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Research Article

Comparison of serum level of zinc and magnesium in healthy subjects and patients with diabetes and metabolic syndrome and its association with insulin resistance in individuals aged over 10 in Ahvaz, Khuzestan Province, Iran

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Abstract: Many studies suggest the fluctuation of the serum level of zinc and magnesium in diabetic patients compared with healthy individuals and etiological role of these elements in the pathogenesis of diabetes. This study aimed to measure the serum level of zinc and magnesium in three groups of healthy individuals, patients with diabetes, and patients with metabolic syndrome and relationship of these elements with insulin resistance in Ahvaz population. In this cross-sectional descriptive-analytic study 150 person (50 healthy, 50 with diabetes, and 50 with metabolic syndrome) evaluated. For each participant questionnaire filled out including demographic information, blood pressure waist circumference, height measured and blood sampling. The collected data were analyzed using t-test, ANOVA, and Chi-square by SPSS 17 software at a significance level of 0.05. in results in this study Study findings showed that there is a significant relationship between zinc and magnesium serum levels in all groups. Also, a significant inverse relationship was observed between zinc level and insulin resistance in patients with diabetes and also magnesium level and FBS, zinc level and BMI, and magnesium and BMI in all three groups ($P<0.05$). In conclusion given the low levels of zinc and magnesium in diabetic patients, it is recommended that such people include foods rich in zinc and magnesium in their daily diet.

Keywords: Zinc; Magnesium, Patients with diabetes, metabolic syndrome, Insulin resistance.

INTRODUCTION:

Type II diabetes is a disease which occurs as a result of the inability of cells in glucose uptake or the inability of the pancreas to overcome insulin resistance. Type II diabetes accounts for approximately 90-95% of all cases of this disease [1]. Delaying the onset of diabetes complications is one of the major objectives of physicians. It has been reported that hyperglycemia control can greatly reduce the long-term and microvascular complications of diabetes. Also, scientists have observed a decrease in serum levels of some elements in diabetics compared with non-diabetics [2, 3]. If the deficiency of these elements is compensated in diabetics, a significant decrease in blood sugar would be resulted [4]. In diabetes mellitus, zinc deficiency occurs which is because of hyperzincemia and impaired intestinal absorption of this element. In a study conducted in 2014, after adding oral zinc ion to treatment regimen of type I diabetics, concentration of zinc showed a significant increase in erythrocyte cells [5]. In another study, a reduction in HbA1c concentration was found after adding oral zinc ion to the regimen for type II diabetes patients [6].

In the case of zinc deficiency, intracellular enzymes are inactivated and cellular oxidative stress response is activated, which can be effective in both pathogenesis and long-term complications of diabetes [7]. Magnesium is another micronutrient that its low serum level is also effective in insulin resistance, and emergence of secondary complications in diabetics [8]. Researchers believe that hypomagnesaemia typically occurs in patients with diabetes [5]. It has been reported that the reason for high prevalence of this phenomenon

in diabetic is the relationship between renal excretion of glucose and urinary excretion of magnesium simultaneously [7].

It has been stated that magnesium deficiency hampers the entry of glucose into cells which leads to impaired insulin function [1, 2]. Some researchers have reported the relationship between magnesium deficiency and insulin resistance [6]. It has been found that adding magnesium supplement to the regimen for patients with type II diabetes leads to improved insulin response and significant reduction in fasting blood sugar in these patients [8]. On the other hand, some researchers have mentioned that further studies are needed in this regard [7].

Many studies suggest the fluctuation of the serum level of zinc and magnesium in diabetic patients compared with healthy individuals and etiological role of these elements in the pathogenesis of diabetes. This study aimed to measure the serum level of zinc and magnesium in three groups of healthy individuals, patients with diabetes, and patients with metabolic syndrome and relationship of these elements with insulin resistance in Ahvaz population.

MATERIALS AND METHODS:

In this cross-sectional descriptive-analytic study, among 25 health centers in Ahwaz, 7 centers were randomly selected by multistage cluster sampling method. Based on the population contribution 4 centers in east and 3 centers in west were selected. The sample included 150 people of Ahvaz (50 healthy, 50 with diabetes, and 50 with metabolic syndrome) who were randomly selected from those referred to these 7 health centers. The present study was under the supervision of Ahvaz Jundishapur University of Medical Sciences. After explaining the study procedures to all participants, informed written consent obtained from each participant over 18 years old and parents of those under 18 years old.

