

# The Joint Influence of Protein Supplements, Soft-drinks and Extreme Physical Activity on the Development of Acute Renal Injury and Hypokalaemia

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## ABSTRACT

*We present a case of a 33-year-old man who complained of weakness, fever and decreased urination. A personal history revealed a consumption of creatine, protein supplements, soft-drinks containing caffeine and stevia, and extreme physical activity which included lifting of heavy weights. The patient developed anuria, uraemia, fatigue, rhabdomyolysis and paradoxical hypokalaemia. After the patient had seven successive dialysis treatments, normal kidney function was restored. The report presents the first case of acute renal injury followed by hypokalaemia due to the combined action of the excessive consumption of supplements, soft-drinks with stevia and caffeine, and extreme physical activity.*

**Keywords:** Acute renal failure, physical activity, proteins, soft-drinks

## Influencia Conjunta de Suplementos Proteínicos, Bebidas Estimulantes y Actividad Física Extrema en Desarrollo de Insuficiencia Renal Aguda e Hipocalemia

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## RESUMEN

*Presentamos un caso de un hombre de 33 años de edad que se quejaba de debilidad, fiebre y micción disminuida. La historia personal reveló el consumo de creatina, complementos proteínicos, bebidas estimulantes con cafeína y stevia, y la actividad física extrema que incluyó levantamiento de pesas. El paciente desarrolló anuria, uraemia, fatiga, rabdomiolisis y hipocalemia paradójica. Después de siete tratamientos de diálisis consecutivos, el paciente restableció la función renal normal. El informe presenta el primer caso de insuficiencia renal aguda después de hipocaliemia debido a la acción combinada del consumo excesivo de suplementos, bebidas con stevia y la cafeína, y la actividad física extrema.*

**Palabras clave:** Proteínas, refrescos, la actividad física, la insuficiencia renal aguda

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## INTRODUCTION

Performance enhancing supplements are being increasingly used by athletes and those who want to gain mus-

cle bulk, strength and endurance, despite the many opposing opinions on their benefit and detriment. The number of commercial combinations with vitamins, minerals, creatine and drug extracts with potentially nephrotoxic effects is rising. The medical data show that an extensive use of caffeine, ingredients of soft-drinks and energy-increasing supplements can lead to renal damage (1). The consumption of natural sweetener, stevia, can cause severe hypokalaemia and nephrotoxicity (2, 3). Forced physical activity during weight-lifting in combination

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with nephrotoxic supplements can consequently lead to rhabdomyolysis and precipitation of myoglobin in tubules causing the development of acute renal injury (4).

### CASE REPORT

A 33-year-old patient was hospitalized at the Clinic of Nephrology due to uraemia, anuria and fatigue. The patient was an athlete who was admitted to the hospital two days after he had been exposed to extreme physical activity, during a competition, with symptoms of weakness, dyspeptic problems, vomiting and decreased urination. He was on a restricted diet on the day of the competition. Symptoms of renal failure showed up during the competition while he was lifting 160 kg, 250 kg and 390 kg weights and rolling a 490 kg tire. Before the competition, the patient took around 11 g of proteins with half a liter of water, and after the competition around 60 g of proteins with another half a liter of water. During the day he was drinking around 2 L of soft-drinks. He was regularly taking proteins for ten days before the competition. He had been taking various supplements with proteins, herbal extracts, vitamins, minerals, creatine and glutamine at irregular intervals on his own.

On the following day the symptoms were more intense, and the patient experienced fever and decreased urination. He had visited the doctor one day before he was admitted to the Clinic, when he was diagnosed with azotaemia (urea 8.6 mmol/L and serum creatinine 545  $\mu\text{mol/L}$ ), hypertension 150/95 mmHg and mild swollen lower limbs. Due to the deteriorating health conditions, the patient was hospitalized in a local hospital, where an increase in nitrogen products (urea 11 mmol/L and serum creatinine 804,  $\mu\text{mol/L}$ ) and oliguria were documented, because of which he was transferred to the Clinic.

The patient was admitted with signs of uraemia, anuria and in a subfebrile state (37.4 °C). After a complete clinical, laboratory and echosonography scanning, he was diagnosed with acute kidney insufficiency. Upon admissions, his laboratory results were the following:

serum creatinine 919.2  $\mu\text{mol/L}$ , urea 12.1 mmol/L, uric acid 948 mmol/L, serum electrolytes – sodium 129 mmol/L, potassium 3.2 mmol/L, ionized calcium 0.94 mmol/L, myoglobin 789 nmol/L, leukocytosis  $15.4 \times 10^9/\text{L}$  and C-reactive protein 9.2 mg/L. His bodyweight was 120 kg (2.5 kg more than usual).

Due to uraemia and anuria, treatment with haemodialysis was started, after placing an internal jugular catheter. The patient had seven successive dialysis treatments 3–4 hours long. For the first four days, diuresis was less than 500 mL, on the fifth day 1800 mL, maximum was recorded on the eleventh day 6800 mL after which a declining trend of diuresis was recorded (Figure).

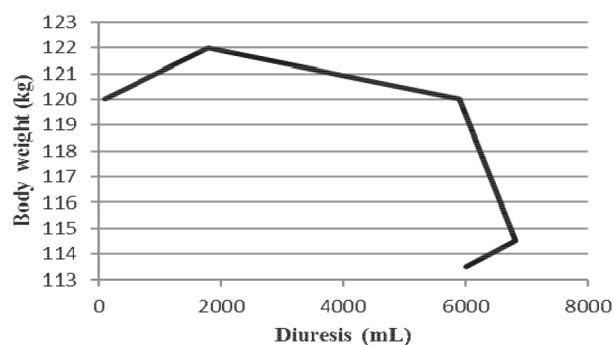


Figure: Relationship between diuresis and bodyweight by days.

