J Renal Inj Prev. 2018; 7(4): 275-279.

http://journalrip.com

DOI: 10.15171/jrip.2018.61

Journal of Renal Injury Prevention

The relationship between vitamin D deficiency and metabolic syndrome in obese individuals

Mahmood Mirhoseini[1*], Hamid Daemi[2], Mahshid Masoom Babaiee[1], Majid Asadi-Samani[3], Leilaassadat Mirhoseini[4], Morteza Sedehi[2]

[1]Shiraz University of Medical Sciences, Shiraz, Iran
[2]Cellular and Molecular Research Center, Basic Health Sciences Institute, Shahrekord University of Medical Sciences, Shahrekord, Iran
[3]Students Research Committee, Shahrekord University of Medical Sciences, Shahrekord, Iran
[4]Arak University of Medical Sciences, Arak, Iran

ARTICLE INFO

Article Type:
Original

Article History:
Received: 9 January 2018
Accepted: 10 May 2018
Published online: 18 May 2018

Keywords:
Obesity
Metabolic syndrome
Vitamin D
Insulin resistance

ABSTRACT

Introduction: Decreased vitamin D levels may have a role in the development of metabolic syndrome due to its effect on the metabolic syndrome components or because of insulin resistance.

Objectives: The aim of this study was to investigate the prevalence of vitamin D deficiency in obese individuals and to determine the relationship between deficiency of vitamin D with metabolic syndrome in obese people with metabolic syndrome and healthy individuals.

Patients and Methods: In this descriptive-analytical study, samples were selected among obese individuals admitted to Hajar and Kashani hospitals in Shahrekord. Metabolic indices of the samples were measured and recorded along with information such as demographic characteristics. According to the indices, the subjects (n= 192) were divided into two equal groups of healthy obese and obese people with metabolic syndrome. Vitamin D levels were measured in both groups followed by determination of relationships between the vitamin D levels with metabolic syndrome and its indices.

Results: The mean ages of the patients and healthy groups were 50.09±1.95 years and 52.57±2.05 years, respectively. The average serum vitamin D levels in the two groups showed a significant difference with significantly lower vitamin D levels in the metabolic syndrome group than those in the obese subjects ($P<0.001$). The relationship between each of the metabolic syndrome indices at different levels of vitamin D showed that levels of triglyceride (TG) and fasting blood sugar (FBS) decreased with increasing serum vitamin D. However, the level of vitamin D was not significantly related to the waist size and body mass index (BMI) ($P>0.05$).

Conclusion: The results of this study indicated that vitamin D determination can be used for the prognosis and early detection of people at risk for metabolic syndrome.

Implication for health policy/practice/research/medical education:
The results of this study suggest that examining the serum levels of vitamin D allows screening people at risk for metabolic syndrome development.

Please cite this paper as: Mirhoseini M, Daemi H, Masoom Babaiee M, Asadi-Samani M, Mirhoseini L, Sedehi M. The relationship between vitamin D deficiency and metabolic syndrome in obese individuals. J Renal Inj Prev. 2018;7(4):275-279. DOI: 10.15171/jrip.2018.61.

Original

Introduction

Metabolic syndrome (insulin resistance syndrome) includes a series of metabolic disorders that increase the risk of cardiovascular diseases and type II diabetes (1-3). Following increased urbanization, inactivity, stress, and consumption of fatty, high-carbohydrate and high-calorie foods, the incidence of metabolic syndrome has been growing steadily throughout the world over the past 20 years, in which up to 25% of the population has been involved according to the latest research (4). In fact, changes in the lifestyle of people over the past decades have contributed to the prevalence of obesity

***Corresponding author**: Mahmood Mirhoseini, Email: seidmahmood_mirhoseini@yahoo.com

and metabolic syndrome in societies. Along with disease complications, special attention to studies on obesity, its complications, and related factors has attracted in recent years. Although the cause of metabolic syndrome has not been fully understood, insulin resistance and visceral fat accumulation have been suggested as the underlying causes (5). It seems that a combination of genetic, metabolic, and environmental factors such as diet have an important role in the development of metabolic syndrome (6). Some studies have shown that decreased levels of vitamin D may be involved in the development of metabolic syndrome owing to its effect on each component of the metabolic syndrome, or because of insulin resistance (7-10). However, such a role has not been confirmed in some other studies (11,12).

Objectives

The present study, therefore, aimed to study more precisely a possible cause of metabolic syndrome by examining the serum levels of vitamin D and its relationship with metabolic parameters.

