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Implications of sleep and energy drink use for health disparities

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Abstract

The popularity of energy drinks has increased rapidly in the past decade. One of the main reasons people use energy drinks is to counteract effects of insufficient sleep or sleepiness. Risks associated with energy drink use, including those related to sleep loss, may be disproportionately borne by racial minorities and those of lower socioeconomic status. In this review, a brief introduction to the issue of health disparities is provided, population-level disparities and inequalities in sleep are described, and the social-ecological model of sleep and health is presented. Social and demographic patterns of energy drink use are then presented, followed by discussion of the potential ways in which energy drink use may contribute to health disparities, including the following: 1) effects of excessive caffeine in energy drinks, 2) effects of energy drinks as sugar-sweetened beverages, 3) association between energy drinks and risk-taking behaviors when mixed with alcohol, 4) association between energy drink use and short sleep duration, and 5) role of energy drinks in cardiometabolic disease. The review concludes with a research agenda of critical unanswered questions.

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INTRODUCTION

Although data are still emerging with respect to the prevalence and parameters of contemporary energy drink consumption, use of these beverages has both social and physiological implications for public health, particularly as it relates to sleep. The present review briefly outlines what is known about disparities and inequalities in both health and sleep at the population level, social patterns of energy drink use, and potential pathways by which energy product use could exacerbate health disparities. This discussion is followed by a proposed research agenda, consisting of critical unanswered questions that could aid understanding of the role of energy product use in sleep and health disparities.

HEALTH DISPARITIES: A MAJOR UNMET PUBLIC HEALTH PROBLEM

Despite remarkable improvements in health and healthcare over the last century, policymakers and the public health community have become increasingly concerned by well-documented racial, ethnic, and socioeconomic health disparities that have proven both substantial and costly.¹⁻³ Both underrepresented minorities and other socioeconomically disadvantaged populations have worse outcomes across a range of health conditions. In the United States, cardiovascular disease, asthma, HIV/AIDS, and tuberculosis are all significantly more common among black/African American and Hispanic population groups than among non-Hispanic whites.^{1,3} Racial and ethnic disparities persist even after stratification by education or household income.^{1,3} Such pervasive health disparities at the individual and societal level are likely mediated by a combination of physiological, psychological, and behavioral differences across populations.²⁻⁶ In addition, neighborhood factors play a role in perpetuating health disparities. Neighborhoods affect health through differential exposures to social (cultural norms about health behaviors), psychological (neighborhood safety and neighborhood disorder), and physical (exposure to toxins, air, or noise pollution) factors.⁷ The present article focuses on energy drink consumption as a key modifiable pathway that may contribute to disparate health outcomes.

While policymakers have sought to identify, explain, and address disparities in health, the landscape of health behaviors is constantly evolving. The popularity of caffeine-containing energy drinks is one example of a relatively new phenomenon, the implications of which have not yet been fully elucidated. It is likely that pathways linking disparities in energy drink use to health outcome disparities are related to sociodemographic differences in sleep patterns and beliefs about health, energy, and the importance of sleep. That is, sleep may play a pivotal role at the interface of social/environmental factors and health outcomes. The use of energy drinks likely constitutes an attempt to partially cope with symptoms associated with insufficient sleep (e.g., sleepiness, tiredness, fatigue). To the extent that sleep patterns differ across groups, energy drink use may have disproportionate effects on health outcomes. Alternatively, there may be effects of energy drinks that are relatively

independent of sleep but still play a role at the interface of social/ environmental factors and health.

SOCIAL PATTERNING OF SLEEP

The prevalence of insufficient sleep and sleep disturbances is unequally distributed across the population. Indeed, the patterns of sleep mirror disparities in other health indicators described above. Individuals from minority races/ethnicities, particularly blacks/African Americans, and those of lower socioeconomic status are more likely to experience sleep-related problems.

