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The Relationship between Serum 25-hydroxyvitamin D Levels and Metabolic Syndrome in Birjand Children, East of Iran

Mahmoud Zardast[1], Fatemeh Taheri[2], Ahmad Gholinedjadan[3], *Kokab Namakin[4] , Seyed Alireza Javadinia[5]

[1]Assistant Professor, Birjand Atherosclerosis and Coronary Artery Research Center, Department of Pathology, Faculty of Medicine, Birjand University of Medical Sciences, Birjand, Iran.
[2]Professor, Birjand Atherosclerosis and Coronary Artery Research Center, Faculty of Medicine, Birjand University of Medical Sciences, Birjand, Iran.
[3]Student Research Committee, Department of General Surgery, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran.
[4]Associated Professor, Birjand Atherosclerosis and Coronary Artery Research Center, Birjand University of Medical Sciences, Birjand, Iran.
[5]Student Research Committee, Department of Radiation Oncology, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran.

Abstract

Background: Metabolic syndrome (MS) is an important risk factor that is associated with vitamin D deficiency, according to recent studies. This study aimed to evaluate the relationship between serum 25-hydroxyvitamin D level and risk of metabolic syndrome in children in Birjand.

Materials and Methods: A case-control study on 6 to 18 years old metabolic syndrome patients, this investigation was performed in Birjand University of Medical Sciences, Cardiovascular Research Center. Thirty six children were enrolled in a non-random sampling manner, and the data were analyzed using SPSS-13 using independent t-test and chi square.

***Results*:** A total of 36 children entered the study (n=18 per group). The mean serum levels of vitamin D in metabolic and non-metabolic groups was 11.61±3.79 and 14.09±6.41 ng/ml (P>0.05), respectively. The mean serum levels of vitamin D in the group with normal and abnormal triglyceride levels were 11.05±3.80 and 14.65±6.12 ng/ml, respectively (P<0.05).

Conclusion: The prevalence of vitamin D deficiency and insufficiency among children was high. Also, no association was found between vitamin D deficiency and metabolic syndrom. Controlled longitudinal studies are needed to better define the relationship between vitamin D status and pediatric metabolic syndrome.

Key Words: Children, 25-hydroxyvitamin D, Metabolic syndrome, Vitamin D deficiency.

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Corresponding Author:

Kokab Namakin, Faculty of Medicine, Birjand University of Medical Sciences, Birjand, Iran.

Email: d_namakin@yahoo.com

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1- INTRODUCTION

Metabolic syndrome includes a cluster of conditions as abdominal obesity, elevated blood pressure, high blood sugar and abnormal cholesterol. Such syndrome in childhood and adolescence is considered as a predictor of cardiovascular diseases (CVD) and type 2 Diabetes in adulthood (1-4). Moreover, it can increase the risk of stroke, fatty liver and cancer as well (5-6).

The current changes in lifestyle, increased urbanization and sedentary ways of living, and frequent fast food consumption have all resulted in the prevalence of obesity which has in turn led to rise in metabolic syndrome. This may explain why large numbers of people are suffering from this type of syndrome in developed and developing countries (7-12).

Metabolic syndrome is closely associated with having a positive family history, weak diet, and lack of physical activity as its prominent risk factors. It is hypothesized that resistance to insulin and adipose tissue disorder can contribute to its incidence as well. Adipocyte dysfunction also plays an important role in the pathogenesis of obesity-driven insulin resistance (13). Overall, a study conducted in the framework of Tehran, lipid and glucose study on 10-19 year-old adolescents demonstrated the presence of metabolic syndrome in 10.1% of the subjects. According to this research, only 42% of the overweight adolescents and 4% of the normal-weight adolescents met the criteria for metabolic syndrome (14). As revealed in another study, metabolic syndrome had a prevalence rate of 6.9% among 11-18 year-old children in Birjand-Iran (15). Vitamin D deficiency is a risk factor for metabolic syndrome and both have a high prevalence among the Iranian population (16). This type of vitamin has anti-inflammatory and regulatory effects and can reduce insulin resistance in addition to leading to increased insulin secretion (17, 18). Different studies have revealed that serum vitamin D level is inversely related to diabetes prevalence (19-21), glucose serum level (21-27) and resistance to insulin (27-30). There is an increasing evidence to suggest that vitamin D deficiency may be an important factor in the development of cardiovascular disease (31). Low vitamin D levels imprint on the functional characteristics of various tissues throughout the body, leaving the affected individual at increased risk of developing a range of adult onset disorders (32). Based on epidemiology, and on In vitro fertilization (IVF) and animal experiments, vitamin D has been linked to multiple sclerosis, certain cancers (prostate, breast and colorectal), and also depression (33). But some studies showed no relationship between vitamin D levels and cardiovascular diseases (metabolic syndrome) (34).