Patients and Methods

Study population

In this descriptive-analytic study, all obese subjects with body mass index (BMI) values of ≥25% were randomly selected through convenient sampling at Hajar and Kashani hospitals in Shahrekord. The inclusion criteria were BMI values of ≥ 25 kg/m^2, ages of >18 years, and presence of metabolic syndrome. The exclusion criteria included kidney disease, liver disease, and use of weight loss drugs or weight loss efforts. Additionally, vitamin D intake, pregnancy, breast feeding, withdrawal from the continued cooperation or non-participation in tests and examinations, and intake of estrogen and progesterone pills in women were the exclusion criteria. Accordingly, a total of 192 individuals were selected as the sample size. Lipid profile and fasting blood sugar (FBS) of all subjects were determined by blood sample tests. Blood glucose was measured on the sampling day by enzymatic colorimetry using glucose oxidase. Triglyceride levels were measured by BIONIK commercial kits with a BT-3000 device by cholesterol esterase colorimetric tests, cholesterol oxidase, and glycerol phosphate oxidase. The laboratory reported a normal cholesterol range of 130-200 mg/dL. Serum HDL cholesterol was measured after the precipitation of APoB protein lipids using phosphotungstic acid solution. Serum LDL cholesterol was assessed after determining total cholesterol concentration using the Friedewald formula. Serum LDL-C was evaluated by an enzyme kit when serum triglyceride levels exceeded 400 mg/dL. All samples were evaluated with an acceptable standard after an internal quality control. The internal and external changes were 1.6 and 0.6% for triglyceride (TG), and 2% and 0.5% for total cholesterol, respectively. Serum triglyceride levels equal to or greater than 150 mg/dL, HDL-C concentrations less than 40 mg/dL in men and less than 50 mg/dL in women, and fasting glucose values of 100 mg/dL or higher were defined according to National Cholesterol Education Program (NCEP), Panel III NCEP-ATP III (13). Metabolic syndrome was defined by the NCEP-ATP III criteria. After identification of subjects with metabolic syndrome, they were divided into two groups of 96 patients (those with metabolic syndrome during obesity) and 96 healthy subjects (those without metabolic syndrome). The two groups were selected based on gender, age, occupation, physical activity, smoking, type of urban and rural populations, and similar education levels.

Blood samples were collected from all participants in the study after 12 hours of fasting to measure serum vitamin D 25(OH) levels at 8 AM. The following vitamin D levels were defined based on the laboratory report; vitamin D 25 (OH) deficiency when it is less than 20 ng/mL. Insufficient vitamin D 25(OH) level; 20-30 ng/mL, and toxic doses of vitamin D 25(OH) when it is over 100 ng/mL. After measuring levels of vitamin D in both groups, direct correlations of the vitamin values were determined with metabolic syndrome and its indices in obesity.

Ethical issues

1) The research followed the tenets of the Declaration of Helsinki; 2) informed consent was obtained; and 3) This study was approved by the Ethics Committee of Shahrekord University of Medical Sciences. This study is the result of a dissertation of Hamid Daemi (MD dissertation).

Data analysis

Data were entered into an Excel database and then analyzed using the SPSS software version 22. Descriptive and inferential statistics including mean, standard deviation, *t* test, chi-square, and Pearson's correlation coefficient was conducted by SPSS software. The threshold of $P < 0.05$ was considered significant.

Results

The selected participants (n = 192) in this study had an average age of 51.37 ± 19.22 years and were assigned to two groups after distribution normality of data was confirmed. The first group comprised 96 obese people with metabolic syndrome and the second group consisted of 96 non-obese subjects with metabolic syndrome. There were 40 male smokers, 20 of which were in the metabolic syndrome group and 20 individuals in the healthy group (Table 1). The metabolic syndrome parameters are presented in Table 2.

The prevalence of vitamin D deficiency was 58.85%. A mean vitamin D levels of 18.88 ± 1.24 ng/mL was found in subjects with metabolic syndrome. The vitamin level in the obese group without metabolic syndrome was 40.38 ± 2.15 ng/mL. The decrease in the mean level of vitamin D in our patients was significant when compared to healthy participants ($P < 0.001$). Distribution of vitamin D status

Table 1. Demographic data of individuals in the two groups studied

Groups	Age (y)	Gender		Smoker	
	Mean± SD	Male No. (%)	Female No. (%)	Yes No. (%)	No No. (%)
Patients with metabolic syndrome (n=96)	50.09±1.95	52 (54.17)	44 (45.83)	20 (20.83)	76 (79.17)
Control (obese individuals without metabolic syndrome; n=96)	52.57±2.05	51 (53.12)	45 (46.87)	20 (20.83)	76 (79.17)
P value	0.38	0.92		0.82	

Table 2. Metabolic syndrome indicators in the studied subjects

Variables	Patients with metabolic syndrome	Control (obese individuals without metabolic syndrome)	Minimum	Maximum	Coefficient of variation (CV)	P value
Length (cm)	161.56±1.82	162.44±1.51	142	185	43	0.71
Weight (kg)	74.91±0.97	74.17±1.03	47.5	105	57.5	0.602
BMI (Kg/m^2)	27.95±0.28	27.77±0.27	25	42.66	17.66	0.655
Blood pressure (mm Hg)	137.47±1.74	124.65±1.46	90/60	190/110	100/50	<0.001
Waist size (cm)	95.42±1.02	94.48±0.89	73	117	44	0.49
HDL-C (mg/dL)	42.89±0.56	54.56±1.15	31	63	32	<0.001
TG (mg/dL)	176.51±1.45	145.49±2.07	93	224	131	<0.001
FBS (mg/dL)	128.11±4.60	95.49±1.75	71	312	241	<0.001

in the studied groups is presented in Table 3.