Sleep and race/ethnicity

Several studies have examined racial/ethnic differences in sleep duration and quality. Based on self-reported sleep duration, blacks/African Americans were more likely to sleep for shorter (< 6 h) or longer (>8 h) periods compared to non-Hispanic whites,⁸⁻¹⁰ but in two of the three studies evaluated, the sleep duration for Mexican Americans did not differ from that of non-Hispanic whites.^{8,9} Studies of subjective sleep quality have been inconsistent. A recent study found that subjective sleep complaints are generally lower among minority groups after adjustment for socioeconomic factors, but that these results depend on how the sleep difficulties are assessed.¹¹ This may explain why another study found that self-reported symptoms of insomnia did not differ between blacks/African Americans and non-Hispanic whites,¹² and a national telephone interview study of over 150,000 adults in the United States found that African American, Latina, and Asian women, as well as Asian men were actually less likely to report frequent sleep complaints than their non-Hispanic white counterparts.¹³ Studies that used objective recordings (with actigraphy) are consistent with self-reported results showing shorter sleep durations and lower sleep efficiency among minorities, particularly blacks/African Americans, compared to non-Hispanic whites.^{14,15} Finally, a meta-analysis of studies that examined sleep in adult blacks/African Americans and non-Hispanic whites using objective measures found that blacks/African Americans had poorer sleep continuity and duration and less slow-wave sleep.¹⁶

The studies described above were all performed in adult populations but others have found some racial/ ethnic differences in children as well. In one study of 2–7-year-old children, black/African American children had greater daytime sleepiness and shorter sleep durations based on parental reports than non-Hispanic white children.¹⁷ A 1990 US national survey found that black/ African American teenagers were most likely to report sleeping 6 hours or less.¹⁸ In Texas, Chinese American adolescents were less likely to report insomnia symptoms while Mexican American adolescents were more likely to do so than non-Hispanic whites.¹⁹ Taken together, these data from children suggest that some sleep differences develop early in life and place racial and ethnic minorities on a trajectory towards deficient sleep in adulthood. Thus, understanding health behaviors, such as caffeine use, that may underlie these differences could help to identify significant areas in which to intervene and improve sleep at younger ages.

Sleep and socioeconomic status

Sleep also varies by socioeconomic status, which is typically represented by levels of education, income, occupational status, or social class. Studies have generally found a higher prevalence of self-reported sleep problems, such as difficulty falling asleep, staying asleep or waking too early, or poorer sleep quality associated with individuals of lower socioeconomic status.^{11–13–20–24} Shorter average sleep duration may also be more common among populations with lower socioeconomic status.^{8,10} A few studies have also found that lower socioeconomic status is associated with worse sleep quality, as measured objectively using polysomnography.^{23–26}

Many, but not all, studies conducted among children have also observed an association between lower socioeconomic status and decreased sleep duration and quality. In one study of US children aged 5–17 years, children from families with lower socioeconomic status were less likely to sleep 9 or more hours and more likely to sleep 6 hours or less per night.¹⁸ Thus, socioeconomic status may be related to sleep duration and quality among children as well as adults.

It is in this context that energy drink use is examined here, since this likely constitutes an attempt to compensate for sleep-related problems (e.g., sleepiness, tiredness, fatigue).²⁷

SOCIAL PATTERNS OF ENERGY DRINK USE

Existing reports about the social patterns of energy drink use indicate energy drinks were introduced into the US market less than 20 years ago²⁸ and usage patterns are continuing to evolve. Because use of these products was not defined as a potential public health concern until the mid-2000s,²⁸ the body of research on energy drink use has been limited, and little reliable information on who is drinking how much of each type of energy beverage is currently available. However, based on the limited available studies, some generalizations can be made.

Patterns according to socioeconomic status

Energy drink use has been associated with an overall energy-dense dietary pattern that is positively associated with poverty.²⁹ This association may be promoted by the fact that energy drinks are eligible for purchase using government assistance programs, and sugary drinks (which include energy drinks) account for approximately 48–58% of the beverage budget for individuals receiving this type of assistance.³⁰ Research also indicates that caffeine use among shift workers is very high, although energy drink use among this population is understudied.³¹