As regards the effect of climatic condition, lifestyle and genetic factors on such diseases as metabolic syndrome, epidemiologic studies on its prevalence, risk factors and coexisting diseases are highly essential. Furthermore, the review of the available literature on this disease showed that no examination of the serum concentration of vitamin D has been conducted yet on metabolic syndrome patients in Southern Khorasan. Based on this, the present study aimed to determine the relation between vitamin D serum concentration and metabolic syndrome among the children population of Birjand city, the capital of Southern Khorasan, Iran.

2- MATERIALS AND METHODS

As a case-control investigation, this descriptive-analytical study was conducted on 6-18 year-old patients with metabolic syndrome. Performed in the Atherosclerosis and Coronary Artery Research Center, this research had a sample size of 36 subjects as proposed in a study by Borzouei et al. (29). The case group samples were

selected using simple random sampling out of a list of children with metabolic syndrome which was offered by the Comprehensive Metabolic Syndrome Project while out of the individuals with no such syndrome in the Comprehensive Project, the samples were collected through random systemic sampling. Following the examination and confirmation of the project in the Research Counsel of the Birjand University of Sciences University, The study protocol was approved by the Medical Ethics Committee of Birjand University of Medical Sciences (IR.BUMS.1394.369). The legal steps were taken to get the needed letters of introduction from the competent authorities. To observe the ethical considerations in the research, before the implementation of the project, along with the children's own satisfaction, the written consent of the legal guardian of the children was also obtained. Presence of 3 instances of the following components in a child was considered as metabolic syndrome:

- abdominal obesity (WC)>90 for age and gender (waist circumference above gender- and age-specific 90th percentile),
- systolic or diastolic blood pressure above age-and-gender specific 90th percentile,
- HDL<40mg/dl, FBS>110mg/dl, and TG>110mg/dl (15).

Children referred to laboratory and 5 ml Blood, was derived from cubital vein. After centrifugation, blood serum samples were divided in small tubes before being frozen and stored at -20°C. Then, the samples were analyzed. In the next stage, serum levels of 25- hydroxyl vitamin D were measured by applying Electro-Chemi-Luminsence (ECL) (the System Close Company Roche E411 Series kits made in Germany in 2013).

After collection, the data was analyzed in SPSS software, version-13 using the statistical test (independent t-Test) at the significance level of P-value < 0.05.

3- RESULTS

A total of 36 children entered the study out of which 18 were in metabolic syndrome group (case) and 18 others belonged to the control group. The comparison of sexual frequency distribution showed no significant difference between the two groups (P>0.05) (**Table.1**). Similarly, the mean age and height comparison between the two groups yielded an insignificant difference (P=0.466 & P=0.979, respectively) (**Table. 2**).

As for the frequency of metabolic syndrome components in the metabolic group, abnormal BMI was seen in 66.7%(n=12) of the subjects, hypertension was observed in 38.9% (n=7) of patients, abnormal HDL was common in 88.9% (n= 16) of individuals, TG abnormality was present in 94.9% (n=17) of subjects and finally abnormal blood glucose level was observed in 38.9% (n=7) of participants.

Out of the subjects that were in metabolic syndrome group, 61.1% (n=11) had three components of the metabolic syndrome, 33.3% (n=6) demonstrated four of its components and 0.5% (n=1) showed all five components of metabolic syndrome. Furthermore, the frequency of metabolic syndrome components in non-metabolic group was as follows: abnormal BMI (11.1% of the participants, n=2); abnormal blood pressure (0% of the participants, n=0); HDL abnormalities (0% of participants, n=0); abnormal TG (6.5% of participants, n=1); and finally abnormal blood sugar (0% of the participants, n=0).

