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SHORT COMMUNICATION

# Serum zinc is associated with plasma leptin and Cu–Zn SOD in elite male basketball athletes

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ABSTRACT

This paper investigates the relationship between plasma trace element and plasma leptin, as well as percent fat mass, in 16 male basketball athletes. Blood samples were obtained before intensive training and 24 h after intensive training to measure plasma zinc (Zn), copper (Cu), calcium (Ca), magnesium (Mg), iron (Fe), and leptin levels. High-density lipoprotein cholesterol (HDL), low-density lipoprotein cholesterol (LDL), triglyceride (TG), total and cholesterol (TC) levels were determined using commercially available kits for humans. Subjects presented similar values in terms of age (21.1 ± 2.2 years old), body mass index (23.9 ± 2.00 kg/m$^2$), percent body fat (14.40 ± 1.52%), plasma hemoglobin (150.1 ± 9.4 g/L), plasma Zn (17.47 ± 1.28 μmol/l), plasma Cu (13.42 ± 1.40 μmol/L), plasma Ca (2.41 ± 0.14 mmol/L), and plasma Mg (0.96 ± 0.02 mmol/L). The correlation analysis between degree of plasma leptin and plasma element contents was performed using the SPSS 16.0 software. Plasma Zn correlated positively with plasma leptin ($r$ = 0.746, $P$ < 0.01), Cu–Zn SOD ($r$ = 0.827, $P$ < 0.01), and negatively with percent fat mass ($r$ = –0.598, $P$ < 0.05) under no-training conditions. Meanwhile, plasma Cu, Ca, Mg, and Fe did not correlate with plasma leptin or percent fat mass ($P$ > 0.05). In conclusion, plasma Zn may be involved in the regulation of plasma leptin and may serve as a lipid-mobilizing factor in Chinese men's basketball athletes.



## Introduction

Leptin, which is considered as one of the most important hormones secreted by adipose tissue [1], has been demonstrated to be vital not only in the regulation of appetite and energy balance, but also in neuroendocrine and immune functions [2,3]. Several factors directly influence leptin levels; these factors include exercise [4] and trace element [5–7].

Basketball is a dynamic and intermittent exercise that involves high-intensity anaerobic activity [8]. In particular, men's basketball physiologically requires considerable amounts of energy and metabolic homeostasis [9]. Regular basketball training is followed by a decline in circulating leptin levels, even in athletes without body weight changes [10]. However, no changes were observed in plasma leptin levels after short-term moderate aerobic exercise or after intensive fitness and speed exercise in basketball players [10].

Trace elements are functional components of numerous enzymes and are involved in various metabolic processes [11]. Although trace element concentrations are subject to homeostatic control, changes in trace element levels in the organs and body fluids during physical exercise may adversely affect athletic performance [11]. Among the essential trace elements, zinc (Zn) and copper (Cu) serve crucial functions in regulating the hematologic system [12,13]. Serum zinc profiles were significant reduced in adipose people in comparison with controls [14,15]. Calcium (Ca) is required for robust Akt phosphorylation and leptin secretion [16]. Circulating leptin may be related to increased urinary magnesium (Mg) loss in patients with type I diabetes [17]. Circulating leptin and Mg are significantly correlated with birth weight, birth length, and adiponectin in infants [18]. The increased production of leptin in overweight individuals may be a major contributor to the aberrant iron (Fe) status observed in these population groups [19]. These controversial studies investigated the relationship between circulating trace elements and circulating leptin [6,20].

In this study, we determine plasma trace elements, plasma leptin, and percent fat mass in Chinese men's basketball athletes and analyze the correlation of circulating trace element to circulating leptin and percent fat mass.

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## Materials and methods

### Subjects

Sixteen senior elite basketball athletes participated in this study after we fully explained the objectives and obtained written consent. The Research Ethics Committee of the China Institute of Sport Science approved the study protocol. All athletes were adults (mean age 21.2 ± 2.2 years old) who performed rigorous daily training and participated in national and international competitions. Each athlete received an individualized dietetic orientation based on the maintenance of adequate body composition for the sport modality for 10 months. This study began when the weights of the athletes had stabilized in the individual category. During this study, the athletes did not use vitamin or mineral supplements.

### Anthropometric measurements and body composition

Total body mass was measured to the nearest 0.1 kg using a scale. Height was measured to the nearest 0.5 cm using a height gauge. Based on the weight and height values, body mass index (BMI) was calculated for each individual using the formula of (weight/height$^2$).

Subcutaneous body fat was measured by using the skinfold measurement technique with a Lange skinfold caliper. Seven specific sites (triceps, pectoral, midaxillar, subscapular, abdominal, suprailiac, and quadriceps) were localized and measurements were performed as described by Lohman [21]. All measurements were performed on the right side of the body in triplicate, and the average skinfold score was used. A trained human morphology expert performed all measurements to reduce errors associated with technical difficulty. Body density was assessed using the predictive equation of Jackson and Pollock for men [22]. Percent body fat was calculated by the formula proposed by Siri [23]. Fat mass was calculated by using the formula [(percent body fat × weight)/100], and lean body mass was determined by subtracting the fat mass from the total weight.

