Journal of Diabetic Complications & Medicine

Alam et al., J Diabetic Complications Med 2016, 2:1

Research Article Open Access

Serum Selenium Concentration and Subsequent Risk of Diabetes Miletus in Pakistan

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Received date: Sep 08, 2016; **Accepted date**: Oct 03, 2016; **Published date**: Oct 08, 2016

Abstract

Background: The purpose of the study was to explore a relationship between serum Selenium level and diabetes.

Methods: Analysis of 100 blood samples were carried out, collected from Institute of Medical Sciences (PIMS), Islamabad, Pakistan. All the subjects selected were local inhabitants of Rawalpindi and Islamabad and their serum selenium levels were measured by hydride generation atomic absorption spectrometer.

Results: Analysis of the mean serum selenium level in the male and female patients of both type I and II were 169 ± 91 µg/L and 199.25 ± 120 µg/L respectively while mean serum selenium level among males and females of healthy subjects was 245.59 ± 131 µg/L and 239.92 ± 138.

Conclusion: Serum Selenium level and Diabetes has an inverse relation.

Keywords: Selenium contents; Diabetes; Micronutrient; Chronic hyperglycemia

Introduction

Diabetes mellitus is now the leading cause of morbidity and mortality throughout the world. Diabetes is associated with high rates of hospitalization, blindness, renal failure and non-traumatic amputation [1]. Diabetes mellitus is a group of metabolic disorder categorized by complete or comparative deficits in insulin secretion or insulin action linked with chronic hyperglycemia and disorders of carbohydrate, protein and lipid metabolism. Diabetes mellitus (DM) has become an epidemic disease that is prevailing all around the world. According to the International Diabetes Federation, diabetes has an effect on nearly 285 million people around the world, and this figure is likely to reach 438 million by the year 2030 [2]. At present Pakistan is the 7th leading diabetic nation in the World and would become fourth largest nation within 20 year i.e.; from the year 2010 to 2030 if the current rising trend continues [3]. Trace elements make up about 0.012% of the human body weight and are necessary for normal growth and development of the body [4]. Trace minerals influence the metabolism of glucose through various ways such as acting as co-factors, enhancing insulin sensitivity and in activating insulin receptor sites [5,6]. There are certain evidences supporting that metabolism of some trace elements are altered in diabetes mellitus [7,8]. Disturbances in trace element status and its resulting elevated oxidative stress in diabetes may enhance the insulin resistance and lead to the progress of diabetes and diabetic complications [9,10]. Since free radical production is increased whereas capacity of antioxidant systems is reduced in diabetes, it has been proposed that diabetic patients may require more antioxidants compared to healthy individuals [11,12]. Consequently, development of diabetes may also lead to agitation in trace mineral homeostasis and metabolism. It is not within one's knowledge whether a disease sets in due to insufficiency of trace elements or whether trace element status leads to disease, it is usually believed that a strict metabolic control delays the development of complications in diabetes mellitus. Trace elements help in every point of view of existence from hormones formation, blood sugar, digestion, vitamins, in contraction of muscles, neurotransmission and pH regulation [13].

Selenium among trace elements, required in minute amount, is requisite for the continuation of good health [14,15]. Selenium is a unique indispensable element in that it takes the place of sulfur in cysteine to form the 21st amino acid selenocysteine that is directly integrated into selenoproteins, as compared to other metals that act as prosthetic groups or cofactors [16]. Numerous immune impairment conditions are linked with selenium deficiency. Free radicals are generated in the body as a consequence of many biochemical processes. To combat this oxidative stress all aerobic organisms own an antioxidant defense mechanism. Intrinsic enzymatic and non-enzymatic antioxidants detoxifying mechanisms are present that decrease reactive oxygen species concentration in human body. Selenium and glutathione are some of the major non-enzymatic antioxidants in the body. Therefore, the idea of using antioxidants to prohibit development of diabetes as well as its complications and to treat diabetic patients is getting more attention than ever [17,18]. Keeping I view the current research status, the purpose of the study was to assess the serum selenium level in the most populated cities of

Pakistan and to examine relation between serum selenium level and Diabetes.

