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The Correlatin of Dietary Cr, Cu and Zn Levels with Serum Lipid Healthy College Women Living in Choongnam Area

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ABSTRACT

The purpose of this study was to examine the intake of Cr, Cu, and Zn, which play important roles in lipid metabolism, and the relationship of these microminerals with serum lipids of healthy college women living in the Choongnam area. The nutritional status of the subjects (35 women) was evaluated based on anthropometric measurements, 24-hr dietary recall for 3 days Three-day meals and fasting blood were collected to analyze Cr, Cu, and Zn. The mean age, height, weight and BMI were 20 years, 158 cm, 55 kg and 22.42 kg/m^2, respectively. The mean daily energy intake was 85.9% of RDA for Koreans. The ratio of energy from carbohydrate, protein and fat was 60 . 24 : 16. The mean daily intake of Cr, Cu, and Zn was 60.07 μg/day, 2 64 mg/day, and 11.35 mg/day, respectively. The mean serum levels of Cr, Cu, and Zn were 143 μg/dl, 81.34 μg/dl, and 101.54 μg/dl, respectively. The mean serum levels of total cholesterol, triglycerides, HDL-cholesterol, LDL-cholesterol were 158.56 mg/dl, 29.27 mg/dl, 56.00 mg/dl, 6.12 mg/dl, respectively. In conclusion, the subjects of the present study were healthy and consumed normal levels of dietary Cr, Cu and Zn, which play roles in lipid metabolism. Therefore, serum lipids of the subjects were all in the normal range. There was no significant correlation between dietary microminerals and serum lipids.

KEY WORDS: chrominum, copper, zinc, serum lipids.

INTRODUCTION

The nutritional status of Koreans has improved as a result of rapid economic growth.[1] Although nutritional status has improved, other health problems such as obesity, atherosclerosis and diabetes have appeared.[1-6]. In 1989, the Economic Planning Board reported that as a major cause of death in Koreans, infectious disease tends to decrease but chronic disease tends to increase.[5] The board reported that coronary heart disease (CHD) accounted for more than 30% of all deaths.[6-8] CHD is caused by elevated blood lipid levels, which are influenced by dietary carbohydrate amount, kind of dietary lipid, energy intake, and dietary minerals[9-18]. These are all well established, except dietary minerals. Dietary Copper (Cu) and Zinc (Zn) were the only minerals that have been reported,[15-19] and Chromium (Cr) recently joined the list.[20] In Cu deficiency, synthesis and release of bile acid decreased and concentration of blood cholesterol increased.[21,22] Since Zn plays an antagonistic role to Cu, if Zn intake increases even with normal Cu intake, Zn/Cu ratio increases – causing Cu deficiency and resulting in increases in blood cholesterol level.[23] Zn deficiency affects synthesis of lipoprotein composing chylomicron, resulting in decreases in lipid absorption.[24] Additionally, it is reported that Zn supplementation reduces HDL-cholesterol.[25] Cr concentrations in human tissues decline with age, except for the lungs, in which Cr accumulates. Parity, juvenile diabetes, and coronary artery disease are associated with low Cr concentrations in hair or serum.[26] The intestinal absorption rate of dietary Cr is approximately 0.5% when the daily intake is 40 μg or more, and this absorption rate increases up to 2% when the daily intake is less than 40 μg.[27] Absorbed Cr is excreted almost completely through the urine. Cr deficiency increases blood cholesterol and triglyceride concentration.[28] The relationship of Cu and Zn with blood lipids has been reported by many investigators.[9,19] However, the relationship (s) of Cr with blood lipids have not been well established. Ad-

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ditionally, Korean RDA of Cr has not yet been established yet.

Thus, microminerals have a relationship to lipid metabolism but this relationship is not well established.

Therefore, we examined the relationships of several microminerals (Cr, Cu, and Zn) with serum lipid levels in college women living in the Choongnam area in order to provide the basic data for CHD.