### Sample collection

Blood samples were obtained from seated subjects before intensive training and 24 h after intensive training to prevent acute changes in circulating trace elements because of muscle damage and/or element loss because of sweat [24]. Mineral-free vacutainer tubes containing EDTA and heparin were used in the study. Blood samples were centrifuged at 3000 rpm for 10 min to separate the plasma and blood cells. Plasma aliquots were stored at −20 °C until analysis.

### Biochemical analysis

The trace element levels of plasma were measured using an atomic absorption spectrophotometer (Bohui model BH5500S). Plasma leptin was measured by using standard procedure in micrograms per liter using an ELISA kit (Leptin ELISA, Invitrogen, USA). High-density lipoprotein cholesterol (HDL), low-density lipoprotein cholesterol (LDL), triglyceride (TG), total and cholesterol (TC) levels were determined using commercially available kits for humans (Nanjing Jiancheng Bioengineering Institute, China). Plasma Cu–Zn SOD activity was measured according to L'Abbe et al. [25]. By using a blank and potassium thiocyanate in which all reagents present except the supernatant sample and determining the absorbance of blank and potassium thiocyanate, the T-SOD and Mn-SOD activity was calculated. Cu–Zn SOD activity (U/mL) = T-SOD activity − Mn-SOD activity. Blood hemoglobin and hematocrit were obtained by using an electronic hematology analyzer (ACT DIFF II 2, Beckman Coulter, USA). The intra-assay coefficient of variation for all measurements was lower than 5%. All assays were run in duplicate or triplicate.

**Table 1**
Anthropometric profile and body composition of the basketball athletes.

| | Subjects ($n$ = 16) |
|---|---|
| Age, years | 21.2 ± 2.2 |
| Height, cm | 203.00 ± 8.64 |
| Weight, kg | 98.34 ± 9.92 |
| BMI, kg/m$^2$ | 23.9 ± 2.00 |
| Body fat, % | 14.40 ± 1.52 |

Values are expressed as the mean ± SD. BMI, body mass index.

**Table 2**
Biochemical parameters in the basketball athletes.

| Subjects ($n$ = 16) | Before intensive training | After intensive training |
|---|---|---|
| Hb, g/L | 151.9 ± 8.9 | 150.1 ± 9.4 |
| Hct, % | 45.1 ± 3.9 | 44.8 ± 2.4 |
| Plasma leptin, μg/L | 10.12 ± 4.5 | 9.06 ± 3.50 |
| Plasma zinc, μmol/L | 18.29 ± 2.31 | 17.47 ± 1.28 |
| Plasma copper, μmol/L | 13.95 ± 1.97 | 13.42 ± 1.40 |
| Plasma calcium, mmol/L | 2.62 ± 0.28 | 2.41 ± 0.14 |
| Plasma magnesium, mmol/L | 0.93 ± 0.11 | 0.96 ± 0.02 |
| Plasma iron, mmol/L | 23.51 ± 6.31 | 21.84 ± 5.26 |

Values are expressed as the mean ± SD. Hb, hemoglobin; Hct, hematocrit.

### Statistical analysis

All results were expressed as the means ± SD. Pearson's correlation coefficients between the circulating trace elements and circulating leptin or percent fat mass were employed. $P < 0.05$ denotes statistical significance.

## Results

Subjects presented similar values in terms of age (21.1 ± 2.2 years old), BMI (23.9 ± 2.00 kg/m$^2$), and percent body fat (14.40 ± 1.52). The anthropometric parameters and body composition of the basketball athletes are shown in Table 1. The athletes showed no signs of anemia and hemodilution or hemoconcentration, as indicated by the hematocrit and hemoglobin values. The plasma Zn, Cu, Ca, Mg, and Fe concentrations, either before intensive training or after intensive training, were adequate for the nutritional status of all athletes (Table 2). Plasma leptin levels were within the normal reference range for lean adults [26], and there were not difference before intensive training and after intensive training in the basketball athletes (Table 2).

Plasma leptin expressed a strong correlation with plasma Zn ($r$ = 0.746, $P < 0.01$; Fig. 1), and no significant correlation with plasma Cu, Ca, Mg, and Fe was observed ($P > 0.05$, Table 3). In addition, the percent fat mass exhibited a strong negative correlation with plasma Zn of the basketball athletes ($r$ = –0.598, $P < 0.05$; Fig. 1), but no significant correlation with plasma Cu, Ca, Mg, and Fe was found ($P > 0.05$, Table 4). No significant correlation was found

**Table 3**
Results of the Pearson correlation coefficient between plasma elements and plasma leptin in the basketball athletes.

| | $r$ value | $P$ value |
|---|---|---|
| Plasma copper | 0.193 | 0.473 |
| Plasma calcium | 0.382 | 0.144 |
| Plasma magnesium | 0.243 | 0.365 |
| Plasma iron | 0.406 | 0.118 |