Data collection was done like our previous study [9]. A questionnaire included: age, sex, marital status, ethnicity, education level, family history of diabetes (DM), Hypertension (HTN) and obesity, smoking and parity and previous history of gestational diabetes Mellitus in women were filled for each person. Blood pressure, weight, height, body mass index (BMI) [Weigh (kg)/Height (m) 2], abdominal and waist circumference were measured in each participant. Blood pressure was measured by a standard sphygmomanometer after 15 minutes rest in a sitting position.

The cuff was placed on the right arm at the heart level and then quickly pushes the device until 30 mm Hg above radial pulse disappearance. Blood pressure was measured twice at least 30 minutes interval between two measurement and mean of these two measurements, was taken as blood pressure. Anthropometric measurements were taken after removing shoes and wearing a light dress. Weight and height were measured according to the standard program. Waist circumference was measured at the midpoint between the lowest rib and the upper lateral border of the right iliac crest and hip circumference at the point of maximum hip diameter. After 12 h of fasting, blood samples were taken in the morning. Samples was centrifuged, serum stored in the refrigerator and was sent to Diabetes Research Center laboratory. Triglyceride (TG), Fasting Blood Sugar (FBS), Cholesterol and high density lipoprotein (HDL) were measured using an enzymatic colorimetric method with Pars Azmoon kit. (With Biotechnical instruments model BT-3000 Germany). For diagnosis of metabolic syndrome at least three of the following five components were considered necessary (according to ATP III criteria update 2005) [10, 11].

For diagnosis of metabolic syndrome at least three of the following five components were considered necessary (according to ATP III criteria update 2005) [12, 13, 14].

1. Abdominal obesity (Waist circumference ≥ 102 cm in men and ≥ 88 cm in women).
2. TG ≥ 150 mg/dl or history of drug consumption for hypertriglyceridemia.
3. HDL ≤ 40 mg/dl in men and ≤50 mg/dl in women or history of drug consumption
4. BP Siastolic ≥ 130 mmhg or BP diastolic ≥ 85 mmhg or history of anti hypertensive drug consumption
5. FBS ≥100 mg/dl, history of diabetes mellitus history or using anti diabetic drugs.

For people under 19 years old Modified ATP III criteria 2005 [5,6, children syndrome] were used to define M.S as follows:

1. Abdominal obesity (waist circumference ≥ the age and sex specific 90th percentile using C.D.C percentiles)
2. Elevated BP (systolic and/or diastolic blood pressure ≥the age and sex -specific 90the percentile using C.D.C percentiles except for 18 and 19 years Old subjects, for whom the cut off values of ≥130 and/or ≥85 mmHg for systolic and diastolic blood pressure were used, respectively.
3. HDL-cholestrol≤40
4. TG≥110 mg/dl
5. FBS≥100mg/dl

Subjects with 3 or more characteristics of the above components were categorized as M.S.

Overweight, at risk for Overweight and normal weight were defined based on the study specific percentile curves of BMI for age and sex as ≥95th percentile, ≥85 to <95th percentile and <85th percentile, respectively. Experiments of zinc were done by Atomic Absorption method and the tests on magnesium were performed using auto-analyzer device and ELitek biochemical kit in the laboratory of Center for Diabetes Research at Ahwaz Jondishapur University of Medical Sciences. The samples were kept at a temperature of -70˚C. Insulin concentration measurement was done by radioimmunoassay method in the laboratory of Physiology Research Center. In addition,

HOMA-R formula was used to determine the degree of insulin resistance as follows:

HOMA-R = Glucose and insulin were measured in mmol/l and µu/l, respectively, and K was considered equal to 22.5. Healthy people were considered those who had no diabetes and lacked 3 simultaneous parameters of metabolic syndrome.

Data analysis:

ANOVA and t test were used for comparison of mean values, and Chi-square was used for comparison of ratios all statistical analyses were done by SPSS 17 software at a significance level of 0.05.

RESULTS:

In this study, 58.3% of subjects were male and 41.7% were female. Mean age was 41.38±17.00 years old. 77.8% of them were married and others were single, the majority of them were Arab-speaking and housekeeper. Patients' characteristics showed in (Table 1).