SUBJECTS AND METHODS

1. Subjects and data collection

Thirty-five healthy college women living in the Choongnam area were selected. Food Samples were collected for three days determine the intake of energy and each nutrient by 24-hr recall method.

The collection of diet for three days was conducted to determine the intake of Cr, Cu, and Zn. Anthropometric measurements and blood pressure were taken, blood samples were collected to determine the levels of blood micromineral concentrations, and the correlation of dietary Cr, Cu, and Zn with blood lipids was examined.

2. Anthropometric measurements

Height and body weight were measured by Martin's instrument and Mean Balance Scale (Continental Scale Corp., Chicago, USA), and Body Mass Index (BMI) were calculated.

Systolic and diastolic blood pressure were measured by standard mercury manometer.

3. Energy and nutrient analysis

The amount of nutrient intake was determined by 24-hr recall method using the CAN program. Meal samples were collected for three days, homogenized, and micromineral contents were measured by wet method of Lim[29] using ICP (Inductively Coupled Plasma : Lactam 8440 Plasmalac).[30]

4. Blood analysis

After fasting for 12 hours, 15 ml of venal blood was collected, diluted 5-fold with secondary distilled water and centrifuged for 10 min (4℃, 3000 rpm) to remove protein. Serum Cr, Cu, and Zn were analyzed from supernatants using ICP serum triglycerides, total-cholesterol and HDL-cholesterol levels were analyzed by kit using enzymatic method (Yongdong Pharmaceutical Co.). LDL-cholesterol was calculated using the Friedwald equation.[31]

5. Statistical analysis

The statistical analysis was carried out with the Statistical Analysis System (SAS).[32] Mean and standard errors for all data were determined, and coefficient correlations were used to determine possible relationship between serum lipids and micromineral intake.

RESULTS AND DISCUSSION

1. Anthropometric measurements

Physical characteristics of the subjects are presented in Table 1. The mean age of the subjects was 20 years old, mean height was 158.4 cm and mean body weight was 55.1 kg. The average BMI values of subjects, and PIBW were 22.4 kg/m^2 and 103.3%, respectively, and physical characteristics of the subjects were considered normal. Mean blood pressure was 106.6/71.5 mmHg which is within the normal range. Therefore, these results indicate that the subjects for this study were normal.

2. Energy and nutrient intake

Mean energy and nutrient intake per day and a com-

Table 1. Anthropometric measurements of subjects (n=35)

Variables	Mean ± S.E.
Age (years)	20 00 ± 1.00
Height (cm)	158 41 ± 0 69
Weight (kg)	55.12 ± 1.38
BMI[1] (kg/m^2)	22.42 ± 0 44
SBP[2] (mmHg)	106.57 ± 1.58
DBP[3] (mmHg)	71.51 ± 1.03
PIBW[4] (%)	103.30 ± 2.46

1) Body mass index=Weight/Height^2
2) Systolic blood pressure
3) Diastolic blood pressure
4) Percent ideal body weight=body weight/ideal body weight×100

Table 2. The mean daily energy and nutrient intake of subjects (n=35)

Variables	Mean ± S.E.	% of RDA
Energy (kcal)	1717.03 ± 55.99	85 85
Protein (g)	68.14 ± 2 60	113.57
Animal protein	37.08 ± 2.66	
Plant protein	31.06 ± 2.14	
Fat (g)	46.21 ± 2.68	
Animal fat	21 76 ± 1.91	
Plant fat	24 45 ± 1.88	
Cholesterol (mg)	390.14 ± 34 73	
Carbohydrate (g)	257.63 ± 10.08	
Crude fiber (g)	4.79 ± 0.35	
Vitamin A (R.E.)	653.41 ± 52.33	93.34
Vitamin B_1 (mg)	1.72 ± 0.72	172.00
Vitamin B_2 (mg)	0.98 ± 0.05	81 67
Niacin (mg)	24.48 ± 11 25	188.31
Vitamin C (mg)	103.14 ± 86.12	187.53

parison with the Korean RDA are shown in Table 2. Mean daily energy intake was 1717 kcal, which was 85.9% of Korean RDA.

