



## Sweat Copper, Zinc, Iron, Magnesium and Chromium Levels in National Wrestler

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This study was undertaken to evaluate sweat copper, zinc, iron, magnesium and chromium levels in 26 adult sportsmen (wrestlers) aged between 17-20 and average weight of 73 kg in Turkey. To eliminate the possibility of intestinal parasites that could be effective on element absorption, all subjects were examined for intestinal parasites. Sweat samples were collected at 50%  $VO_{2peak}$  for 30 min while wrestlers trained at room the temperature ( $\sim 27^\circ C$ , RH=51%) by the whole body method. All samples were analyzed by atomic absorption spectrometry. The mean concentrations of copper, zinc, iron, magnesium and chromium were found to be  $28.58 \pm 3.3 \mu g/dl$ ,  $42.6 \pm 4.0 \mu g/dl$ ,  $109.6 \pm 8.5 \mu g/dl$ ,  $53.15 \pm 6.72 mg/dl$  and  $10.31 \pm 1.31 \mu g/dl$  respectively. It appears that substantial quantities of trace elements are excreted in the sweat of those sweating during the training. These observations suggest that excretion of trace elements by sweating induces trace element decrease. Mineral elements, including magnesium, zinc, copper, iron and chromium are required by the body in modest amounts for the maintenance of health and for the development of optimal physiological function. For sportsmen, adequate amounts of these minerals are required for physical training and maximum performance.

**Key words:** Copper, Zinc, Iron, Magnesium, Chromium, Sweat, And Atomic Absorption Spectrometry

### Milli Güreşçilerde Ter Çinko, Bakır, Demir, Magnezyum ve Krom Seviyeleri

Yaşları 17-20 arasında değişen ve ortalama ağırlıkları 73 kg olan 26 erkek milli güreşçi üzerinde yapılan çalışmada, ter bakır, çinko, demir, magnezyum ve krom seviyeleri değerlendirildi. İntestinal parazitlerin element absorpsiyonuna olabilecek etkisi göz önünde bulundurularak parazitli bireyler çalışmaya dahil edilmedi. Ter örnekleri %50  $VO_{2tepe}$  içinde 30 dakika süre ile antrenman sırasında oda ısısında ( $\sim 27^\circ C$ , RH= % 51) total vücut metoduyla polietilen tüpler içine toplanmıştır. Bütün örnekler atomik absorpsiyon spektrofotometrede analiz edildi. Sonuçlar sırasıyla, bakır  $28.58 \pm 3.3 \mu g/dl$ , çinko  $42.6 \pm 4.0 \mu g/dl$ , demir  $109.6 \pm 8.5 \mu g/dl$ , magnezyum  $53.15 \pm 6.72 mg/dl$  ve krom  $10.31 \pm 1.31 \mu g/dl$  olarak elde edilmiştir. Bu sonuçlar, antrenman sırasında sporcuların ter kaybıyla birlikte oldukça fazla miktarda elementin vücuttan atıldığını göstermektedir. Mineral elementler; magnezyum, çinko, bakır, demir ve krom sağlıklı bir yaşamın sürdürülebilmesi için ve optimum fizyolojik fonksiyonların yerine getirilebilmesi için gereklidir. Sporcular için optimum fizyolojik fonksiyonlar ve maksimum performans için de bu gereklidir.

**Anahtar Kelimeler:** Magnezyum, Bakır, Çinko, Demir, Krom, Ter, Atomik absorpsiyon Spektrofotometre, Güreşçi

The loss of body fluids is essential to our well being, skin has also been called our 'third kidney'. Sweat is a particularly healthy activity for lots of reasons - renewal of the immune system, discharge of toxins and heat regulation. Today we know that a body, which cannot perspire, because the passage of sweat is impeded one way or another, accumulates poisons and dies within a few hours.<sup>1,2</sup> The determination of the metal ions in biological materials such as blood, hair, nail and urine are of increasing interest of many clinical and research laboratories. Sweat is an also important biological material for the determination of metal ions and element status.<sup>3-5</sup> Mineral elements, including magnesium, zinc, copper, iron and chromium are required by the body in modest amounts for the maintenance of health and for the development of optimal physiological function. For sportsmen, adequate amounts of these minerals are required for physical training and performance. Studies of sportsmen during training, as compared to non-training control subjects, indicate the potential for increased losses of minerals in sweat. Some studies report sub-optimal intakes of minerals, particularly among sportsmen who are actively attempting to lose

weight to meet standards for competition. However, most sportsmen consume diets that provide adequate amounts of minerals to meet population standards. Sportsmen should be counseled to consume foods with high nutrient density rather than to rely on mineral supplements. General use of mineral supplements can alter physiological function and impair health.<sup>3,6-14</sup> Magnesium status is adequate for most sportsmen, however it is not clear whether magnesium supplements can enhance performance.<sup>3,8,11</sup> It has been shown that magnesium may be lost in sweat.<sup>15</sup>

