeutic effects of energy drinks. The search criteria included the following terms: Energy drinks, health, effects, public health, and caffeine. Studies that discussed the health effects of mixing energy drinks with alcohol were excluded along with any systematic reviews and any studies that involved animals in the process of the study. After the initial search engines and terms were used, thirty-four articles were identified and twenty-five of them were excluded, nine remained for data extraction.

The nine remaining quantitative articles were reviewed for their characteristics to see if each article has sufficient and quality data that are appropriate for a systematic review to answer the research questions being asked in this study. After this process, three articles were excluded due to a low methodology score of two or below. The articles that received a methodology score of three or above remained in the systematic review. This left six articles to extract data from. The number of studies analyzed for data extraction is presented in Figure 1.

**Figure 1:** Process to select studies for inclusion in the systematic review.
Results

The included articles were reviewed for the purpose of extracting and qualifying the data that was presented in each article. A table was used to list the characteristics of the included study and allow for a quality scoring process. This table included: The names of the article’s authors, setting of the study, design of the study, sample size, population, intervention used, primary outcomes, and the quality score. The quality score, also known as a methodology score was determined by adding points based on the type of study design that was used and points for each of the following criteria: The problem of the study was clearly identified in the article, the effects measure in the study were clearly identified, the efforts that the authors made to minimize bias in their study was identified, and if the limitations of the study were identified. In the nine articles that were reviewed, only one of them clearly identified any efforts made to minimize any bias during the study. This process was used to eliminate three studies for low quality score of less than three. This left six study articles that received a score of three or higher to be used for the purpose of this systematic review on the health effects of energy drinks.

Please see Table 1 for the data extraction and quality score results.

Table 1
Characteristics of Included Studies

<table>
<thead>
<tr>
<th>Study (Authors name)</th>
<th>Setting</th>
<th>Study Design</th>
<th>N</th>
<th>Population</th>
<th>Intervention</th>
<th>Primary Outcomes</th>
<th>Quality Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Drink Consumption is Associated With Anxiety in Australian Young Adult Males (Trapp, Allen, O'Sullivan, Robinson, ...)</td>
<td>Public Antenatal Clinic and Local Health Clinics in Perth, Western Australia.</td>
<td>Cohort Study</td>
<td>1,069</td>
<td>502 Males and 567 Females. (Mean age = 20 ± 3 years). Members of the Western Australian Pregnancy Cohort (Raine) Study that followed participants from gestation to early adulthood</td>
<td>Self-Report questionnaire to assess energy drink consumption and mental health using the Depression Anxiety Stress Scale-21</td>
<td>Energy drink consumption was associated with increased anxiety but not depression or stress in</td>
<td>4</td>
</tr>
<tr>
<td>Study Title</td>
<td>Author(s)</td>
<td>Year</td>
<td>Study Design/Participants</td>
<td>Method/Findings</td>
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<td>---------------------------------------------------------------------------</td>
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<tr>
<td>Revving up and Staying up: Energy Drink Use Associated With Anxiety and Sleep Quality in a College Sample</td>
<td>Jacoby and Oddy</td>
<td>2013</td>
<td>College/University</td>
<td>107 young adult males. Questionnaire that used the Beck Anxiety Inventory, the Pittsburgh Sleep Quality Index, and questions related to caffeinated beverage usage and Regression Analyses. Energy drink use explained 29% of the variance in anxiety scores and 20% in sleep disturbance scores.</td>
<td></td>
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<tr>
<td>An Analysis of Energy Drink Toxicity in the National Poison Data System</td>
<td>Stasio et al.</td>
<td>2011</td>
<td>Examinations of calls to the US National Poison Data System</td>
<td>4854 calls to US NPDS related to energy drink consumption. All calls made in the United States to the NPDS between October 1, 2010 and September 30, 2011 all ages. Review of phone calls. Of 2.3 million calls to the NPDS, 4854 (0.2%) were energy drink related. Major adverse health effects consisted of three seizures, two non-ventricular dysrhythmias, one ventricular dysrhythmia, and one tachypnea.</td>
<td></td>
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<tr>
<td>The Effect of Energy Drink Consumption on One’s Heart Rate</td>
<td>Moothan</td>
<td>2013</td>
<td>Gym/laboratory Intervention Study</td>
<td>1 The subject was a 16-year-old female with BMI in the normal range (18.5-24.9) with a consumption frequency of energy drinks at 1-2 times a week, and a typical physical consumption of 80 mg of caffeine (1 250 ml can of Red Bull®). Physical activity on the treadmill for 2 minutes at a running speed of 4.5 km/h causes an increase in heart rate at rest as well as after.</td>
<td></td>
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<tr>
<td>activity level of low to moderate.</td>
<td>7 km/h.</td>
<td>physical activity.</td>
<td></td>
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<tr>
<td>Vital signs assessed.</td>
<td></td>
<td>Resting heart rate after consumption of energy drink increased by 5 beats per minute and 30 beats per minute with physical activity.</td>
<td></td>
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</tbody>
</table>

