

# Energy drinks: pros and cons

## Abstract

Energy drinks (EDs) constitute a health hazard among adolescents and young adults. Few beneficial effects of EDs are reported as they are frequently consumed by youth to overcome fatigue and sleepiness. EDs may also promote healing of soft tissue wounds. They are ingested alone or mixed with alcohol to lessen alcohol sedation. They may cause cardiovascular manifestations like tachycardia, elevated blood pressure, arrhythmias, electrocardiographic changes and myocardial ischemia. On the nervous system, EDs affect cognition, mental health and motor skills, and they may increase the risk adventures. Prenatal consumption of EDs results in increased locomotion, anxiety and irritability of the newly born infants. Moreover, excessive ingestion of these drinks is associated with blood changes, renal and gastrointestinal disorders, obesity and dental caries. It is recommended that regulatory sales restrictions, particularly toward young adults, must be undertaken to minimize the magnitude of this health problem.

**Keywords:** energy drinks, cardiovascular, nervous, digestive, renal, dental, breast feeding, obesity

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**Abbreviations:** BP, blood pressure; ED, energy drink; GABA, gamma-amino butyric acid; G-6-PDH, glucose-6-phosphate dehydrogenase; GPA, grade point average; HR, heart rate; LQTS, long QT syndrome

## Introduction

Energy drinks (EDs) are beverages which contain sugar, caffeine, taurine, herbs and vitamins. They have been increasingly consumed, particularly by teen agers and young adults, in the States, Europe and Asia. Marketing of the beneficial effects of EDs magnifies their role in improving physical and mental status. These beverages are thought to overcome sleepiness, maintain alertness, and increase physical and mental fitness. Recently, consumers use the stimulant effect of EDs to counteract the sedative effect of alcohol. EDs are more used by male athletes practicing sports, by students during study and exams, and by young adults facing career interviews. The current article aims at reviewing the hazards of excessive consumption of EDs.

A controversy has developed regarding the benefits and possible adverse effects of EDs. Most of the benefits of EDs are related to two constituents: caffeine and taurine. High caffeine level, of ED, may result in caffeine intoxication in susceptible individuals.<sup>1</sup> Caffeine intoxication may result in tachycardia, cardiac arrhythmias, vomiting, fits and death. Also, excessive consumption of EDs may be associated with poor mental health, metabolic and renal disorders, and obesity. Frequent ED consumers usually suffer from headache, anger, breathlessness, polyurea, and seizures. Dental enamel erosion could be produced by the acidity of these drinks. EDs mixed with alcohol are linked to increased risk-taking behaviors by adolescents.<sup>2-6</sup>

Justifications for consumption of EDs, among adolescents of both genders and different ethnicities, were assessed as follows: to promote energy (61%), to accentuate study concentration (32%), to potentiate sports performance (29%), and to diminish weight (9%). Many users mix ED with alcohol or illicit drugs such as marijuana, cocaine, and methamphetamine.<sup>7,8</sup> Red Bull, as one of EDs, was supposed to accentuate the volume of concomitantly consumed alcohol.<sup>9</sup> Consumption of alcohol mixed with EDs, by adolescents, has the risk of practicing gambling.<sup>10</sup> In a group of Saudi female university students, the reasons to consume EDs included having good company with friends, better learning concentration, and

successful exam performance. The commonest side effect of ED, among these users, was headache and the rarest one was allergy. Many users were aware of the adverse effects of ED consumption during pregnancy and lactation.<sup>11</sup> Regular check-up of the stimulant effect of EDs on the cardiovascular and nervous systems is required in young athletes to guard against health hazards.<sup>12</sup> It is also advisable to launch restrictions on EDs marketing to youth below the age of 18 years.<sup>13</sup>

## EDs and the cardiovascular system

The commonest detrimental effects of EDs are imposed on the cardiovascular and nervous systems.<sup>3,14</sup> Recent studies have attributed the cardiovascular hazards of EDs mainly to caffeine and sugar.<sup>15</sup> Serious cardiovascular effects of EDs include cardiac arrhythmias, myocardial infarction, prolonged QT interval, aortic dissection, and death.<sup>16-18</sup> There is a good evidence that caffeine moderately increases the blood pressure (BP) and heart rate (HR).<sup>19</sup>