Mean daily protein intake was 68 g. Animal protein intake was 54 %, and vegetable protein was 46%. The ratio of energy from carbohydrate : protein : fat was 60 : 24 : 16. Therefore, carbohydrate intake was lower and protein intake was higher compared to Korean recommended nutrient ratio (65 : 15 : 20).

Vitamin A and vitamin B_2 intake were 93% and 82% of Korean RDA, respectively. Vitamin B_1, niacin, and vitamin C intake was 172%, 188% and 187% of Korean RDA, respectively. Mean daily cholesterol intake was 390 mg, which was higher than the amount recommended (300 mg/day) by FAO/WHO.

3. Dietary intake levels of Cr, Cu, and Zn

Mean daily intake of Cr, Cu, and Zn is shown in Table 3.

Cr intake from typical Western diet varies widely from 25 μg/day in elderly persons in England to approximately 200 μg in the Belgian and Swedish diets, but in the most recent international studies,[26] intake levels below 100 μg/day were reported. Two experimental diets, prepared to meet the RDA for all nutrients and furnishing 2, 800 kcal, contained 62 to 89 μg of Cr at a fat content of 25 to 43% of the energy, respectively.[35] This is in contrast to the average Cr intake of 25 to 33 μg/day from self-selected diets of adults in Beltsville, Maryland that contained 1,600 to 2,300 kcal, respectively.[27] A range of Cr intakes of 50 to 200 μg/day is tentatively recommended for adults.[34] This range is based on the absence of signs of Cr deficiency in the major part of the U.S. population, consuming an average of 50 μg/day. Also, the safety of an intake of 200 μg has been established in long-term supplementation trials in human subjects receiving 150 μg/day in addition to dietary intake.[35] In this study, mean daily Cr intake was 60.1 μg, which is in the range of 50–200 μg/day.

Mean daily intake of Cu and Zn, which have been known to play a crucial role in lipid metabolism, were 2.64 mg and 11.35 mg, respectively, and their levels were within Korean safety and adequate intake levels (2–3 mg/day, 13 mg/day).[36]

There are not many reports on Cu or Zn intake levels among Koreans. Mean daily intake Cu intake level was reported as 2.3 mg in college women[37] and 2.2 mg in women living in rural areas.[38] However, Joung *et al.* reported Cu and Zn intake levels of 1.1 and 6.7 mg, which are less than half those in the present study.[39]

Older studies suggested that the adult requirement for Cu ranged from 2.0–2.6 mg/day, whereas later studies showed that intakes of less than 2.0 mg/day, and often not much more than 1.0 mg/day, could maintain positive copper balance.[40] In another metabolic ward study, 13 men consuming a variety of typical U.S. diets were found to need 1.30 mg/day to replace fecal and urinary losses.[41] Because of the uncertainty about the quantitative human requirement for copper, it is not possible to establish an RDA for this trace element. Rather, the subcommittee recommends 1.5 to 3 mg/day as safe and adequate range of dietary copper intake for adults.

Acute toxicity, resulting in gastrointestinal irritation and vomiting has been observed following the ingestion of 2 g or more of Zn in the form of sulfate.[42] The more subtle effects of moderately elevated intake levels, not uncommon in the U.S. population, are of greater concern because they are not easily detected. Impairment of the copper status of volunteers by dietary Zn intake of 18.5 mg[43] or 25 mg/day[44] has been reported. Zn supplementation of healthy adults with amounts 20 times the RDA for 6 weeks resulted in the impairment of various immune responses.[45] Daily supplements of 80 to 150 mg caused a decline of high-density lipoproteins in serum after several weeks.[46] For these reasons, chronic ingestion of Zn supplements exceeding 15 mg/day is not recommended without adequate medical supervision.