Consumption of an energy drink causes the heart rate to take longer to return to normal resting heart rate level after physical activity.

Post physical activity the heart rate took 8 minutes longer to return to normal levels after the consumption of an energy drink.

Heart rate peaked at 45 minutes after consuming
<table>
<thead>
<tr>
<th>Study Title</th>
<th>Setting</th>
<th>Method</th>
<th>Participants</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Drink Consumption and Associations With Demographic Characteristics, Drug Use and Injury Among Adolescents (Hamilton, Boak, Ilie, Mann) 2013</td>
<td>Ontario, Canada province school system</td>
<td>Data collected through the 2011 Ontario Student Drug Use and Health Survey, a province wide school based survey of students in grades 7-12. The survey was based on a two-stage cluster design and analyses that included appropriate adjustments for the complex sample design.</td>
<td>4,342 adolescents in 7-12 grades in Ontario, Canada school system.</td>
<td>Survey results were reviewed to examine how many students consumed energy drinks in the previous year and the health behaviors that were associated with energy drink consumption. 49.6% of the adolescents consumed energy drinks in the previous year. 13.8% of 7th graders consumed energy drinks in the previous week, compared to 19.1% of adolescents overall. The consumption of energy drinks is related to sensation-seeking activities and injuries.</td>
</tr>
<tr>
<td>Energy Drink Consumption and Its Association with Sleep Problems Among U.S. Service Members on a Combat Deployment-Afghanistan, 2010 (Centers for Disease Control and Prevention) 2012</td>
<td>Combat deployment in Afghanistan in 2010</td>
<td>Retrospective Cohort Study.</td>
<td>1,249 military members of all ranks and ages in Operation Enduring Freedom in Afghanistan 2010.</td>
<td>Survey results of how many military members drank energy drinks and the side effects found from drinking these products. The prevalence of energy drink usage was 44.8%; 13.9%-consumed 3 or more drinks per day. Those who consumed 3 or more a day slept ≤4 hours a night and had a diagnosis of sleep pattern.</td>
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<td>Is Energy Drink Safe? A Cross-Sectional Study on the Effects of Energy Drink on Medical Students From a Medical School of Nepal (Banerjee, Pugazhandhi, Sathian, Nagpal, Roy) 2015</td>
<td>Manipal College of Medical Sciences, Pokhara, Nepal.</td>
<td>Cross-Sectional questionnaire Study</td>
<td>206 students were given the questionnaire, 202 Students completed the survey, which found 88 (43.56%) consumed energy drinks.</td>
<td>Medical students in Nepal</td>
</tr>
</tbody>
</table>

| Methodologic and Metabolic Considerations in the Study of Caffeine-Containing Energy Drinks (Shearer) 2014 | Biochemistry Lab Analysis of ingredients on body. A review of systems. None. Review of systems. | Studies on the action of caffeine-containing energy drinks on gastrointestinal tract, liver, and skeletal muscle. | Energy drinks have been found to: Salivary glands: increase salivary secretions. Liver: Increase glucose uptake, lactate production, and fat oxidation. Large intestine: Gut microbiota incretin | Study not included |
| Effects of a Caffeine-Containing Energy Drink on Simulated Soccer Performance (Del Coso, Munoz-Fernandez, Munoz, Fernandez-Elias, Ortega, Hamouti, Barbero, Munez-Guerra) 2012 | University Athletic Lab in Spain | Experimental Study Design | Semiprofessional soccer players from the same team. Mean standard deviation age of 21 ± 2 years, body mass of 67 ± 2 kg, height of 173± 6 cm and maximal heart rate of 197 ± 12 bpm. All participants had previous soccer experience of at least 5 years, were non-smokers, and all were light caffeine users (< 60 mg per day) | 630±52 mL of a caffeinated energy drink that was sugar-free to provide 3 mg of caffeine per kg of body mass, or a decaffeinated control drink. After 60 minutes they performed a jump test, repeated sprint test and played a simulated soccer game. Post-exercise urine test was completed to assess the amount of caffeine that was concentrated in the urine. | Those who drank the energy drink increased mean jump height (control = 34.7±4.7 versus 35.8±5.5 cm for energy drink), mean running speed increased control = 25.6±2.1 versus 26.3±1.8 km for energy drink), total distance covered at a speed higher than 13 km/hr. (control group = 1205±289 versus 1226±232 km) | 2 Study not included |
energy drink consumption of 100 mL a day was significantly associated with increased energy drink consumption. This study examined how drinking energy drinks can lead to anxiety and other mental health diagnoses in a population-based sample of 1,069 young adults that were participating in the Western Australian Pregnancy Cohort (Raine) Study. They found that in the article, the effects measure in the study were clearly identified, the efforts that the authors made to minimize bias in their study was identified, and if the limitations of the study were identified.