Overall, however, documentation of socioeconomic patterns of energy drink use is inconclusive. In a study of alcohol use patterns in Brazilian college students, Locatelli et al. demonstrated that the use of energy drinks mixed with alcohol was negatively correlated with socioeconomic status (operationalized in 1 of 5 categories), declining from 45.5% use among those in the lowest socioeconomic category to 17.7% among those in the highest category.³² Compared to those in the highest category, a significantly higher prevalence of use was found for those in the lowest category (odds ratio [OR], 2.14) and the second-lowest

category (OR, 1.59). However, a study in Puerto Rico by Rios et al.³³ did not find any socioeconomic patterning. Also, a population-based community study in Milwaukee, Wisconsin did not find any patterning by education level, employment status, or household income.³⁴ Finally, analysis of data from a nationally representative sample included in the National Health Interview Survey found that beverages in the sports and energy drinks category (which includes energy drinks as well as more commonly used beverages such as Gatorade and VitaminWater) were more frequently used among those with household incomes exceeding \$100,000 versus those earning less than \$35,000 (OR, 1.16); no significant differences among the other income groups were found.²⁹

Patterns according to age and sex

According to the national Monitoring the Future annual survey of US secondary school students, in 2011, energy drinks were consumed by 35% of 8th graders and 29% of 10th and 12th graders. Almost one in five 8th grade students reported daily use.³⁵ In a study of middle schoolers in Italy, 17.8% of 6th graders reported use of energy drinks, and the percentage increased to 56.2% by the 8th grade. About one-third of energy drink users reported frequent use, though this rate was higher in boys.³⁶ The strongest predictors of frequent use, besides age, were smoking and alcohol use. More than one-third of US college students are energy drink consumers (range, 36–38%),^{37–39} with consistently higher rates reported for males than females. Among college students in Puerto Rico, energy drink use was more common in younger students (26.3% in students aged 21–30 years versus 9.4% in students aged 31–53 years), and, as in the Italian study, use was higher among males (35.6%) versus females (18.9%).³³

This gendered pattern was also seen in the population-based Greater Milwaukee Survey.³⁴ Males were more likely to report energy drink use than females (OR, 3.74), and use was more common in younger respondents than those 55 years of age or older (OR, 8.83 for 18–29-year age group and OR, 3.55 for 30–54-year age group). In a study of the nightclub-going population of young adults in New York City, males were, again, more likely to report energy drink use (36.9% versus 29.8% in females).⁴⁰ Further analysis of the gender-related findings showed that heterosexual women reported the lowest use, followed by lesbian/bisexual women, heterosexual men, and gay/bisexual men, who reported the most use. These differences were statistically significant between heterosexual women and the other groups, but results of other pairwise comparisons were not significant.

Patterns according to race/ethnicity

Nationally representative data with respect to racial and ethnic differences in energy drink use have been sparse and inconsistent; however, according to the National Health and Nutrition Examination Survey results evaluated by Bailey et al.,⁴² overall use of energy drinks among males is highest among non-Hispanic white respondents, followed by Hispanic respondents, and then black/ African American respondents. This pattern is particularly evident in the 14–18-year and 19–30-year age groups, with much smaller differences in other groups. Several studies have corroborated this variation in racial/ ethnic distribution for energy drink use, with and without alcohol, among college students.^{39,42}

In contrast, the Greater Milwaukee Survey found no differences between non-Hispanic white and black participants, but higher usage rates among participants with a racial designation of “other”.³⁴ Based on the demographic characteristics of this area (45% non-Hispanic white, 37% black/African American, 12% Hispanic/ Latino, 3% Asian, and 3% multiracial), this category likely reflects Hispanic/Latino participants. Using data on the use of “sports and energy drinks” from the National Health Interview Survey, Park et al.²⁹ found that use of this aggregate beverage category was reported more frequently by blacks (OR, 1.18) and Hispanics (OR, 1.28), and less frequently by Asian, other, and multiracial respondents (OR, 0.80), than by non-Hispanic whites. Finally, among nightclub-going young adults in New York City, Hispanic/Latino individuals reported the highest prevalence of energy drink use (52.5%), followed by blacks/African Americans (35.4%), other (35.0%), non-Hispanic whites (32.5%), and Asian/Pacific-Islanders (25.0%). Significant differences were found between Hispanic/Latino and both non-Hispanic white and Asian/ Pacific-Islander groups.⁴⁰