4. Serum Cr, Cu, and Zn status

Blood micromineral levels of the subjects are shown in Table 4. The serum Cr level of this study was 1.43 μg/dl. This level was lower than that of the subjects in the reports of Kim *et al.* (2.88 μg/dl),[47] similar to those of Nielson (1.3–1.7 μg/dl),[48] and fell within the normal range for serum Cr concentration of healthy adults (0.14–0.15 mg/ml).[36]

Serum Cu, and Zn concentrations were 81.34 and 101.54 μg/dl, respectively. These values were 68 and 92% of normal value (Cu : 120 μg/dl and Zn : 110 μg/dl).[36]

Table 3. *Dietary intake of Cr, Cu and Zn of subjects* (n=35)

Dietary	Mean ± S.E.
Cr (μg/day)	60.07 ± 6.24
Cu (mg/day)	2.64 ± 0.06
Zn (mg/day)	11.35 ± 0.23

Table 4. Concentration of serum microminerals in subjects (n=35)

Serum	Mean ± S.E.
Cr (μg/dl)	1.43 ± 0.58
Cu (μg/dl)	81.34 ± 3.39
Zn (μg/dl)	101.54 ± 4.01

Table 5. Serum levels of lipids of subjects (n=35)

Serum lipids	Mean ± S E
Total cholesterol (mg/dl)	158.56 ± 6.01
Triglyceride (mg/dl)	129.27 ± 18.57
HDL-cholesterol (mg/dl)	56.00 ± 1 99
LDL-cholesterol (mg/dl)	76 12 ± 4.39

Table 6. Correlation between dietary microminerals and serum lipids

Serum / Diet	Total cholesterol	Triglyceride	HDL-cholesterol	LDL-cholesterol
Cr	0 14453	−0.07385	−0.29052	0.27984
Cu	0.06759	−0.08240	−0.21186	0.24231
Zn	0.12290	0.08115	−0.00192	0.06914

5. Blood lipid levels

Serum lipid levels of the subjects are shown in Table 5. The average serum triglycerides level was 129.3 mg/dl. This was similar to that of Kim *et al.* (128.6 mg/dl),[47] higher than that of Rhie *et al.* (83.7 mg/dl).[38] All these reported values fell within the normal range for Korean adolescents (55−139 mg/dl).[47] Total cholesterol, HDL-cholesterol and LDL-cholesterol levels were 158.6, 56.0 and 76.1 mg/dl, respectively. Total cholesterol level was lower than that in Korean adolescents female data (168mg/dl).[47]

6. Correlations between dietary microminerals and serum lipid composition

The relationship between dietary microminerals and serum lipids was analyzed using the Pearson correlation test. The results are summarized in Table 6. There was no significant difference between dietary microminerals and serum lipids. Our results might imply that there is some relationship between dietary Cr, Cu and Zn levels and serum lipids levels when the dietary intake of these microminerals is not in the normal range.

However, these relationships barely exist when dietary intake levels is in the normal range.

SUMMARY AND CONCLUSION

We examined the dietary intake levels of microminerals, blood levels of microminerals and lipids, and the correlation of these nutrients in 35 women college students living in Choongnam.

The average age was 20 years, and mean body weight and height were 55.1 kg and 158.4 cm, respectively. BMI was 22.4 kg/m^2. Average daily energy intake was 85.9 % of Korean RDA. Protein intake was 68.4 g, and animal and plant origin was 54.4% and 45.6%, respectively. The average fat intake was 46.2 g, and animal and plant origin was 47 % and 53 %, respectively. The energy % of carbohydrate : fat : protein was 60 : 16 : 24, which was within the normal range. Dietary Cr, Cu and Zn intake were 60.1 μg/day, 2.6 mg/day and 11.4 mg/day, respectively. Blood Cr, Cu and Zn levels were 1.4, 81.3 and 101.5 μg/dl, respectively. Dietary Cr, Cu, and Zn had no significant difference with serum lipids in this study.

In conclusion, the thirty-five subjects of the present study were healthy college women who had normal intake levels of dietary Cr, Cu, and Zn, which play roles in lipid metabolism.

Therefore, the serum lipid levels of the subjects were in the normal range and there was no significant correlation between dietary micromineral and serum lipids.

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