Materials and Methods

Blood samples

After obtaining ethical approval from the ethical committee of PIMS hospital and informed consent from the subjects, 5 ml of blood was taken from the subject with an overnight fasting and who were already diagnosed for diabetes, in serum bottles. The blood was kept to clot for an hour. Centrifugation of the coagulated samples was performed at 4000 rpm for 7-10 minutes so that serum can be separated using Model Z216 MK, Made in Germany. Aliquots of Serum (1 ml) were frozen at -20°C and were stored in Eppendorf tubes till further examination.

Study Procedure

Standard solution for selenium having concentration of 1000 mg/L was obtained from Merck, Germany. Preparation of working standards was done by appropriate dilution of the stock solution with 0.5% nitric acid. Nitric acid (HNO3 65%) hydrochloric acid (HCl 37%) and sodium hydroxide (NaOH) were of Merck (Germany) while perchloric acid (HClO4 70%), sodium borohydride (NaBH4) were of BDH, UK. The sodium borohydride pellets were dissolved in a 1% sodium hydroxide solution to give a 3% (w/v) NaBH4 solution. 3 mL of 3% of pure hydrochloric acid were used for the hydride generation.

Sample digestion

For mineralization 0.5 ml of serum was poured into a glass beaker and 3 ml of $HNO_3/HClO_4$ (1:1 v/v) was added. This mixture was heated on the hot plate and temperature was increased slowly to 175°C till the appearance of $HClO_4$ fumes. The serum mixture was then heated to 175°C for one hour then at 200°C for one hour and at last at 250°C for one hour. The mixture was then cooled down to room temperature. In the end 10 ml 6 N HCl was added and the mixture was heated again at 170°C for 30 minutes so that Se (VI) can be reduced to Se (IV).

Measurement

Selenium concentration in the digested serum samples were examined by using atomic absorption spectrophotometer outfitted with hydride generation system, model Analytic Jena (Vario III). All the analytical calibrations were performed with aqueous standards in 0.5% (v/v) HNO_3 (Table 1).

S No.	Subjects	Age (years)	Mean serum selenium concentration (µg/L)
1	Healthy	17-51	245.59 ± 131 µg/L
2	Diabetic type I	Oct-30	169 ± 91 µg/L
3	Diabetic type II	28-70	199.25 ± 120 µg/L

Table 1: Mean serum selenium concentration (µg/L) among healthy, diabetic type I and II subjects.

Fresh calibrations were made each time before examination. Table 1 shows the analysis of the mean serum selenium contents in the male and female patients of both type I and II as well as the healthy subjects which were found to be 169 ± 91 µg/L, 199.25 ± 120 µg/L and 245.59 ± 131 µg/L respectively.

Results

Selenium concentration in the serum of patients affected with diabetes type I

A total of 25 diabetic type I patients were taken for the selenium content estimation in their serum, including 12 female and 13 male patients lying in the age series of 10-30 years. The results are presented in Table 2.

S#	Age	BMI	M1	M2	M3	Mean serum Se conc (µg/L)
1	17	21.2	278.7	278.4	280.1	279.5
2	16	23.6	114.1	114.5	114.8	114.6
3	22	22.7	149.3	149.7	149.1	149.4
4	19	24.8	311.3	311.9	311.6	311.5
5	10	21.5	244.4	244.8	245.7	244.9
6	15	25.1	293.5	292.9	293.1	293
7	11	23.5	44.6	44.9	45.6	45
8	27	26.2	9.9	10.4	9.1	9.4
9	25	23.8	110.5	110.1	109.2	109.6
10	30	21.9	180.5	179.9	179.3	179.4
11	18	25.3	259.3	260.8	260.8	259.6
12	18	28	152.8	152.9	153.1	152.5
13	15	23.1	119.1	119.8	119.5	119.5
14	24	24.7	29.6	29.8	29.7	29.5
15	11	25.4	289.5	289.8	289.1	289.6
16	26	26.3	219.2	219.9	219.3	219.5
17	25	23.9	128.9	129.4	129.2	128.5
18	15	21.6	196.2	196.1	195.2	195.4
19	12	22	150.1	148.8	150.5	150.1
20	18	23.3	210.2	209.2	210.1	209.5
21	23	23.5	169.2	169.1	169.8	169.5
22	15	22.5	169.3	169.5	169.2	169.4
23	28	23.6	302.8	303.9	303.8	303.7
24	29	25.9	115.1	115.6	115.8	115.5
25	28	21.4	0	0	0	0

Table 2: Selenium concentration in the serum of patients affected with diabetes type I.