The reasons for these inconsistent findings are currently unclear, but they may reflect changing patterns of use associated with an emerging marketing trend disproportionately aimed at minority youth consumers.⁴³ A report from the Yale Rudd Center found that, in 2010, energy drinks were disproportionately marketed to minority youth.⁴³ For example, black children saw more than 2.5 times as many advertisements for energy drinks as non-Hispanic white children. This was primarily driven by differences in television advertisements for 5-H Energy and Red Bull, which were seen at a ratio of 2.70:1 and 2.52:1 compared to non-Hispanic white children, respectively. Black teenagers saw over twice as many advertisements for energy drinks as non-Hispanic white teens, including over twice as many ads for 5-H Energy and over 2.5 times as many ads for Red Bull. For Hispanic youth, among only eight brands of sugary drinks found to be advertising on Spanish-language television, both 5-H Energy and Red Bull were prominently featured. There were fewer advertisements for sugary drinks on Spanish-language radio than on English-language stations; however, there were 22% more advertisements for energy drinks on Spanish-language radio, compared to English-language radio. Therefore, even if racial and ethnic patterns are not currently seen, they may eventually emerge. Inconsistency in the data on patterns of energy drink use by various racial, ethnic, and socioeconomic groups may reflect the rapidly evolving landscape of this emerging market.

OTHER PATHWAYS LINKING ENERGY DRINK USE TO SLEEP AND HEALTH DISPARITIES

There are a variety of ways in which energy drink use may have deleterious effects on users, irrespective of the prevalence of use within a population. Several examples include the following: 1) effects of excessive caffeine in energy drinks, 2) effects of energy drinks as sugar-sweetened beverages, 3) association between energy drinks and risk-taking behaviors when mixed with alcohol, 4) association between energy drinks and short sleep duration, and 5) role of energy drinks in cardiometabolic disease. These are illustrated in Figure 1.

Energy drinks and excessive caffeine consumption

Caffeine is a primary ingredient of many energy drinks that has well-documented effects on sleep. These effects are thought to be mediated by antagonism of the adenosine A1 and A2a receptors.^{44,45} Indeed, the most commonly reported side effects associated with caffeine in the quantities typically present in energy drinks are insomnia, nervousness, headache, and tachycardia. In addition to caffeine, energy drinks may also contain other ingredients, including taurine, guarana, ginseng, *Ginkgo biloba*, B vitamins, and sugar. Guarana, for instance, is the plant with the highest caffeine content,⁴⁶ thereby providing another source of caffeine within energy drinks.

Evidence suggests that reducing sleepiness and/or fatigue (and/or increasing alertness) is a primary reason users consume energy drinks.²⁷ Therefore, populations with high rates of insufficient sleep duration and of sleep disturbances are likely to comprise a significant proportion of energy drink consumers. For instance, Calamaro et al.⁴⁷ found that, compared to adolescents who didn't report daytime sleepiness, those who did had 76% higher consumption of energy drinks. In a study of over 1,000 US military personnel, those who drank 3 or more energy drinks per day were more likely to report sleeping 4 h per night, compared to service members who drank 2 energy drinks per day.⁴⁸ Similarly, evidence suggests that children and adolescents who are moderate-to-high-level caffeine consumers have more sleep problems compared to their counterparts who are low-level consumers or do not consume caffeine.^{49,50} These findings are consistent with the hypothesis that populations at high risk for insufficient sleep or sleep disturbances may utilize energy drinks as a compensatory strategy, which, in turn, may further perpetuate sleep disturbances due to the known effects of caffeine on sleep. This vicious cycle, particularly when initiated early in life, may result in a heightened risk trajectory for chronic sleep problems as well as associated morbidities. These effects may be particularly salient in racial minorities and those of low socioeconomic status. Also, certain genotypes may exacerbate risks associated with excessive caffeine; for example CYP1A2 polymorphisms that affect caffeine metabolism are more common in several minority groups.⁵¹

Energy drinks as sugar-sweetened beverages

Obesity is a leading preventable cause of death in the United States that disproportionately affects minorities, including blacks and Hispanics, as well as individuals with low socioeconomic status.⁵²⁻⁵⁴ Despite substantial efforts to curb the obesity epidemic, two-thirds of adults in the United States are either overweight or obese.⁵⁵⁻⁵⁷ Alarming, the rates of overweight and obesity are also at epidemic levels in children and adolescents, especially those who are black/African American or Hispanic/Latino. Such dramatic differences contribute to pronounced disparities in obesity-related morbidities across the lifespan (including diabetes mellitus and cardiovascular diseases [CVD]), as well as premature mortality.^{58,59}

