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# Evaluation of the Effects of Caffeinated Energy Drink Consumption on Renal Function

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## Abstract

Energy drinks have become popular among people from all age groups because of the instant supply of energy and mental alertness. The main component of these high energy drinks is caffeine. Several studies have reported the negative effects of caffeine consumption in any form. Animal studies have shown the negative effects of energy drinks containing caffeine on cardiovascular, renal, and neuro-cognitive functions. There are no studies to evaluate the effects of energy drinks on renal function in the human population. The most famous energy drink in Iraq is the caffeinated energy drink, Tiger. The consumption of this drink has dramatically increased in Iraq. So, with this premise, the present study aimed to evaluate the effects of high energy drink (Tiger) on renal function. Forty-nine participants who had no history of any systemic illness, non-alcohol consumers, and non- smokers, who consumed high energy drink (Tiger) for at least 90 days and 49 age and sex-matched healthy participants who did not consume any high energy drink were recruited for the study. The baseline and post 90 days serum creatinine and blood urea were measured by using the kit-based method. The paired sample t-test was used to compare the baseline and the post 90 days of serum creatinine and blood urea levels. A p value <0.05 was significant. The serum creatinine and blood urea levels were significantly increased in the group of participants who consumed high energy drink (Tiger) at 90 days of high energy drink consumption. There was a significant change in the levels of serum creatinine and blood urea in the control group. The elevated levels of serum creatinine and blood urea are indicative of renal damage caused by the consumption of high energy drink (Tiger). The results of the present study suggest that indiscriminate use of high energy drinks should be stopped.

**Keywords:** High energy drinks; Tiger; Caffeine; Renal function; Creatinine; Blood urea

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## Introduction

The energy drinks were introduced in the global market in 1987. Since its introduction, it has gained popularity among people. Energy drinks increase the mental alertness, physical strength/ stamina, promote brain response, reduces lethargy, and tunes the body in an active state [1,2]. The major active ingredients of energy drinks are caffeine, taurine, guarana, glucuronolactone, vitamins, and carbohydrates. Carbohydrate components serve as a source of energy and the caffeine acts as the stimulant of the central nervous system [1].

The energy drinks reduce the feeling of lethargy and activates the body by reducing the feeling of tiredness. This is the main reason of the popularity of the energy drinks. Energy drinks increases the performance of the consumers. It becomes an abuse in the people who over drink them beyond the allowed concentration of caffeine, especially the students and the athletes [3]. The major problem with the energy drinks are the variable concentrations of caffeine and other psychoactive components [4]. Unregulated or indiscriminate consumption of energy drinks may cause poisoning and may affect several organs [4]. Reports suggest the overuse of energy drinks to be associated with caffeine poisoning seizures [5], strokes [6], and gonadotoxic effects [7].

The consumption of energy drinks has drastically increased in the recent past (Saad, 2014) and has reached $52 billion in 2016 [8-10]. Energy drinks constitute a major part of the US sports and weight management market [9, 10]. According to a study, about 66% of children consume at least one carbonated drink and about 77% adolescents consume these drinks daily [11]. The popularity of these drinks is more in the males as compared to the females [12].

Studies in animal models have shown adverse effects of energy drink consumption on the liver and kidney morphology and functions [13-15]. The rats treated with energy drinks showed increased levels of blood urea and creatinine [16,17].

These energy drinks are sold as dietary supplements and escape the Dietary Supplement Protection Act claims. There are several adverse reports related to the consumption of energy drinks. In 2011, the number of emergencies due to the consumption of energy drinks crossed 20,000. Majority of these cases were due to the misuse of these energy drinks [18]. Energy drink consumption is rapidly increasing in the people in all the age groups. This increase popularity of energy drinks raises a serious public health concern due to overdose of caffeine [19]. The major misuse or abuse results when people use these energy drinks with other prescribed drugs, alcohol and/or other illicit drugs [8]. As per reports, about half of the energy drink consumers are

constituted by the children, adolescents, and young people. Majority of the caffeine overdose due to the drinks are reported in people younger than 19 years [20]. Since these energy drinks contains large doses of stimulants but are labelled as dietary supplements so these products escape the US Food and Drug Administration (FDA) caffeine limits [20-22]. The recommended limits for caffeine are 71 mg per 12 ounces in cola-type beverages and up to 200 mg per dose every 3 to 4 hours for over-the-counter drugs [23].