Table 1: Demographic information

Variable		N	%
Gender	Male	88	58.3
	Female	63	41.7
Marital status	Single	20	13.2
	Married	117	77.5
	others	14	9.3
Ethnicity	Arab	71	47.3
	Lor	20	13.3
	Fars	57	38
	Turk	1	.66
	Kurd	1	.66
Education	Illiterate	24	16
	Primary school	29	19.3
	Guidance school	28	18.7
	High school	13	8.6
	Diploma	32	21.3
	Associate's degree	5	3.3
	Bachelor or higher	19	12.6
Occupation	Unemployed	28	18.6
	Housekeeper	53	35.3
	Worker	7	4.6
	Employee	15	10
	Self-employed	27	18
	Other	20	13.3

According to the results, there is a significant relationship between zinc and magnesium serum levels in all groups (P=0.001). Also, a significant inverse relationship was observed between zinc level and insulin resistance in patients with diabetes (P=0.006), while such a relationship was not found between magnesium level and insulin resistance in diabetics and also between zinc and magnesium level and insulin resistance in patients with metabolic syndrome (P>0.05). In addition, the relationship between magnesium level and FBS (P=0.001), zinc level and BMI, and magnesium and BMI (P=0.009) were significant in all three studied groups (Table 2).

Table 2: Comparison of serum level of zinc and magnesium in healthy subjects and patients with diabetes and metabolic syndrome and its association with insulin resistance

Variable		N	%	The value of the statistic	P-value
Comparison of mean level of Zinc	Normal	50	34	F=192	0.001
	Diabetic	50	34		
	Syndrome	50	34		
Comparison of mean level of magnesium	Normal	50	34	F=7.7	0.001
	Diabetic	50	34		
	Syndrome	50	34		
Zinc level and resistance to insulin	Diabetic	50	34	r=-0.38	0.006
Magnesium level and resistance to insulin	Diabetic	50	34	r=0.17	0.23
Zinc level and resistance to insulin	Syndrome	50	34	r=-0.05	0.72
Magnesium level and resistance to insulin	Syndrome	50	34	r=0.01	0.89
Zinc level and FBS	Normal	50	34	r=-0.006	0.94
	Diabetic	50	34		
	Syndrome	50	34		
Magnesium level and FBS	Normal	50	34	r=-0.28	0.001
	Diabetic	50	34		
	Syndrome	50	34		
Zinc level and BMI	Normal	50	34	r=0.15	0.15
	Diabetic	50	34		
	Syndrome	50	34		
Magnesium level and BMI	Normal	50	34	r=-0.27	0.009
	Diabetic	50	34		
	Syndrome	50	34		

DISCUSSION:

Study findings showed that there is a significant relationship between zinc and magnesium serum levels in all three groups of healthy, diabetic, and metabolic syndrome. It has been reported that magnesium serum level in type II diabetics is higher than in healthy individuals [2]. In a study conducted in 2014, it was found that serum level of zinc in patients with diabetes is lower than healthy individuals [3]. The results of another study revealed that serum level of zinc and magnesium in diabetics is lower than healthy individuals [4]. These findings are consistent with the results of the present study.

In a study which has done on 35 patients with type 2 diabetes in Andimeshk has shown that with an increased level of FBS serum will decrease level of magnesium serum. This level of serum in diabetic patients was significantly lower than non diabetic patients [15].

In the present study, a significant inverse relationship was observed between zinc level and insulin resistance in patients with diabetes, while such a relationship was not found between magnesium level and insulin resistance in diabetics and also between zinc and magnesium level and insulin resistance in patients with metabolic syndrome. In a study in 2014, it was reported that zinc concentration in erythrocyte cells in patients with type I diabetes is lower than the control group [5]. In another study, it was shown that serum level of zinc and magnesium in diabetics is lower than the healthy individuals but equal to diabetics with long-term complications [16]. Kauser *et al*. [17] found a decrease in serum level of magnesium in non-insulin dependent diabetic patients compared to healthy individuals [16]. This conflict with the findings of the present study can be attributed to difference in sample size, race, lifestyle, and so on.

In the study of serum level of magnesium and FBS, a significant difference was found between three studied groups, while such a difference was not observed in the relationship of zinc and FBS. In addition, there was a significant difference three studied groups in terms of the relationship between serum level of magnesium and BMI. In contrast, no significant difference was observed between these groups in the relationship of serum level of zinc and BMI. These results are consistent with the findings of a study conducted by Jemma [18].

CONCLUSION:

Since the results of this research indicate that serum level of zinc and magnesium is low in diabetics, it is recommended that such people include foods rich in zinc and magnesium in their daily diet.

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