EDs were found to produce changes in the autonomic cardiovascular functions: Valsalva ratio, systolic and diastolic BP, mean arterial BP, and pulse pressure. These changes sometimes necessitated hospitalization and were enhanced by overweight or obesity.<sup>20,21</sup> EDs alter electrolytes and result in repolarization abnormalities leading to arrhythmias and sudden death. Two cases of fatal ventricular arrhythmias were recently reported in young individuals following ED consumption.<sup>22,23</sup> On the contrary, a previous research documented that acute ingestion of Red Bull ED, by healthy young volunteers, had increased both systolic and diastolic BP as well as HR without changing the ventricular repolarization.<sup>24</sup>

Excessive ingestion of EDs is reported to significantly increase the QTc interval by 6ms and the systolic blood pressure by 4mmHg.<sup>25</sup> On the contrary, other reports reveal that consumption of EDs by healthy young adults had non-significant changes in systolic and diastolic BP, PR and QTc intervals, and QRS duration.<sup>26</sup> In patients with familial long QT syndrome (LQTS), caffeinated EDs induced an acute increase in the arterial BP.<sup>27</sup> Other researchers mentioned that EDs consumption did not change QTc interval, HR and systolic BP whereas the diastolic BP and mean BP were slightly elevated.<sup>28</sup>

Few documents support a possible link between excessive consumption of caffeinated EDs and incidence of myocardial infarction.<sup>29-32</sup> *In-vitro*, the caffeine content of ED exerted a

significant inotropic action on human myocardial specimens while taurine content did not.<sup>33</sup> In male Wistar rats, long-term consumption of EDs had significantly increased the cardiac glucose and glycogen levels, the total protein level as well as the ALT and AST enzymes; meanwhile, the total cholesterol level was significantly decreased.<sup>34</sup> Some authors postulate that ED consumption increases platelet aggregation, thus accentuating the risk of blood hypercoagulability and thrombus formation.<sup>35</sup>

## EDs and the cognitive, mental and motor functions

Caffeinated EDs are assumed to increase mental and physical energy, however these effects are of short term. These drinks proved to have a negative impact on mental health in young consumers.<sup>36</sup> Excessive consumption of EDs was associated with a lower grade point average (GPA) among undergraduates.<sup>37</sup> Among UK secondary school students, consumption of EDs was linked to poor academic results for maths and English; an observation which was thought not to be due to ED but to lacking breakfast or having junk food.<sup>38</sup> Some university students considered EDs as a tool to manage health, performance and appearance.<sup>39</sup> Following consumption of EDs, Italian young athletes showed a minimal anxiety but no depression.<sup>40</sup>

Caffeine, in EDs, is supposed to change the brain chemistry through increasing the activities of the enzymes: cytochrome C oxidase and glucose-6-phosphate dehydrogenase (G-6-PDH), and the neurotransmitters: gamma-amino butyric acid (GABA) and dopamine.<sup>12</sup> The detrimental effects of EDs in Korean youth were assessed to include sleep deprivation, severe stress, depression, and suicide planning and attempts; such effects were more evident in those habitually consuming junk foods.<sup>41</sup> In medical students, ED consumption was associated with insomnia and irritability.<sup>42</sup> Also, ingestion of 3mg/kg of caffeine, in an ED, was found to increase insomnia and nervousness without gender differences.<sup>43</sup> Chronic sleep deprivation and circadian rhythm disruption, caused by highly caffeinated EDs, may increase risk-adventures and use of illicit drugs.<sup>44-47</sup> Furthermore, consumption of EDs at the age of 14 years is considered as a predictor of drug use at the age of 16.<sup>48</sup>

Taurine amino acid is richly present in the brain, retina, heart, reproductive organs, meat and seafood.<sup>49</sup> It is sometimes hypothesized that neither caffeine nor glucose has a significant effect on cognition, mood and self-judgement.<sup>50</sup> In male Wistar rats a mixture of caffeine and taurine, but not full ED, could improve memory and attention.<sup>51</sup> A young male experienced a fit which was linked to excessive consumption of ED rich in caffeine and taurine.<sup>52</sup> Also, a psychotic episode, probably caused by excessive ED, was reported in a young adult lacking history of psychotic ailments.<sup>53</sup>

Ingestion of sugar-free EDs had led to decreased intracortical facilitation, shortened simple reaction time, and increased pre- and post-exercise facilitations of motor potentials.<sup>54</sup> Shortly after ingestion of two cans of Red Bull, a middle-aged male showed abnormal treadmill test compared to normal test before ED ingestion.<sup>55</sup> Improvement of physical performance in muscle strength, endurance exercise tests, and sports is correlated to the dose of taurine in EDs.<sup>56</sup> However, caffeine and taurine administration at doses like those of EDs did not promote sprint cycling performance.<sup>57</sup>