Caffeine toxicity is associated with several neurological and systemic disorders such as tremors, agitation, anxiety, irregular heart rate, high blood pressure, insomnia, psychosis, seizures, and cardiovascular instability [20, 21, 24, and 25]. The caffeine toxicity worsens when consumed together with other stimulants such as prescribed drugs and alcohol [8]. A recent study conducted in albino rats to evaluate Pepsi cola and Tiger beverages on physiological parameters and histopathological changes highlighted that the treatment of these energy drinks resulted in increased body weight, sperm morphological defects, increased blood urea, glucose, and triglyceride concentration as compared to the control group [14]. Tiger is a very popular energy drink in Iraq. With the premise of this background, the present study was conducted to evaluate the effects of energy drink (Tiger) consumption on the renal function in a healthy population in Iraq. We evaluated the levels of serum creatinine and urea as measures of renal function in healthy participants who consumed the high energy drink for at least for 90 days and in a group of age and sex matched of participants who never consumed the drink. We observed a significant increase in the serum levels of creatinine and urea in the group that consumed the energy drink (Tiger) for at least 90 days. There was no significant change in the levels of serum creatinine and urea in the control group.

## Materials and Methods

### Participants

The study was conducted in Kirkuk city in 2018. The study included 49 participants as cases who consumed 250 ml of energy drink (Tiger) for at least 90 days and 49 age and sex matched participants as controls who did not consume any type of energy drinks. All the participants were healthy and did not have history of any systemic illness, liver or kidney disorders, never consumed alcohol, non-smokers, and never had drug practice.

### Sample collection and biochemical analysis

Ten ml of blood sample was collected from peripheral blood vessels and centrifuged immediately at 6000 rpm for 15 min for serum collection (Hitachi centrifuge). The serum creatinine and blood urea levels were analyzed by automatic machine (Genotic chemistry analyzer, smart 150). Instructions were followed as per manufacturer's protocol. The serum creatinine and urea levels were expressed as mg/dl.

## Statistical Analysis

SPSS version 21 was used to analyse the data. Data was presented as mean±SD. Paired t test was used to evaluate the significance of change in the serum creatinine and blood urea at day 0 and day 90. P value <0.05 was significant.

## Results

The effect of energy drinks on the renal function was evaluated by comparing the serum creatinine levels and blood urea levels at day 0 and day 90 of energy drink consumption. Forty-nine participants who consumed energy drink (Tiger) (250 ml/day) for at least for 90 days and 49 participants who did not consume energy drinks were monitored for the serum creatinine and blood urea levels at day 0 and day 90. The mean age of the participants was 22.59±3.82 years and 21.59±2.88 years in the group consuming high energy drink (Tiger) and the control group respectively (p=0.15). All the participants in the study were males.

The serum creatinine levels significantly increased post 90 days of regular energy drink consumption. The serum creatinine levels were significantly higher (p<0.0001) post 90 days (1.55±0.42) of regular energy drink consumption as compared to day 0 (0.97±0.33). There was no significant difference (p=0.45) in the serum creatinine levels between the day 0 (0.82±0.19) and day 90 (0.96±1.19) in the control group (Table 1).

The blood urea levels significantly increased post 90 days of regular energy drink consumption. The blood urea levels were significantly higher (p<0.0001) post 90 days (34.27±8.33) of regular energy drink consumption as compared to day 0 (19.55±3.89). There was no significant difference (p=0.41) in the blood urea levels between the day 0 (15.96±4.21) and day 90 (15.67±4.5) in the control group (Table 2).