Bodyweight was 120 kg for the first four days, 122 kg on the fifth day, with a gradual fall to 113.5 kg on the thirteenth day of hospitalization. The values of serum creatinine reached maximum value of 989.1  $\mu\text{mol/L}$  on the fifth day, after which there was a recorded decrease (648.8  $\mu\text{mol/L}$  on the seventh day, 156.2  $\mu\text{mol/L}$  on the fourteenth day). On the seventeenth day of hospitalization, the values of serum creatinine were 131.7  $\mu\text{mol/L}$ , urea 2.3 mmol/L, uric acid 161  $\mu\text{mol/L}$  and potassium 3.6 mmol/L. The values of myoglobin were 259.72 nmol/L on the fifth day and 133.53 nmol/L on the seventh day, while they normalized on the thirteenth day (Table).

Table: Patients parameters in sera during hospitalization

Day	Concentration of potassium mmol/L	Concentration of myoglobin nmol/L	Concentration of creatinine $\mu\text{mol/L}$	Concentration of uric acid $\mu\text{mol/L}$	Concentration of urea mmol/L
1.	3.2	789.00	919.2	948	12.1
5.	4.2	259.72	989.1	309	10.3
7.	4.4	133.53	648.8	231	7.9
14.	4.9	69.38	156.2	204	2.1
17.	3.6	/	131.7	161	2.3

The patient was in a stable condition, with a normalized kidney function, when he was discharged from the hospital on the seventeenth day, with a recommendation for his liquid intake to be above 2000 mL and to avoid any physical activity in the short-term.

## DISCUSSION

Literature has shown cases of kidney dysfunction in men caused by creatine supplementations. Recommended daily dose of creatine monohydrate is 20 g daily, for a few days followed by 1 to 10 g/day. On the other hand, there are studies that have demonstrated that long-term oral creatine supplementation in healthy athletes did not result in renal function impairment (5). In our case, the patient took small amounts of creatine and not continuously. However, he used other substances and had intense physical activity which, presumably in combination, contributed to renal impairment.

In addition, the patient used high doses of hydrolyzed whey protein supplements continuously. Contrary to the benefits of the use of proteins by athletes, literature shows that an increase in protein intake through food or supplements can lead to renal stress, loss of calcium and bone catabolism. No abnormalities have been noticed among the body builders using 2.8 g/kg proteins a day. However, with existing kidney disease, a halved protein intake of the RDA (around 0.8 g/kg daily) is recommended (6).

An excessive physical activity could be one of the risk factors for kidney damage. Physical activity can lead to relative organ ischaemia related to the degree of adaptation of the organ, as well as to the damage of the muscle and rhabdomyolysis as a consequence. Although athletes adapt to sympathetic vasoconstriction, relative ischaemia can damage organ functions. On the other hand, a connection between the muscle damage and kidney damage was established in the case of rhabdomyolysis in different sports, including body building (4).

Verified hypokalaemia is unusual due to reported anuria, rhabdomyolysis and acute renal injury, which is usually associated with hyperkalaemia. Some of the assumptions for developing hypokalaemia are increased intake of proteins, as well as increased intake of caffeine and stevia from soft-drinks and supplementations. The dose of caffeine of 180–360 mg can lead to redistribution of potassium into the cells and an increase in the renal excretion (7). Caffeine increases the level of renin and consequently angiotensin II and decreases the effect of adenosine so that glomerular hypertension and renal

damage can occur (1). It is shown that oral intake of hydrolyzed proteins and amino acids in combination with carbohydrates can increase the secretion of insulin up to 100% as compared to the intake of carbohydrates alone (8). Insulin increases activity of Na<sup>+</sup> pump in the muscle cells and the entrance of potassium into the cells which leads to hypokalaemia (9).

Stevia is one of the natural sweeteners of the cola drinks with a herbal origin, whose leaves contain a complex mixture of natural sweet diterpene glycosides – stevioside, steviolbioside, the rebaudiosides A, B, C, D, E and dulcoside A responsible for the sweet taste (10). There was a reported case of a 30-year-old woman admitted to the hospital with oedema, hypertension and hypokalaemia due to a chronic use of stevia sweetener (6–8 g daily per cup of coffee, 2–3 times a day and in cakes once a week for 9 months). The conclusion was that stevia inhibits 11-β-hydroxysteroid dehydrogenase Type 2, which is responsible for the conversion of cortisol into cortisone. Cortisol, cortisone and aldosterone maintain a proper balance of sodium and potassium in the serum regulating their excretion through the kidneys. Phytochemicals from stevia and liquorice, disturbs this balance and lead to hypokalaemia and hypertension (2). There was a reported case from our working group of a woman hospitalized with acute renal failure and hypokalaemia due to excessive use of teas sweetened with liquorice (3). These cases point to the potential danger of the natural sweeteners.

This case study for the first time indicates that creatine and protein supplementation combined with extreme physical activity and excessive use of soft-drinks with caffeine and stevia could be a potential aetiological factor for the development of acute kidney damage. Hypokalaemia occurred unexpectedly in acute renal injury presumably caused by the excessive use of proteins, natural sweetener stevia and caffeine from soft-drinks. Commercial supplements with lack of evidence on efficiency and safety are widely used in everyday practice, although they could manifest potential toxic effect.

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