In parallel with the rising rates of obesity in children and adults, consumption of sugar-sweetened beverages in the United States increased by 61% in adults from 1977 to 1997⁶⁰ and more than doubled in children and adolescents in roughly the same time period.⁶¹ Non-Hispanic black children and adolescents consume more sugar-sweetened beverages relative

to their overall diet and are more likely to consume them at a younger age compared to their Mexican American counterparts.⁶² Among adults, non-Hispanic blacks and Mexican American Hispanics consume more sugar-sweetened beverages than non-Hispanic white adults.⁶² Similarly, low-income children and adults consume more sugar-sweetened beverages relative to their overall diet compared to higher-income individuals.⁶² Thus, increased consumption of sugar-sweetened beverages, which disproportionately affects specific sociodemographic groups, may directly contribute to widening health disparities in obesity and obesity-related morbidity. Indeed, strong evidence suggesting a temporal relationship between increased consumption of sugar-sweetened beverages and the prevalence of obesity, particularly in children and adolescents, has motivated efforts to curb the intake of sugar-sweetened beverages.^{43,63}

Association of energy drinks and risky behavior when mixed with alcohol

Energy drink use may contribute to health disparities by exacerbating the risks associated with excessive alcohol consumption. Use of alcohol mixed with energy drinks has been linked with elevated risk for heavy or heavy episodic (“binge”) drinking among young adults in the United States,^{37,38,64–66} Canada,^{67,68} Australia,⁶⁹ and Italy.⁷⁰ Three factors make consumption of energy drinks plus alcohol riskier than drinking noncaffeinated alcohol alone. First, by counteracting the somnogenic effects of alcohol and facilitating longer drinking sessions, caffeine may promote higher alcohol consumption.^{71,72} Second, caffeine modulates the effect of alcohol on executive brain function, ameliorating the slowed reaction time characteristic of intoxication but not the impulsivity or diminished judgment.^{71,73} Third, by distorting subjective perceptions of impairment, caffeine may undermine compensatory adaptive responses^{74,75} or protective behaviors^{76–78} that would otherwise be used by the drinker to manage intoxication and its consequences. Unsurprisingly, therefore, use of alcohol mixed with energy drinks has also been linked with elevated risk for a range of adverse drinking outcomes, most notably sexual risk-taking^{39,79,80} and intoxicated driving.^{68,81}

The use of energy drinks may contribute to risk-behavior-based health disparities across gender, racial, or ethnic groups. First, if some groups are more likely to use these beverages, they will bear a disproportionately larger share of the associated risks. Second, energy drink use among vulnerable groups (e.g., women, racial/ethnic minorities, individuals with low socioeconomic status, and/or children) may generate more serious health impacts than those experienced by more protected groups. For example, adverse sexual consequences (e.g., unwanted pregnancy, shaming, coercion/victimization) tend to fall more heavily upon women, who are commonly subjected to more severe physical risk and cultural stigmatization if they engage in sexual activity outside of a conventionally sanctioned relationship.^{82,83} Women are also perceived as more sexually accessible when drinking,^{84,85} which places them at particular risk for unwanted sexual contact. This risk is normally offset to some extent by compensatory vigilance; compared to men, women report more effective use of protective behavioral strategies against overdrinking⁸⁶ and unintended sex-related drinking outcomes.⁷⁷ But as discussed above, combining energy drinks with alcohol may undermine the use or efficacy of those strategies.

Energy drinks in the context of high-risk sleep duration

Taken together, the available evidence suggests that racial minorities^{8,9,15} (especially blacks/African Americans) and individuals with low socioeconomic status^{8,10} are most prone to short sleep duration and may be most vulnerable to the adverse health effects of insufficient sleep. Since caffeine is often consumed as a countermeasure to fatigue,²⁷ consumption of energy drinks in these groups may, at least in part, represent an attempt to maintain function in the context of insufficient sleep. However, although caffeine can increase alertness,⁸⁷ the effects of caffeine are limited and caffeine does not protect against all the adverse effects of sleep loss.⁸⁸ Therefore, caffeine use may mask the consequences of insufficient sleep among those who may be at greatest risk.