**Table 1:** Effect of energy drink consumption on serum creatinine levels. Paired t test was done to compare the levels at day 0 and day 90. A p value <0.05 was significant.

| **Serum Creatine (mg/dl)** | | | |
|---|---|---|---|
| | Serum Creatine baseline (Day 0) | Serum Creatinine at 90 days | P value |
| Case | 0.97±0.33 | 1.55±0.42 | <0.0001 |
| Control | 0.82±0.19 | 0.96±1.19 | 0.45 |

**Table 2:** Effect of energy drink consumption on blood urea levels. Paired t test was done to compare the levels at day 0 and day 90. A p value <0.05 was significant.

| **Blood Urea (mg/dl)** | | | |
|---|---|---|---|
| | Blood Urea (Day 0) | Blood Utrea at 90 days | P value |
| Case | 19.55±3.89 | 34.27±8.33 | <0.0001 |
| Control | 15.96±4.21 | 15.67±4.5 | 0.41 |

## Discussion

Kidney disease is a complex disease and is associated often with other systemic illnesses such as diabetes and hypertension. Kidney disease has several causes [26]. Together with other serious health problems like heart diseases, diabetes, and hypertension, kidney diseases contribute a major part in the total global morbidity and mortality [27]. According to an estimate, 1.2 million deaths, 19 million disability-adjusted life-years (DALYs) and 18 million years of life lost were directly associated with kidney disorders especially the reduced glomerular filtration rates [28,29]. There is a constant rise in the number of people dying due to kidney failure [29].

Several people die without access to dialysis and each year about 1.7 million deaths occur due to acute kidney problems [30,31]. Overall, 5–10 million mortalities occur due to kidney disease [27].

Kidney diseases pose a huge financial burden on the economy of the country. Studies report that developed countries utilize about 2-3% of the health care budget in the treatment and management of kidney diseases. This huge amount of budget goes in the treatment of only 0.03% of the total population those undergoing treatment for kidney diseases [32]. It is estimated that by the year 2030 there will be about 5 million people who will receive dialysis due to kidney failure [30,33,34]. So, it becomes imperative to study and evaluate the lifestyle related factors responsible for renal failure. One of the important lifestyle habits; consumption of caffeinated high energy drink, may be

considered as a contributing factor in renal failure.

Several studies in rat models have shown the negative effects of caffeine on the renal function [13-15]. Various mechanisms have been proposed for the mechanism of action of caffeine. Caffeine acts by inhibiting the adenosine receptors, that subsequently inhibit rennin release [35]. Adenosine and angiotensin II play pivotal roles in maintaining the vascularity of the afferent and efferent arterioles of the kidney. So, adenosine and angiotensin II are crucial for the maintenance of intraglomerular pressure. The inhibition of adenosine by caffeine may result in alteration in the vascularity of the afferent and efferent arterioles, thereby increasing the flow of arterial blood into the glomerular capillaries. These events may subsequently result in increased glomerular pressure and lead to kidney damage [36].

Studies conducted in animals highlight the negative effects of chronic use of energy drinks containing caffeine, resulting in renal failure. Recently a study conducted in rats reported elevated levels of blood urea in energy drink (Tiger) treated group [14]. There is a paucity of studies evaluating the effects of high energy drinks like Tiger in human population. A recent case report presented the effects of acute consumption of huge amounts of energy drink (Red Bull) on kidney. This study highlights that large quantities of high energy drink (Red Bull) resulted in acute renal failure [37]. There are two more case reports available that have shown adverse effect of caffeine containing energy drinks on renal function in humans [38,39]. To the best of our knowledge we are the first to report a study showing the negative effects of energy drink (Tiger) consumption on markers of renal function i.e. serum creatinine and blood urea. Consistent with the results of the published case reports, we observed a significant rise in the levels of serum creatinine and blood urea in the participants consuming energy drink (Tiger) for at least 90 days. Tiger contains 20 mg/250 ml of caffeine which is considered as moderate level but if consumed for long periods can result in renal alterations in the serum creatinine and blood urea, the markers for kidney function. The results of the present study warrant for further studies with large sample sizes to validate the findings of the present study. Other renal function indicators like glomerular filtration rate should have been evaluated to further ascertain the negative effect of energy drink (Tiger) consumption on renal function. Considering the negative effects on the renal function, the indiscriminate use of high energy drinks should be stopped or regulated. People should be educated about the contents of the energy drinks and made aware of the negative effects of long term consumption of these drinks. The main purpose of these energy drinks is to act as a stimulant for physical and mental activeness. There are several other alternative ways one can adopt to achieve this. Alternative like healthy food, healthy lifestyle, meditation, yoga, and exercise can be incorporated in the routine life-style habits to keep the body and mind alert and active [40,41].

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