The first study that was selected for this systematic review is by Trapp et al. (2013). This study examined how drinking energy drinks can lead to anxiety and other mental health diagnoses in a population-based sample of 1,069 young adults that were participating in the Western Australian Pregnancy Cohort (Raine) Study. They found that energy drink consumption of 100 mL a day was significantly associated with increased energy drink consumption. This study examined how drinking energy drinks can lead to anxiety and other mental health diagnoses in a population-based sample of 1,069 young adults that were participating in the Western Australian Pregnancy Cohort (Raine) Study. They found that in the article, the effects measure in the study were clearly identified, the efforts that the authors made to minimize bias in their study was identified, and if the limitations of the study were identified.

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anxiety in young adult males, but not depression. The second study in this systematic review, conducted by Stasio et al. (2011) examined energy drink consumption with anxiety and sleep quality in a 7-day retrospective study of 107 young adults at a college. Using regression analysis, they found that there was a 29% variance in those who consume energy drinks and anxiety scores and 20% variance in sleep disturbance scores.

The third study article used in this systematic review by Seifert et al. (2013) is an analysis of calls made to the National Poison Data System (NPDS) that were related to energy drink consumption during the time period of 01 October 2010 and 30 September 2011. This analysis found that 0.2% of the 4854 calls made to the NPDS during this time period were related to energy drinks, some with serious medical conditions. The authors found that areas of the country with these programs had significantly less calls made to the NPDS (p=0.036). The fourth article selected for this systematic review is an intervention study by Moothan (2013) found that the participant’s heart rate took longer to return to resting heart rate with the introduction of an energy drink.

The fifth article in this systematic review is a retrospective cohort study that examined energy drink consumption and the association with sleep quality among U.S. service members that were on a combat deployment in Afghanistan in 2010. The research was reported by the Centers for Disease Control and Prevention in a Morbidity and Mortality Weekly Report in 2012. The study that included 1,249 military members in a cluster sample of randomly selected U.S. Army and Marine combat platoons found that those who reported drinking three or more energy drinks per day were 38% more likely to get four hours or less of sleep per twenty-four hour period than those who did not consume energy drinks (23.9%). The sixth article selected for this systematic review
is a cross sectional study on the effects of energy drinks on medical students from a medical school in Nepal by Banerjee et al. (2015). This study examined the results of a survey that was completed by 202 medical students and found that 43.56% of them drink energy drinks and report autonomic, neurologic, psychiatric, cardiovascular, and gastrointestinal complications. The authors also reported the need for continued studies to evaluate the long-term effects of energy on both the physical and psychological well being of consumers.

Table 2 provides a brief description of each study that was used in my systematic review and their results. The articles that scored lower than a three on the quality score have been removed. Due to the wide assortment of possible health effects that energy drinks may have on the body, a systematic review was an appropriate study design to gather data from the last five years for analysis. There were cohort, interventional, and cross-sectional studies regarding mental health issues, sleep disturbance issues, cardiac issues, and other health effects that were found related to the consumption of energy drinks. In each study the interventions and measures were different, but the results were significant enough to warrant concern regarding the consumption of energy drinks and the resulting health effects.