Sportsmen may have a zinc deficiency induced by poor diet and loss of zinc in sweat and urine. Most of the body Zn content is present in muscle (%60) and bone (%30). Limited data exist on the relationship of performance and zinc status. Widespread deficiencies in copper have not been documented, and there are also limited data to suggest that copper supplementation will enhance performance.<sup>3,6-10,12,16</sup>

Because of the low intakes of chromium for the general population, there is a possibility that sportsmen may be deficient.<sup>2</sup> Exercise may create a loss in chromium because of increased excretion into the urine and sweat.<sup>2,8,16,17</sup> Many sportsmen are iron depleted, but true iron deficiencies are rare.<sup>8,13,14</sup> Kayseri is in the middle Anatolia region of Turkey and the approximate population is around 500.000. According to our literature search, no report has been published about the sweat copper, zinc, iron, magnesium and chromium levels of sportsmen in Turkey.

In the present study, the sweat copper, zinc, iron, magnesium and chromium concentrations of twenty-six healthy adult sportsmen (wrestlers) living in Kayseri, Turkey were determined by atomic absorption spectrometry.

## MATERIAL and METHODS

The present study was carried out in collaboration with the Department of Biochemistry and Department of Parasitology, Faculty of Medicine, Kayseri, Turkey. As the samples were collected after a training camp period, each subject naturally kept a food diary for one week prior to the sample collection. None of the subjects were smokers and had any known pathologies at the time of sampling. Prior to exercise, subjects thoroughly washed with liquid soap and dried with towels that had been

rinsed in water in order to prevent contamination of the sweat samples. The subjects were informed of the procedures to be used in the study and signed an informed consent statement. The subjects were weighed in their training clothes. Subjects consumed 250 ml of water prior to exercise.

Sweat samples were collected at 50%  $VO_{2peak}$  for 30 min while wrestlers trained at room temperature (~27 °C, RH =51%) by the whole body method using polyethylene bags and were stored in glass tubes, which had been previously cleaned with hydrochloric acid. Briefly; a pre-weighted polyethylene arm bag was placed on one arm and secured with an elastic band at the deltoid tuberosity for 30 min. Arm bag sweat volume was measured in grams by using a digital scale. Total body sweat rate was calculated from change in body mass measured and corrected for fluid intake and urine volume. Sweat samples were stored at 4 °C in de-ionised tubes until analysis. The samples were centrifuged at 3500 x rpm for 15 min, and the supernatant was filtered through a Whatman 542 filter to remove cellular debris prior to analysis.<sup>18</sup> In addition, to eliminate the possibility of intestinal parasites that could be effective on element absorption all subjects were examined for intestinal parasites. For this, wet mount preparations in 0,9 % NaCl, diluted Lugol's iodine and flotation technique in saturated saline solution were used and parasite negative subjects were selected for the study.<sup>19</sup> All chemicals used were of super pure grade unless stated otherwise; aqueous reagents were prepared in double-distilled de-ionized water. Copper, zinc, iron, magnesium and chromium standards were provided from Aldrich chemical company. To prepare working standards, serial dilutions were made with double-distilled de-ionized water. Copper, zinc, iron, magnesium and chromium concentrations of sweat samples were determined by Zeeman atomic absorption spectrometry (Hitachi Z-8000 Model). Sweat was prepared by dilution with de-ionized double-distilled water. We matched the viscosity of the standard solutions to the viscosity of the diluted sweat by adding an appropriate amount of glycerol.<sup>20</sup> The total levels of Cu, Zn, Fe, Mg and Cr in the samples were determined by regression analysis of the sample absorption data on the standard curve.

## RESULTS

Sweat samples of 26 healthy subjects aged between 17 and 20 from Kayseri, Turkey were analyzed for copper, zinc, iron, magnesium and chromium by

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**Table 1.** Sweat copper, zinc, iron, magnesium and chromium levels in wrestlers.