In addition, individuals at increased risk of short sleep duration may also be at increased risk of other effects of caffeine. Data from the 2007–2008 National Health and Nutrition Examination Survey found that in the US population, after adjusting for a large number of covariates, there was a significant interaction between caffeine and sleep duration for nonrestorative sleep.⁸⁹ At higher levels of sleep duration, there was no significant linear association between caffeine and nonrestorative sleep, but as sleep duration decreased, the relationship between caffeine intake and nonrestorative sleep became stronger.⁸⁹ This pattern may play a role in a number of outcomes. For example, short sleepers are more likely to report drowsy driving in the past month, even if they report sufficient sleep every night during the same period.⁹⁰

Energy drink use and cardiometabolic disease risk

Little research has examined the relationship between energy drinks (specifically, products containing both sugar and caffeine) and cardiometabolic outcomes.⁹¹ In a small study of 10 young adult women who were randomly allocated to a standardized dose of sucrose either in an energy drink or in lemonade, those who drank the energy drink showed increased carbohydrate oxidation and reduced lipid oxidation compared to those who drank lemonade. The authors speculate that long-term consumption of energy drinks may contribute to obesity, particularly in sedentary individuals, by promoting lipogenesis and insulin resistance. However, the small sample size and preliminary nature of the findings requires replication before definitive conclusions regarding direct links between combined sugar-sweetened, caffeinated products and obesity can be made.

In contrast, there has been a great deal of work on the cardiovascular effects of caffeine, primarily in adult populations. An examination of the health effects of caffeine or of any of the other ingredients in energy drinks is beyond the scope of this review; however, it is known that although there may not be specific health consequences of caffeine in reasonable doses for healthy populations, certain groups may be at risk for cardiac consequences subsequent to ingestion of high doses of caffeine, which may, in turn, contribute to health-related disparities. For instance, evidence suggests that those who may be predisposed to cardiac arrhythmias due to underlying genetic conditions may be at high risk for cardiac complications from energy drink consumption, particularly when combined with alcohol.⁹² In addition, Savoca et al.^{93,94} found that among adolescents on a sodium-controlled diet, caffeine intake was significantly correlated with elevated daytime blood pressure in African

American adolescents, but not among non-Hispanic white adolescents. In another study, Worthley et al.⁹⁵ found that consumption of a sugar-free energy drink significantly increased platelet aggregation and mean arterial pressure, and significantly decreased endothelial function, all of which are implicated in the pathogenesis of cardiovascular disease. However, the authors did not report the racial/ethnic make-up of their sample, nor did they evaluate potential interactions with race. Importantly, consumers of energy drinks are often unaware of the amount of caffeine they are ingesting because a product's caffeine content does not always appear on its label (sometimes due to the presence of multiple, naturally caffeine-containing ingredients in the product); nor may they be aware of their own risk factors, genetic or otherwise, that may render them at increased risk for adverse health outcomes related to high doses of caffeine.

REMAINING CRITICAL QUESTIONS

Research examining connections among energy drink use, sleep, and health disparities is very preliminary, with many questions remaining. The topics and questions below are examples to help guide future studies.

Sociodemographic patterns of energy drink consumption

What are the emerging sociodemographic patterns of energy product use? As shown above, extant research has revealed inconsistent and possibly changing patterns of use by different racial, ethnic, socioeconomic, gender, and age groups. How are these patterns evolving? How do these patterns relate to ingestion of other products to alleviate sleepiness, such as coffee, or products to induce sleepiness? What underlying mechanisms drive these usage patterns?

Energy drink use and sleep

What role do beliefs and attitudes about healthy sleep play in energy drink consumption? Are individuals using energy drinks to attempt to combat the effects of sleep loss? What is the role of peer pressure? How do misconceptions about the efficacy of caffeine in ameliorating the effects of sleep loss contribute to adverse or disparate health outcomes? How can beliefs about sleep and sleep hygiene practices be improved in the general population? How are advertising, marketing campaigns, and/or public health campaigns shaping beliefs and attitudes about healthy sleep, caffeine use, and use of caffeine-containing energy products?

Risks associated with energy drink use

Are certain groups at particular risk from energy drinks? Are there genetic and physiologic moderators of risk? Are there social or demographic moderators of risk? What additional information is needed in order to develop intervention strategies tailored to the needs of high-risk populations? Are there policy implications to be considered relative to energy product intake in vulnerable groups?