**Table 2: Results of Included Studies**

<table>
<thead>
<tr>
<th>Author</th>
<th>Quality Score</th>
<th>Intervention</th>
<th>Measures</th>
<th>Results</th>
<th>Significance</th>
</tr>
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<tbody>
<tr>
<td>Trapp et al. 2013</td>
<td>4</td>
<td>Self-report questionnaire about amount of energy drink consumption</td>
<td>Depression Anxiety Stress Scale -21 (DASS) score</td>
<td>This relationship was found only in males. ( \beta = 0.32; 95% CI= 0.05, 0.58 )</td>
<td>Yes &lt;0.05</td>
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<tr>
<td>Stasio et al. 2011</td>
<td>4</td>
<td>Self-report on caffinated beverage use.</td>
<td>Beck Anxiety Inventory (BAI)</td>
<td>Frequency of energy drink consumption was positively correlated with BAI scores, ( r=0.54, p&lt;.001 ) and PSQI global scores, ( r=0.44, p&lt; )</td>
<td>Yes &lt;0.05</td>
</tr>
<tr>
<td>Study (Year)</td>
<td>Study Design</td>
<td>Outcome</td>
<td>Findings</td>
<td></td>
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<td>-------------</td>
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<tr>
<td>Seifert et al. (2013)</td>
<td>Call analysis</td>
<td>All unique cases of energy drink calls made to the National Poison Data System from Oct 1, 2010 to Sept 30, 2011</td>
<td>Educational and legislative initiatives to enhance understanding of the health consequences of energy drink consumption were significantly associated with a decreased rate of energy drink related cases (p=0.036)</td>
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<tr>
<td>Moothan (2013)</td>
<td>Consumption of 250 ml energy drink with 80 mg of caffeine.</td>
<td>Heart rate after physical activity both with and without the consumption of energy drink</td>
<td>Average heart rate at rest =64 beats per minute (bpm), average heart rate at rest after consuming energy drink =69 bpm. Average heart rate after running without caffeine =133.3 bpm, average heart rate after running with energy drink = 163 bpm</td>
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<tr>
<td>Centers for Disease Control and Prevention (2012)</td>
<td>Deployment Well-Being Survey</td>
<td>Sleep quantity and quality, Energy drink consumption amount</td>
<td>Those who reported drinking energy drinks also took sleeping medications (p=0.02) Slept 3-4 hours per night (p= &lt;0.001) Fell asleep while on guard duty (p= 0.02) Fell asleep sometimes/often while sitting in briefings (p= 0.01) Had a high concern about lack of sleep (p=0.68) Were prescribed sleep medications while on deployment (p=0.60) Fell asleep while riding in convoys (p=0.12)</td>
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<tr>
<td>Banerjee et al. (2015)</td>
<td>Self-Report Cross-Sectional Questionnaire</td>
<td>Central nervous system (CNS), Gastrointestinal tract (GIT), Cardiovascular system (CVS), Autonomic Nervous System (ANS) manifestations</td>
<td>Logistic regression analysis: CNS manifestations of headache and insomnia were more prevalent in males [OR 1.836, 95% (CI 0.458, 7.367)] and [OR 1.214, 95% (CI 0.517, 2.852)] as compared to females.</td>
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</table>
Each of the six included articles used different ways to express and measure their outcomes. There were odds ratios, p-values, heart rate beats per minute, ratios, percentages, and t-values. Determining if there was a confidence interval and statistical significance found within each article was necessary to conclude if there are health effects related to the consumption of energy drinks. A statistical significance is the result of a quantitative study that is not attributed to chance (Sullivan, 2012). The outcome of this process positively correlated that there are some health effects related to the consumption of energy drinks.

By using a 95% confidence interval, all of the articles found that there was a correlation between the consumption of energy drinks and health effects but not all of the health effects were statistically significant as seen in Table 2. The article by Trapp et al. (2013) found that there was a statistical significance in relation to anxiety in males but did not find a statistical significance regarding female or depression in either males or females. It did find that energy drink consumption was associated with increased anxiety in young adult males and warrants further research into the possible contribution of energy drink consumption with the development of mental health issues.

Another article that found differences in their results was the research conducted by the Centers for Disease Control and Prevention (2012). They found that those who consumed energy drinks also were found to be taking sleeping medication while on deployment, slept only three to four hours a night, and fell asleep easily in meetings and
while on guard duty. While these findings have significant value, their research also found that there was not a scientific significance found to be related to energy drink consumption and prescription sleeping medications being prescribed while on deployment, participants who drank energy drinks having a high concern related to lack of sleep, and falling asleep while riding in a convoy. Banerjee et al (2015) used an odds ratio to determine that the health effects that were statistically significant were dizziness, headache, sleep issues, and diarrhea. While the health effects that were found to not be statistically significant were seizures, nausea, chest pain, and dry mouth.