ED consumption negatively impacts the executive functions of adolescents.<sup>58</sup> Among university students of both sexes, ED shots

were significantly associated with poorly scored hand steadiness tests, but reaction time tests were satisfactory.<sup>59</sup> ED shots also significantly impaired pistol aiming steadiness.<sup>60</sup> Deployed soldiers in Afghanistan consumed greater amounts of caffeine and EDs to combat the drawbacks of sleep loss on cognition and operational performance.<sup>61</sup> In healthy college students of both sexes, ED shot enhanced smaller muscle group performance (like isolated forearm stroke), but not larger muscle group performance (like countermovement vertical jump).<sup>62</sup> Only few studies demonstrated an ergogenic effect of EDs on muscle strength and power.<sup>63</sup>

It is postulated that EDs might correct some adverse effects of alcohol alone like cognition defects, headache, fatiguability, dry mouth, and motor deficits.<sup>64</sup> However, in Taiwan male volunteers, drinks with high caffeine: alcohol ratio did not correct the defective motor function caused by alcohol alone.<sup>65</sup> In male Swiss mice, ED mixed with alcohol significantly reduced motor skills.<sup>66</sup> In rat brain and liver, EDs alone or mixed with alcohol significantly altered malondialdehyde (as a lipid peroxidation marker), and superoxide dismutase, catalase and glutathione peroxidase (as oxidative stress markers).<sup>67</sup>

## EDs and other body organs

The deleterious effects of Power Horse, as one of the commercial EDs, were investigated on the structure of the pancreas and gastric fundic mucosa of albino rat. In this experiment, the serum levels of insulin and glucose were significantly elevated whereas the serum level of gastrin was significantly diminished. Structurally, the pancreas showed features of excessive stimulation of  $\beta$ -cells whereas the gastric fundic mucosa exhibited reduced number of parietal cells.<sup>68</sup> Clinical manifestations of acute hepatitis, in a middle-aged male, were linked to daily ingestion of 4-5 EDs for three weeks.<sup>69</sup>

It is also common that some breast-feeding women tend to ingest EDs and excess vitamins to combat fatigue and sleepiness. Some infants display irritability and sleep disturbances following exposure to excessive caffeine in breast milk and/or excessive prenatal vitamins.<sup>70</sup> Mice, born to mothers consuming EDs during pregnancy and lactation, had shown increased locomotion and anxiety. Also, there were several histological changes like fatty degeneration of hepatocytes, degeneration of renal glomeruli with dilated urinary spaces, pyknosis and chromatolysis of cerebral and medullary neurons, and alterations in the cerebellar Purkinje cells.<sup>71</sup> In addition, acute renal failure is rarely encountered on excessive consumption of EDs alone without mixing with alcohol.<sup>72</sup> Despite its diuretic effect, caffeine content of EDs, is documented to slightly increase the occurrence of renal stones.<sup>73</sup>

Hematological hazards of EDs were sometimes discovered. On exposure to Red Bull and Power Horse, male Wistar albino rats demonstrated significant reduction in red blood cell, platelet and neutrophil counts, in haemoglobin content and haematocrit value. Occasionally, ultrastructural nuclear and cytoplasmic alterations were observed in peripheral blood cells in all rats exposed to all types of EDs.<sup>74</sup> Furthermore, an association was determined between daily consumption of acidic EDs and dental enamel erosion.<sup>75</sup> In rats, a beneficial effect of EDs was also observed in the form of enhancement of soft tissue wound healing possibly through increased collagen deposition, re-epithelialization and new vascularization in the wound.<sup>76</sup> Furthermore, excessive ingestion of sugar- sweetened drinks during the second trimester of pregnancy was linked to greater incidence of obesity in mid-childhood.<sup>77</sup>

## Conclusion

Consumption of energy drinks (EDs) has some benefits as they combat fatigue and sleepiness and increase endurance and fitness. However, many health hazards are shown to be associated with excessive consumption of these drinks by youth. There is a growing evidence of their negative impact on the cardiovascular and nervous systems. Also, these beverages may affect other body organs like pancreas, stomach, kidney, breast and teeth. Adolescents and young adults must be screened and closely monitored for EDs use and their health consequences. Healthcare providers should inform adolescents and their families about the risks of excessive consumption of caffeinated drinks. Regulatory sales restrictions must be undertaken to minimize the magnitude of this health problem.

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## Conflicts of interest

The authors declare there is no conflicts of interest.

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