Zinc in hair and serum of obese individuals in Taiwan[1-3]

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ABSTRACT Zinc concentrations in both serum and hair were assessed in 135 obese patients (51 males, 84 females) and in 57 controls (28 males, 29 females) to study the correlation between Zn and obesity. The body mass index (wt/ht^2) was also measured to evaluate its relationship to the Zn level in obese individuals. The serum and hair Zn contents in obese patients were markedly lower than in normal control subjects by 22 and 34%, respectively. The Zn content was inversely related to the body mass index. Thus Zn may play an important metabolic role in the development of obesity. *Am J Clin Nutr* 1988;48:1307–9.

KEY WORDS Obesity, serum zinc content, hair zinc content, body mass index

Introduction

Obesity appears to be a serious health problem in both developing and developed countries. Obesity, especially in children, has become more prevalent in Taiwan (1, 2). Although zinc is a well-known essential trace element in human nutrition, the correlation between Zn and obesity is not clear. However, lower Zn levels have been found in the hair of obese children and Zn levels were inversely related to serum triacylglycerol content (3). Obviously, Zn is related to obesity. This experiment was done to evaluate Zn levels in obese patients in Taiwan.

Subjects and methods

Obese patients (51 male, 84 female) and normal control subjects (28 male, 29 female) were selected from outpatients at the Veterans General Hospital, Taichung, Taiwan. Obese patients (aged 5–72 y) met the criteria that their body weights be 20% higher than their desirable weights and their body mass indexes (BMI, wt/ht^2) be > 25 kg/m^2 (4). BMIs ranged from 25 to 50 kg/m^2.

The obese patients tested negative for diabetes, hypothyroidism, and hyperlipoproteinemia. Body weight and height were measured between 0800 and 1100; blood and hair samples were taken at the same time. Hair was cut in 2–5-cm lengths measured from the scalp and washed with acetone, then deionized water. This washing process was repeated three times. The Zn contents in both the serum and the hair samples were determined by atomic absorption spectrometry (Model 551, Instrumentation Laboratory, Inc, Wilmington, MA) (5, 6). Statistical analyses (7) were done with the Student's *t* test and analysis of variance (ANOVA).

The procedures used were in accord with the recommendations of the Helsinki Declaration.

Results

Serum and hair Zn levels in the obese patients and the normal controls are shown in **Table 1**. Zn levels in serum and hair in patients with a BMI > 24 kg/m^2 were significantly lower than the normal control subjects. Males had higher serum Zn contents and lower hair Zn contents than did females. There was no interaction between sex and BMI for all three BMI levels (one-way ANOVA). Obese males had 29.7% lower serum Zn contents than did their normal counterparts. Obese females had 16% lower serum Zn contents than did normal females. Normal male control subjects had significantly higher hair Zn levels than did their obese and overweight counterparts, 77.5 and 65.6%, respectively. Normal females also had markedly higher hair Zn levels than did their counterparts, 49.5 and 30.8%, respectively. Serum and hair Zn content in patients with a BMI > 24 kg/m^2 (overweight and obese) was markedly lower than that in normal control subjects by 22 and 34%, respectively. ANOVA showed there to be a significant difference ($p < 0.006$) between sexes and a significant difference ($p < 0.001$) in BMI among the three BMI categories.

Figures 1 and 2 illustrate the correlation of the means of the Zn content and the BMI of each group shown in Table 1. The Zn content in serum and hair was inversely related to the BMI. However, such linear correlation was not found when all individual data were tested.

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TABLE 1
Zinc levels in obese individuals and normal control subjects*

	BMI	n	Serum Zn	Hair Zn
			μmol/L	*μmol/g*
Normal (BMI < 25 kg/m²)				
Male	21.5 ± 0.4†	28	18.1 ± 1.1[a]	2.04 ± 0.19[cd]
Female	22.1 ± 0.3	29	14.7 ± 0.9[b]	2.36 ± 0.17[ef]
Total		57	16.4 ± 0.7	2.20 ± 0.13
Overweight (BMI = 25–30 kg/m²)				
Male	27.4 ± 0.3	16	15.4 ± 1.5	1.23 ± 0.27[c]
Female	27.3 ± 0.2	52	13.0 ± 0.5	1.80 ± 0.17[e]
Total		68	13.6 ± 0.5	1.67 ± 0.15
Obese (BMI > 30 kg/m²)				
Male	34.9 ± 0.7	35	12.7 ± 0.8[a]	1.15 ± 0.10[d]
Female	35.4 ± 0.8	32	12.2 ± 0.8[b]	1.58 ± 0.16[f]
Total		67	12.5 ± 0.6	1.35 ± 0.10

* $\bar{x}$ ± SEM.
† a, b, c, d, e, and f designate pairs of groups significantly different at $p < 0.05$.

Discussion

The normal range for human serum Zn is 10.7–23.0 μmol/L (8) and the normal hair Zn concentrations average 3.30 ± 1.33 μmol/g (6) or range from 2.17 to 3.14 μmol/g (9). This study (Table 1) indicates that both serum and hair Zn levels in patients and normal control subjects are within the normal ranges defined above. In addition, there is a significant difference in Zn levels between sexes although its physiological significance remains unclear. However, Zn contents, even in these normal ranges, were significantly different among the three BMI groups.