The included articles have determined that there is statistical significance of some health effects related to the consumption of energy drinks but the articles also proved that energy drinks affect people differently. The purpose of this systematic review is to take these findings and generalize them for a greater population. Figure 2 highlights the studies that find that there is an association between the exposure to energy drinks and the outcomes and those that did not have this finding after consuming energy drinks. It also highlights the studies that are most reliable and significant to the public health concern in regards to the consumption of these products.
Figure 2 highlights the findings of the studies and whether or not there were health effects related to the consumption of energy drinks. The quantitative research articles written by Trapp et al. (2013) and Banerjee et al. (2015) found that there were some health effects that were significant and some health effects that were found to not be significant after drinking energy drinks. All of the six research articles found that there were some significant health effects related to the consumption of energy drinks.

Knowing that there are health effects found from consuming energy drinks, there is a

<table>
<thead>
<tr>
<th>Studies that suggest no health effects from consumption of energy drinks:</th>
<th>Studies that suggest health effects from consumption of energy drinks:</th>
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</thead>
<tbody>
<tr>
<td>• Trapp et al (2013): Energy drink consumption was not related to depression or stress and found that there was no relation to anxiety, depression, or stress among females.</td>
<td>• Trapp et al. (2013): Energy drink consumption was related to anxiety in young adult males.</td>
</tr>
<tr>
<td>• Banerjee et al. (2015): Energy drink consumption was not related to seizures, chest pain, dry mouth, or nausea.</td>
<td>• Stasio et al. (2011): Energy drink consumption was related to anxiety and poor sleep quality.</td>
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<tr>
<td></td>
<td>• Seifert et al. (2013): Energy drink consumption was related to increase in calls to the National Poison Data System and legislative and education initiatives have decrease the rate of energy drink toxicity calls.</td>
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<tr>
<td></td>
<td>• Moothan (2013): Energy drink consumption raised both resting heart rate and heart rate with exercise.</td>
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<tr>
<td></td>
<td>• The CDC (2012): Energy drink consumption was related to less sleep, having more sleep disruptions from stress and illness, and falling asleep on guard duty and in briefings.</td>
</tr>
<tr>
<td></td>
<td>• Banerjee et al. (2015): Energy drink consumption was related to headaches, dizziness, insomnia, and diarrhea.</td>
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</table>
need to consider the public health importance related to these findings. Figure 3 below discusses the public health importance of this study.

What is already known on this topic?

Energy drinks are beverages that contain high levels of caffeine and other stimulants and have become an increasingly popular choice of beverage, especially among adolescents and young adults, especially males. One average sized energy drink can have enough caffeine to equal five cups of coffee. These drinks have a social reputation of being hip, delicious, and energy boosting. Currently, society supports the drinking of caffeinated beverages and until the potential health risks outweigh the social norm, consuming these beverages should be considered a potential public health risk.

What is added by this systematic review?

Energy drinks are found to produce neurologic, psychiatric, cardiovascular, and gastrointestinal health effects. Energy drinks can cause anxiety, poor sleep quality, headaches, dizziness, diarrhea, and they can cause an increase in resting and exercise heart rate. Energy drinks were not found to be related to depression or stress and they were not found to be related to chest pain, seizures, dry mouth, or nausea.

What are the implications for public health practice?

The result of this systematic review justifies the need for energy drinks to be regulated by the Food and Drug Administration and it is recommended that warning labels be placed on the beverages that are sold as an energy drink. There is also the need to continue to research long-term health effects of energy drinks. Health care providers need to be made aware of the potential health effects related to energy drink consumption.

Figure 3. Public health implications.

Conclusions

Interpretation of the Findings

For this systematic review, data was collected to determine if there are health effects related to the consumption of energy drinks. It analyzed the outcomes of six previously conducted research studies that were done on subjects who consumed different types of these beverages. The findings of the literature review and data analysis
confirm that health effects are related to these drinks, however it also found that there are some health effects that are not significantly related. These findings are consistent with existing literature on this topic. The results did not to refute any previous findings; it was found that the results strengthened the previous research that has been done on this topic. The interpretation of the findings cannot be related to long-term health effects, as none of the current studies have been able to determine this issue as energy drinks have only recently been introduced to the beverage market.