Figure 1 shows serum selenium concentrations among males and females of diabetes type 2 with reference to age.

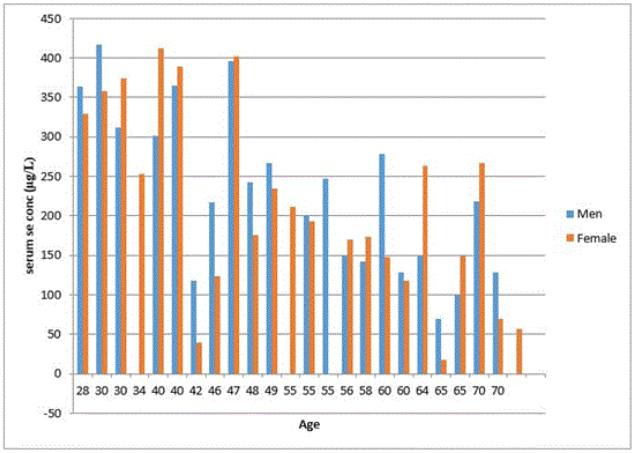

Figure 1: Serum selenium concentrations among males and females of diabetes type 2 with reference to age.

Discussion

Shera et al. reports the third phase of the Pakistan National Diabetes Survey, with the prevalence rate of glucose intolerance and associated factors in North West Frontier Province. In their first two surveys, prevalence of type 2 DM among the adult population (>25 years) was 13.9% in Sindh and 8.6% in Baluchistan with a further 11.1% (men) and 13.4% (Women) with impaired glucose tolerance in two provinces respectively [19]. Our findings are in contrast with a cross sectional study of the health Professionals, which showed an inverse relation between toenail selenium and diabetes prevalence [20] (Table 3).

S.No	Gender	Age	BM1	M1	M2	M3	Mean Serum Se conc (µg/L)
1	Male	52	18	364.8	364.6	364.3	364.5
2	Male	37	21.4	148.7	148.6	149.1	148.8
3	Male	56	23.1	311.7	311.5	311.3	311.5
4	Male	27	117.6	117.4	117	117.3	
5	Male	50	26.8	218.4	218.5	218.9	218.6
6	Male	50	25.1	363.5	363.9	363.4	363.6
7	Male	24	23	0	0	0	0
8	Male	35	24.1	0	0	0	0
9	Male	40	25.3	200.9	200.2	200.1	200.3
10	Male	39	29.4	278.2	278.9	279.3	278.8
11	Male	49	23.4	396.4	396.7	396.8	396.6
12	Male	64	21.9	127.5	127.8	128.4	127.98
13	Male	54	22.4	247.5	247.2	247.3	247.24
14	Male	38	23	69.8	69.1	70.3	69.7
15	Male	45	23.5	301.3	301.5	302.2	301.6
16	Male	45	22.4	216.8	216.3	217.3	216.8
17	Male	29	24.1	416.6	416.4	416.1	416.5
18	Male	49	27.9	242.6	242.5	242.3	242.4
19	Male	37	28.6	148.5	148.6	149.4	148.8
20	Male	54	26.9	142.2	142.9	142.5	142.5
21	Male	46	25.5	266.3	266.7	266.4	266.4
22	Male	23	128.4	128.6	129.1	128.7	166.4
23	Male	61	28.8	101.3	101.6	99.9	101.1
24	Female	62	17	412.2	412.8	412.1	412.3
25	Female	41	24.1	139.5	139.6	138.3	39.23
26	Female	57	28.5	263.4	263.9	263.2	263.5
27	Female	44	27.7	0	0	0	0
28	Female	38	21.6	389.3	389.2	389.7	389.4
29	Female	51	19.2	169.2	169.4	169.7	169.4
30	Female	21	31.8	192.6	191.4	193.3	192.1
31	Female	48	27.9	173.2	173.6	173.8	173.98
32	Female	28	25	118.5	118.6	118.3	118.4
33	Female	49	18.8	23.6	23.4	23.1	23.67
34	Female	48	24.4	148.4	148.5	148.9	148.6
35	Female	55	23.2	70.1	69.3	69.8	69.5
36	Female	48	24.4	267.1	267.5	266.2	267.1
37	Female	47	27.9	18.7	18	19.2	18.6
38	Female	69	24.7	234.8	234.4	233.3	234.1
39	Female	40	23.5	0	0	0	0
40	Female	65	19.2	148.6	148.3	148.7	148
41	Female	40	18.4	357.7	358.6	359.5	358.1