The mean serum vitamin D level in the study participants was 12.85±5.34 ng per milliliter. As the comparison of the mean serum 25-hydroxyvitamin D levels in

children with metabolic syndrome and children without metabolic syndrome demonstrated (**Table.3**), the mean serum level of vitamin D in metabolic syndrome children and non-metabolic syndrome group was 11.61±3.79 and 14.09±6.41 ng per ml respectively; that showed a statistically insignificant difference (P>0.05). Based on the comparison of the mean serum 25-hydroxyvitamin D level in children with abnormal BMI and those with normal BMI in (**Table.4**), the mean serum level of vitamin D in the two groups were respectively 11.73 ± 4.41 and 13.56 ± 56/135.4 ng per mL in the two groups with a difference that was not statistically significant either (P>0.05).

Similarly, the results given in (**Table.4**) on the comparison of the mean serum 25-hydroxyvitamin D levels in children with hypertension and children with normal blood pressure revealed that the mean serum level of vitamin D in the two groups was 12.04±4.72 and 13.04±5.54 ng per mL respectively; this difference was not statistically significant (P>0.05) as well.
The comparison of the mean serum 25-hydroxyvitamin D level in children with HDL abnormality and children with normal HDL (**Table.4**) also demonstrated that the mean serum level of vitamin D in the two groups was 12.05±3.79 and 13.49±6.35 ng per mL respectively. Here, again the difference was statistically insignificant (P>0.05).

Similarly, according to the comparison of the mean serum 25-hydroxyvitamin D level in children with FBS abnormality and children with normal FBS, as given in (**Table.**4), the mean serum level of vitamin D in the two groups was respectively 11.84±4.62 and 13.09±5.55 ng per mL that showed a difference that was not statistically significant (P>0.05).

Finally, as it was shown concerning the mean serum 25-hydroxyvitamin D levels in children with TG abnormality and children with normal TG (**Table.4**), the mean serum levels of vitamin D in the two groups was respectively 11.05±3.80 and 14.65±6.12 ng per mL. Contrary the above results, such a difference was the only statistically significant one (P<0.05).

Table 1: Frequency distribution of the children under study by gender

Gender	Case group Number (%)	Control group Number (%)	P- value
Male	9 (50)	13 (72.2)	0.171
Female	9 (50)	5 (27.8)	

Table 2: Comparison of the mean age, height, weight and body mass index in case and control groups

Parameters	Case group	Control group	P- value
Mean age	12.33±1.18	12.77±2.26	0.466
Mean height	152.8 ± 7.65	152.78 ± 10.92	0.979
mean weight	68.32 ± 12.41	48.42 ± 14.85	0.000
Mean body mass index	27.97 ± 4.62	21.07 ± 5.24	0.000

Table 3: Comparison of the mean serum level of 25-hydroxyvitamin D in case and control groups

Vitamin D	Case group	Control group	P- value
Mean levels of vitamin D	11.61 ± 3.79	14.09 ± 6.41	P=0.167

Table 4: Comparison of the mean serum 25-hydroxyvitamin D level in children in different subtypes of metabolic syndrome

Vitamin D Serum level	Mea n ± SD (ng/ml)	P- value
BMI		
Abnormal	11.73 ± 4.41	0.324
Normal	13.56 ± 5.4	
Blood pressure (mm hg)		
Abnormal	12.04± 4.70	0.662
Normal	13.04± 5.54	
HDL-C (mg/ml)		
Abnormal	12.05± 4.72	0.432
Normal	13.49± 6.35	
FBS (mg/ml)		
Abnormal	11.84± 4.62	0.585
Normal	13.09± 5.55	
TG (mg/ml)		
Abnormal	14.65± 6.12	0.041
Normal	18.05.± 3.80	

4- DISCUSSION

This study aimed to determine the relation between serum 25-hydroxyvitamin D levels and risk factors of metabolic syndrome among children in Birjand, East of Iran. The results of the investigation of the relationship between serum levels of vitamin D in the two groups (metabolic syndrome and non- metabolic syndrome) showed that deficiency, vitamin D insufficiency and sufficiency of serum level of vitamin D in metabolic syndrome group was respectively prevalent in 9 (50%), 8 (44.4%) and 1 (5.6%) subjects while having a frequency of 7 (38.9%), 7 (38.9%) and 4 (22.2%) respectively among patients in non-metabolic syndrome group. However, the observed difference was not statistically significant ($P>0.05$). Moreover, there was not a relationship between the levels of vitamin D and the subtypes of metabolic syndrome including BMI, blood pressure, serum HDL, serum triglycerides, and fasting blood glucose ($P>0.05$).