	Elements						
	Age (Mean ± SD)	Weight (Mean ±SD)	Cu (µg/dl) (Mean ± SD)	Zn (µg/dl) (Mean± SD)	Fe (µg/dl) (Mean± SD)	Mg (mg/dl ) (Mean ± SD)	Cr (µg/dl) (Mean ± SD)
<b>Wrestler</b>	19.52±0.7	73.04±3.42	28.58±3.3	42.6 ±4.0	109.6±8.5	53.15±6.72	10.31±1.31

Zeeman atomic absorption spectrometry. The sweat levels of copper, zinc, iron, magnesium and chromium are presented in Table 1. The mean (±SD) copper, zinc, iron, magnesium and chromium levels were 28.58 (±3.3) µg/dl, 42.6 (±4.0) µg/dl, 109.6 (±8.5) µg/dl, 53.15 (±6.72) mg/dl and 10.31 (±1.31) µg/dl respectively.

### DISCUSSION

The minerals copper, zinc, iron, magnesium and chromium are directly involved in maintaining and regulating many of physiological processes, especially those involved in normal carbohydrate, fat and protein metabolism and the ultimate formation of usable energy. Therefore, it is important to establish whether exercise and training alter the levels of these trace elements, and to determine the overall effects of exercise on nutritional status and physical performance.

This study examines the importance of the mineral loss during the training of the one of much effort needed sport (wrestling), and accordingly whether supplements of these minerals are necessary to enhance the performance. Macro mineral of magnesium, and trace minerals of zinc, copper, chromium, and iron are tested. It is known that magnesium status is adequate for most sportsmen, and it is not clear whether magnesium supplements can enhance performance. Serum magnesium concentration, although commonly used to measure magnesium nutriture in nutritional surveys of physically active persons, is a relatively insensitive index of marginal magnesium status. Indeed, its insensitivity generally rules out a conclusion that physical activity does not adversely affect magnesium status. On the other hand, we know that serum magnesium is in the normal range when intake is adequate, irrespective of physical activity.<sup>3,8,11</sup>

Another route of magnesium loss during exercise is sweat and cellular exfoliation. Men performing controlled work for 8 h on ergocycles in the heat (100°F) lost 15.2–17.8 mg/dl in sweat. In this study, the lost of magnesium by sweat was 53.15 mg/dl. Magnesium loss in sweat accounted for 15% of daily

magnesium intake and 10–15% of total magnesium excretion (feces, urine, and sweat). Sportsmen may have a zinc deficiency induced by poor diet and loss of zinc in sweat and urine. Limited data exist on the relationship of performance and zinc status. We found a 42.6 µg/dl loss of zinc in sweat. Widespread deficiencies in copper have not been documented, and there are also limited data to suggest that copper supplementation will enhance performance.<sup>3</sup> Our study showed a 28.58 µg/dl loss of copper in sweat. Because of the low intakes of chromium for the general population, there is a possibility that sportsmen may be deficient. Exercise may create a loss in chromium because of increased excretion into the urine. In other words, exercise results in a marked mobilization of chromium into circulation, while zinc and copper levels have been shown to either remain stable or increase. However some studies showed that exercise also results in large increases in excretion of chromium, zinc and copper.<sup>2,8,12,16,17</sup> Urinary chromium excretion has been shown to increase on an exercise day compared with a rest day, while increased zinc losses occur in urine and sweat and increased copper losses occur in urine, and feces.<sup>3,9,10,12</sup> Our study showed that chromium lost was to be the minimum with 10.31 µg/dl, as compared to the other minerals, which we assessed in sweat.

Many sportsmen are iron depleted, but true iron deficiencies are rare. Iron depletion does not affect exercise performance but iron deficiency anemia does. Iron supplements have not been shown to enhance performance except where iron deficiency anemia exists.<sup>8,13,14</sup> Iron loss in sweat was found to be 109.6 µg/dl with the second highest level among all five minerals.

It is known that poor diets are perhaps the main reason for any mineral deficiencies found in sportsmen, although in certain cases exercise could contribute to the deficiency. The results of this study shows that some minerals especially magnesium and chromium has, important levels of excretion by sweat. These observations suggest that excretion of trace elements by sweating induces trace element decrease. Therefore, sportsmen doing difficult and

high energy consuming sports (this could be also generalized for workers who work in a hot environment and doing hard labor) and sweat, much habitually should ingest adequate amounts of trace elements. When exercise-enhanced mineral losses are coupled with dietary intakes below the recommended levels, which are common, place for both sedentary and exercising individuals, the nutritional status and overall health of exercising individuals may be sub-optimal. Therefore, mineral supplementation can be important to ensure good health, accordingly for maximum performance for the sportsmen.

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