BMI is widely used for determining obesity because it correlates well with body fat (10, 11). According to Bray (12) obesity is defined as a BMI > 30 kg/m² and overweight as a BMI of 25–30 kg/m². Thus, a person with a BMI < 25 kg/m² is classified as a normal control subject in this study as well as in previous reports (4, 12). These results indicate that serum and hair Zn contents in obese patients are significantly lower than those in normal control subjects. This finding is similar to Collipp's data for children (3). Furthermore, the hair Zn contents even in

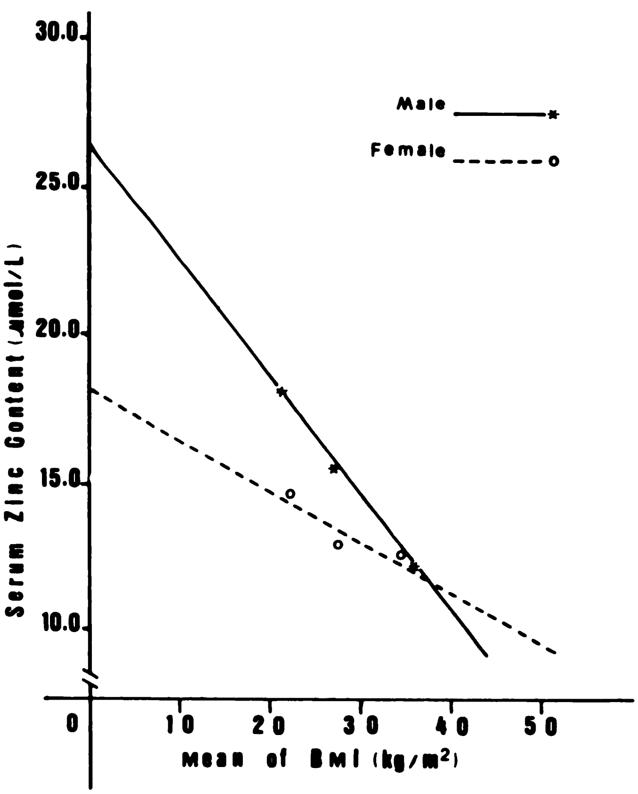

FIG 1. Correlation of serum zinc content and body mass index. Each symbol represents one group of patients from Table 1. The regression line for male serum Zn levels was described by the equation $y = 26.6 - 0.4x$; SEE = 0.26, $r = 0.998$. The regression line for female serum Zn levels was $y = 18.2 - 0.2x$; SEE = 0.60, $r = 0.941$.

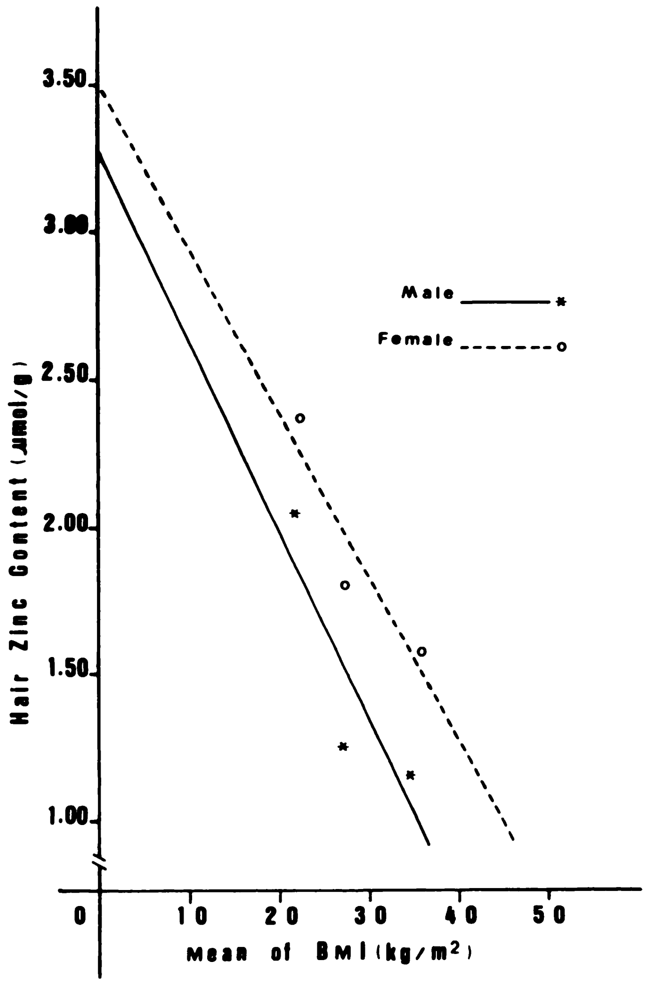

FIG 2. Correlation of hair zinc content and body mass index. Each symbol represents one group of patients from Table 1. The regression line for male hair Zn levels was described by the equation $y = 3.28 - 0.06x$; SEE = 0.34, $r = 0.874$. The regression line for female hair Zn levels was $y = 3.48 - 0.06x$; SEE = 0.20, $r = 0.934$.

the overweight groups are lower than those in the normal groups. Therefore, the correlation between Zn content and BMI may be physiologically important. From Figures 1 and 2 it is obvious that the higher the BMI, the lower the Zn content. On the other hand, Kennedy and Failla (13) reported that genetically obese (ob/ob) mice absorbed more and retained more Zn than did lean controls. These results may reveal a significant metabolic role of Zn in the development of obesity.

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