In line with the results of the present research, Paknahad et al. did not reveal a significant relationship between metabolic syndrome and the level of vitamin D (32). Roshanzamir et al. (33) also reported an insignificant relation between vitamin D deficiency and metabolic syndrome. Compatible with our findings, Soltani et al. showed no relationship between vitamin D level and metabolic syndrome as well (34).

As there is no consensus on the level of vitamin D and risk of metabolic syndrome, contrary to the findings of our study, Hossein-Nezhad et al. in a cross-sectional investigation of the relationship between serum level of vitamin D and metabolic syndrome among Iranian adult population based on WHO criteria (including 646 healthy people who had no history of diabetes), showed that the prevalence of metabolic syndrome was higher in people with vitamin D deficiency than those with normal concentration of vitamin D ($P<0.05$) (16).

A similar study was conducted on the relationship between serum 25-Hydroxyvitamin D level and metabolic syndrome by Borzouei et al. (29). Contrary to our investigation, their case-control study, that was performed on 186 patients with 20 years of age using ATP III criteria, uncovered that there was no significant difference between the two groups of the

healthy and patient people regarding the vitamin D level (32.6±16.5 in the control group vs.17.3±10.7 in the case group) (29). Examining the serum levels of vitamin D and metabolic syndrome, Ford et al. also demonstrated a significant relationship between these two components such that the metabolic syndrome group had a significant lower level of vitamin D compared with the control group (30).

Unlike the results of this study which showed no association between the subtypes of metabolic syndrome and the level of vitamin D, Hossein-Nezhad et al. demonstrated a high prevalence of metabolic syndrome in men with vitamin D deficiency compared to those with normal vitamin D. Based on their study, obesity, hyperglycemia and hypertension were significantly higher among individuals with vitamin D deficiency compared with those with normal vitamin D (obesity: P=0.002, hyperglycemia: P=0.02, HTN: P=0.04, respectively) (16).

Similar to the afore-mentioned study, according to Ford et al., there was an inverse association between the level of 25(OH) D and abdominal obesity, hypertriglyceridemia, and hyperglycemia and the relation was significant (30).

Compatible with the results of our study, that revealed no significant relation between the subtypes of metabolic syndrome and the levels of vitamin D, Borzouei et al. also showed no significant difference between age, waist circumference, blood pressure, calcium and phosphorus, and alkaline phosphatase in patients with vitamin D deficiency and those with normal levels of vitamin D. However, patients with vitamin D deficiency levels had higher level of body mass index and triglycerides while having a lower level of HDL cholesterol (29). Our findings also uncovered higher triglyceride levels in patients with low vitamin D levels.

4-1. Limitation and suggestion

The most serious limitation of this project was that high prevalence of vitamin D deficiency in the study area interrupted careful observation of the results and actual effects of metabolic syndrome on serum levels of vitamin D. hence, based on the proposed hypothesis, to observe such exclusive results, the researchers suggest that a broader study be conducted on the prevalence of vitamin D deficiency and its underlying causes (e.g. nutritional deficiencies or lack of exposure to sunlight) in Southern Khorasan. Also, given the importance of this vitamin in different mechanisms of the body, intervention studies are needed to be performed on ways of improving the levels of vitamin D in children.

5- CONCLUSION

There was a high prevalence of 25(OH) vitamin D deficiency and insufficiency in children. However children with metabolic syndome had lower levels of 25-hydroxyvitamin D than other subjects. Also, no association was found between vitamin D deficiency and the subtypes of metabolic syndrome including: BMI, blood pressure, serum HDL, serum triglycerides, and fasting blood glucose. Controlled longitudinal studies are needed to better define the relationship between vitamin D status and pediatric metabolic syndrome.

6- ABBREVIATION

- WC: waist circumference.
- HDL-C: High-density lipoprotein cholesterol.
- FBS: Fasting blood suger.
- TG: Triglyceride.
- BMI: Body mass index.
- HTN: Hypertention.

6- CONFLICT OF INTEREST: None.

7- ACKNOWLEDGMENTS

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