The results of this systematic review justify the need for energy drinks to be regulated by the Food and Drug Administration and it warrants a consideration to place warning labels on the beverages that are sold as energy drinks. As the popularity of energy drinks continue to increase, these health effects can be considered a public health concern. The findings substantiate that there are enough health effects to warrant education for the public so that they are knowledgeable on the potential risk before they make the decision to consume them.

The findings of this systematic review addresses the two theoretical frameworks of the Theory of Reasoned Action and the Theory of Planned Behavior which states that if people are not aware of the risks associated with energy drinks they are not making an informed decision when consuming these beverages. Both of these theories follow the theory that an individual’s behavioral intention is based on the individual’s motivation (DiClemente, Salazar, & Crosby, 2013, pp. 67-72). If these drinks are regulated and there are warning labels placed on them, it may change a person’s behavior and they may decide that the health risks outweigh the benefit of other therapeutic responses to the drinks. People will elect to stop or limit drinking energy drinks if the health costs are
outweighed by the benefits of personal beliefs. Health care providers also need to be aware of the health risks so that they can educate their patients and be aware of potential health symptoms that they could diagnose in their patients and to be prepared to care for them.

**Limitations of the Study**

This systematic review has added to the body of knowledge of public health by identifying potential health risks of consuming energy drinks but the research is not without limitations. Significant limitations that need be considered were the small sample size and the variety of study measurements that were used. After an extensive literature review, there were only six research studies that were found with quality data to be included for data analysis. In this systematic review, there was only one study that was performed by Moothan (2013) that measured physiologic vital signs on only one subject after only one trial of consuming an energy drink. The remaining studies used self-reports of manifestations of side effects after consuming energy drinks. Each individual that consumes an energy drink may have a different response to the drink depending on their history of caffeine intake, their age, and their co-morbidities. Since energy drinks are not regulated nor required to inform on the correct amount of caffeine per serving, it does not allow for a true estimation of caffeine intake. This can alter the results per serving if comparing one energy drink effects to another type of energy drink. The studies used in this systematic review focused on the demographics of primarily children, adolescents, or young adults, which does not allow the findings from this study to be generalized to a population that includes older adults.
The reliability of this systematic review is low as the different articles in this systematic review used different measurement tools to collect their data. While they all found that the highly caffeinated drinks had health effects, they each evaluated the health effects differently. Although the data that was collected for this systematic review was valid, they cannot be generalized to the population as a whole. Three of the six research studies that were included in this systematic review surveyed young adults in stressful environments, which may have resulted in additional side effects. The Centers for Disease Control (2012) surveyed U.S. service members on a combat deployment and Stasio et al. (2011) and Banerjee et al. (2015) surveyed students in a college setting which further limits being able to generalize the side effects to the general population.

While the six included research articles on the health effects of energy drinks received a quality score of three or higher, none of them included a description of the biases for their particular studies. Not having the ability to consider what these biases were for each study may have allowed for introducing personal bias in over-estimating or under-estimating the true results in this systematic review. Finally, energy drinks are relatively new to the beverage industry and there are limited studies available on their health effects, especially the long-term health effects. This may have led to not assessing all potential health effects that could be caused by the consumption of energy drinks.

**Recommendations**

The limitation of a small sample size of peer-reviewed research already conducted on this topic indicates the need for future research. Some areas that further research is recommended is: larger populations, longer-term studies, and further additional studies on the short-term and long-term psychological and physiologic effects related to energy drinks.
drink consumption. According to the research conducted by Stasio et al. (2011), more research is needed related psychological adjustment variables and energy drink consumption. This additional research on the use of high levels of caffeine and the development of mental health problems in a larger and more diverse population would be beneficial to add to the body of knowledge on this topic. Trapp et al. (2014) also recommends further research of any development of mental health issues in the population of young adults. As the population of energy drink consumers continue to age, it will be necessary to monitor them for health effects. The Morbidity and Mortality Weekly Report in 2012 recommended that there be further research conducted on military members who consume energy drinks both in and out of combat zones (Centers for Disease Control and Prevention, 2012). This population can be more vulnerable due to the potential high physical and emotional stress that is put upon them and the consumption of energy drinks may “tip a troop over from just feeling on edge to having a full- fledged panic attack” (Kime, 2013).