As consumption of energy products increases and scientific research into the patterns of use and patterns of risk moves beyond its current stage of preliminary inquiry, the questions above may be the most critical to answer.

CONCLUSION

The present review has been focused on the social patterning of energy drink use and the potential role these beverages play in sleep and health disparities and/or inequalities. Although age, gender, socioeconomic, and racial and ethnic patterning of energy drink use is currently difficult to distinguish, use appears to be concentrated among younger individuals, particularly males. Socioeconomic and racial and ethnic patterns are less consistent, though use (particularly in the context of alcohol), seems more prevalent among those of lower socioeconomic status, as well as among non-Hispanic white populations. Whether or not social patterns are discernible, it is possible that some of the effects may be felt disproportionately among minorities and/or those of lower socioeconomic status. Additional research is needed to better characterize the use of energy products, the social, environmental, psychological, and behavioral determinants of use, and the resulting physiological and behavioral effects.

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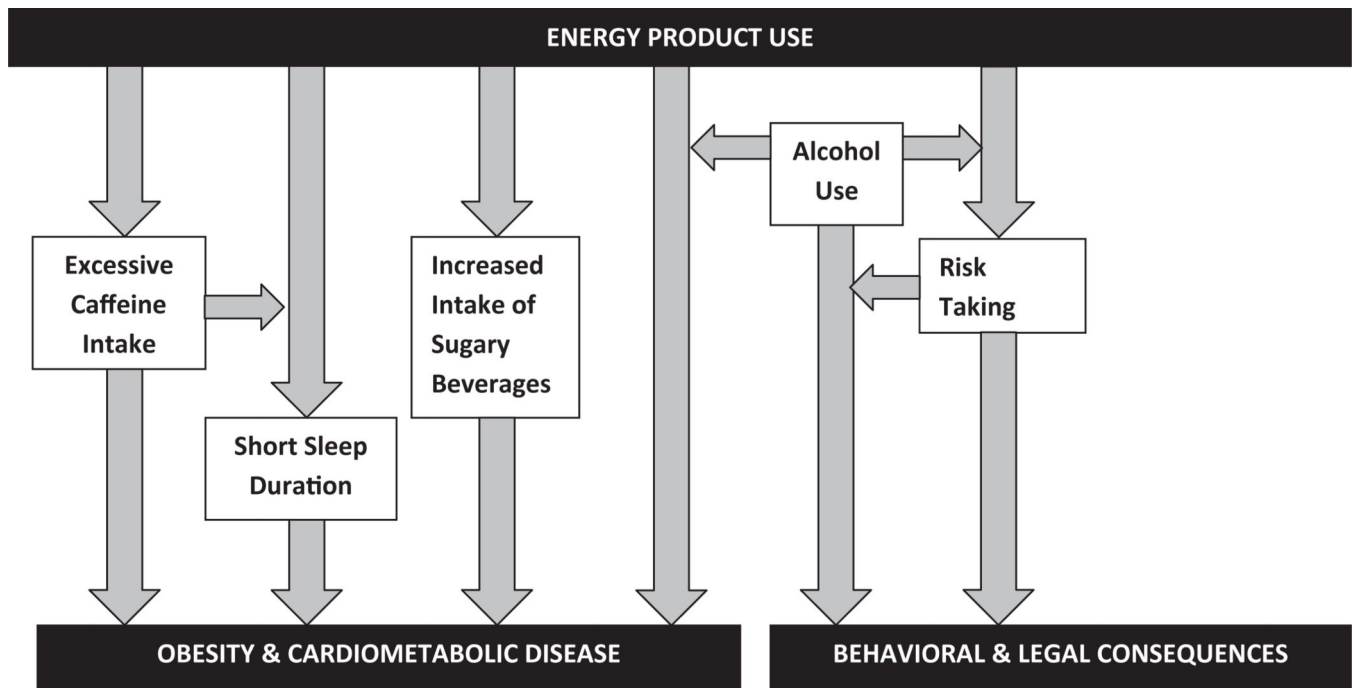


Figure 1.
Conceptual model linking energy product use to adverse outcomes.