Table 3: Selenium concentration in the serum of patients affected with diabetes type 2.

Our findings were consistent with an observational analysis conducted within the supplementation with Vitamins and minerals trail, in which baseline plasma selenium levels were positively associated with combined fasting plasma glucose at baseline and 7.5 years follow up [21].

Keeping in view, the aforementioned studies we attempted to establish a relationship between Serum selenium level and diabetes in Pakistan. Our findings that serum selenium level is higher in men than women is accordingly the previous research studies conducted in Pakistan [22].

For this purpose we collected ninety eight blood samples from the diabetic patients and healthy subjects for the examination of their serum selenium levels (µg/L) to find out the degree of trace mineral (selenium) disturbances in diabetic patients and compare them with the healthy subjects taken as control.

Mean serum selenium level in the male and female patients of both type I and II as well as the healthy subjects which were found to be 169 ± 91 µg/L, 199.25 ± 120 µg/L and 245.59 ± 131 µg/L respectively. Selenium content in the diabetic patients was found to be low as compared to the healthy individual. It is evident from the results that the selenium levels in healthy in participants, was in the range of 0-481µg/L in women and 48-518 µg/L among men. There lies a considerable variation of serum selenium concentration between the two genders with a higher selenium concentration in men population (518 µg/L). The mean serum selenium concentration among women and men is 239.92 ± 138 µg/L and 251.26 ± 181 µg/L.

It is evident from the results that the selenium concentration was in the range of 45-311 µg/L and 0-303 µg/L among the males and females diabetic type I patients with their mean ages ranging between 10-30 years. The mean selenium concentration was 169.91 ± 91 µg/L. The mean serum selenium concentration among females and males is 174 ± 92 µg/L and 165 ± 86 µg/L (Figure 2).

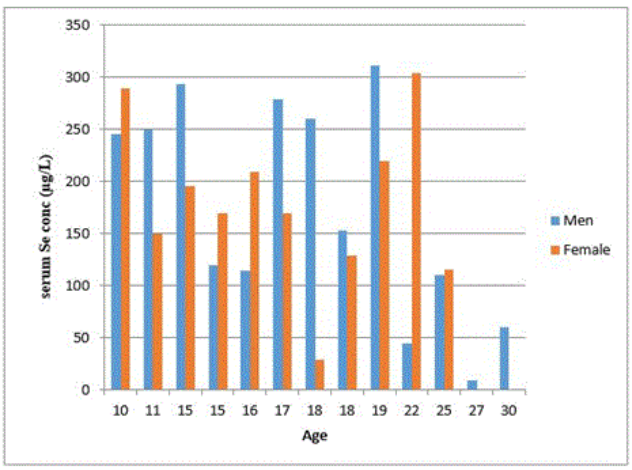

Figure 2: Serum selenium concentrations among males and females of diabetes type 1 with reference to age.

Mean serum selenium concentration for type II diabetic individuals was estimated to be 199.25 ± 120 µg/L. The observed mean and standard deviation of serum selenium concentration in male and female patients with type II diabetes was 209.14 ± 115 µg/L and 190.18 ± 128 µg/L.

Conclusion

Herein we concluded that serum selenium level and diabetes has inverse relationship. Mean serum selenium concentration in healthy subjects was 245.59 ± 161 µg/L whereas as in diabetic type I and II patients concentration was 167.89 ± 89 and 199.25 ± 112 µg/L. Findings from this study might aid public health professionals in identifying people at relatively high or low Se levels, so that chronic disease prevention efforts can be directed toward these subgroups, in developing countries like Pakistan.

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