It is also recommended to examine sleep quality of those who consume these drinks, with both short-term and long-term consumption. Since these beverages are widely available to all consumers, at risk populations of children, elderly, and those with pre-existing physical and mental health conditions need to be considered in a study on these beverages, not only healthy young adults. If future research finds similar results to this limited systematic review, it would be recommended that the U.S. Food and Drug Administration regulate these products. Not only should the manufacturers be required to provide a product label with accurate ingredients in the beverage and serving size, it should also be a requirement that they are appropriately labeled with warnings of
potential side effects. Establishing an appropriate age requirement to sell these products to and regulating these sales is recommended as a way to decrease the consumption of energy drinks by the vulnerable population of children and adolescents.

As energy drinks are fairly new to the market and their popularity is continuing to increase, it is important to research any possible health effects and educate any potential consumers and their health care providers. The impact of energy drinks on mental and physical health remains unknown and the therapeutic benefits that energy drink manufacturer’s claim need to be examined. Seifert et al. (2013) found an association between educational campaigns and legal restrictions on the sale of energy drinks with a decrease in the number of calls to poison centers for energy drink toxicity. This education can allow consumers to be aware of potential health effects and health care providers to be aware of any symptoms of caffeine toxicity in their patients.

**Implications for Social Change:**

Potential social change that is appropriate from this study can be at the individual, societal and political levels. The Theory of Reasoned Action states that behavior can be planned and deliberate if the individual decides that this is the health behavior that they choose (Ajzen & Fishbein, 1980). For individuals, knowing the potential health effects can allow those who are finding these drinks common in their daily beverage intake to consider the health effects and decide if they want to continue consuming these beverages. It can also be beneficial to deter others from potentially starting the habit of drinking these beverages and make other choices. It can also allow parents to be knowledgeable about what they are allowing their children to consume and make educated beverage selections for their families.
On a societal level, energy drinks have become very popular as a quick energy booster. Because they are highly marketed and easily accessible, some may regard these drinks as a safe beverage choice. Given the overwhelming popularity among social cultures such as adolescents, high school students, college students, military members, and people that need to stay awake for long hours, it is clear that education is needed to change the attitude of social norms that energy drinks are also healthy drinks. As society becomes less accepting of the negative health effects of energy drinks, it is believed that this will cause less of the population to drink them.

At the political level, enforcing standards on how energy drinks are marketed to the younger population is important. These products are seen as food supplements with no current standards for regulation of these products existing in the United States. Some foreign countries have banned energy drinks; instituted regulations of energy drinks, or has put pressure on manufactures to responsibly market and sell their products (Wauters, 2015). As there is increasing evidence to prove potential negative side effects from the consumption of energy drinks, the United States needs to follow suit and regulate these products. There is also a need to legislate and institute educational programs on these products to be aware of their dangers. An example of this would be a social media campaign describing the potential health effects that targets a population, such as teens or college students. Another example would be an education campaign by the Department of Defense discouraging the use of energy drinks among military members due to the potential negative health effects, as poor sleep quality and anxiety can affect military readiness.

**Conclusion**
The findings of this systematic review answers the research questions of 1) are there health effects associated from the consumption of energy drinks? 2) Should the FDA regulate the sales of energy drinks? The results indicate that there are health effects from the consumption of energy drinks. While energy drinks give consumers the therapeutic benefit of increased stamina and energy, they come with neurologic, cardiovascular, gastrointestinal, psychological, and sleep quality negative health effects. While the sample size was small, each of the articles used in this systematic review indicated some sort of negative health effect and the need for future research into these products. This systematic review adds to the current body of knowledge regarding energy drink consumption in certain populations.

In regards to the research question of the need for regulation of the sales of energy drinks, the results indicate that there is a need for this type of oversight to protect consumers. In moderation, most consumers of energy drinks may have a short-term boost of energy or no adverse health effects but the long-term health effects are still inconclusive. It is important to continue further research into this topic and to educate the public that a safe dose of caffeine cannot be indicated for a person, as there is an individual response to the ingredients in energy drinks depending on their tolerance. It is imperative for anyone drinking energy drinks to be aware of the potential side effects and to also take into consideration any pre-existing health conditions that could be exacerbated by drinking these products. The Institute of Medicine states that “a wealth of unanswered questions remain about exposure to caffeine in food and dietary supplements and the consequences of that exposure especially in certain potentially vulnerable
populations such as children and adolescents” (Pray, Yaktine, & Pankevich, 2014), which indicates the importance to continue to conduct research on this topic.
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