Table 4 shows the comparison of metabolic syndrome indices at different levels of vitamin D. The mean serum HDL-C level increased with increasing vitamin D levels but the mean serum levels of TG, and FBS and systolic blood pressure decreased significantly ($P<0.05$). However, BMI remained almost constant with increasing serum vitamin D levels with no significant relationships ($P=0.999$). Additionally, the waist size was not significantly correlated with increased serum vitamin D levels ($P=0.825$).

Discussion

The present study aimed to determine the prevalence of vitamin D deficiency in obese individuals and the relationship between vitamin D deficiency and metabolic syndrome with some indices in obese patients with metabolic syndrome and healthy subjects. Vitamin D was found to be rather highly deficient in the subjects. Serum vitamin D levels were significantly lower in the patients than in control group. The relationship between each of the metabolic syndrome indices at different levels of vitamin D showed that levels of TG and FBS decreased with increasing serum vitamin D, and that HDL-C levels were consistent with vitamin D levels showing significant changes. However, the level of vitamin D was not significantly correlated with waist and BMI.

The prevalence and incidence of metabolic syndrome is increasing worldwide. One of the latest studies in Iran reported a metabolic syndrome prevalence of over 30%, which was significantly higher in women than in men (42% versus 24%) (14). Our results revealed a prevalence of 85.58% for vitamin D deficiency. A study by Soltani et al reported a prevalence of 62% and 21.2% for vitamin D deficiency and metabolic syndrome, respectively (15). In addition, Ford et al evaluated a vitamin D deficit prevalence of 72% for serum vitamin D and metabolic syndrome in a total of 8421 adult Americans (16). In another study on 646 Iranian adults, the frequencies of metabolic syndrome and vitamin D deficiency were detected to be 18.3% and 73.3%, respectively (17). A study in South Korea by Park et al revealed a relationship between serum vitamin D levels and metabolic syndrome, with a 76.6% increased incidence of vitamin D deficiency in patients with metabolic syndrome (18). The frequency of vitamin D deficiency in our study is lower than those found in other studies, which can be due to differences in the method of measuring serum vitamin D levels, culture, coverage, solar radiation levels, exposure to sunlight, sample collection season, and geographical coordinates. Our findings also indicate significantly lower serum vitamin D levels in the patients than in the normal group. Such a significant relationship could be related to the role of vitamin D in blood pressure regulation and diabetic insulin resistance. This relationship can also depend on the degree of mobility and exposure to sunlight. In fact, vitamin D is one of the essential fat-soluble vitamins in the body that helps bone growth and strength through the control of calcium and phosphorus balance. The vitamin D increases the absorption of phosphorus and calcium from the intestine, thereby, regulate bone metabolism. Other studies have also demonstrated that decreased vitamin D levels can contribute to the development of metabolic syndrome by affecting either metabolic syndrome components or through insulin resistance (7).

Table 3. Frequency distribution of vitamin D status in the studied groups

Vitamin D	Groups		
	Patients with metabolic syndrome	Control (obese individuals without metabolic syndrome)	Total
Deficient (<20 ng/mL)	58 (60.42%)	8 (8.33%)	66 (34.38%)
Insufficient (20-30 ng/mL)	25 (26.04%)	22 (22.92%)	47 (24.48%)
Sufficient (30-100 ng/mL)	13 (13.54%)	64 (66.67%)	77 (40.10)
Toxicity (>100 ng/mL)	0 (0%)	2 (2.08%)	2 (1.04%)
Total	96 (100)	96 (100)	192 (100)

Table 4. Relationships between metabolic syndrome indicators and different levels of vitamin D in the subjects

Variables	Vitamin D				*P* value
	<20	20-30	30-100	>100	
HDL-C (mg/dL)	44.43 ± 5.69	48.19 ± 8.58	52.86 ± 13.54	50.5 ± 2.12	<0.001
TG (mg/dL)	172.34 ± 19.66	164.1 ± 22.89	149.1 ± 22.05	130.5 ± 6.39	<0.001
FBS (mg/dL)	122.39 ± 41.4	115.63 ± 47.3	100.9 ± 22.04	72.5 ± 2.12	0.002
Waist size (cm)	94.06 ± 11.33	95.52 ± 8.5	95.34 ± 8.44	94 ± 0.0	0.825
Blood pressure (mm Hg)	134.77 ± 17.96	132.6 ± 15.73	126.52 ± 16.19	140 ± 28.28	0.019
BMI (kg/m^2)	27.88 ± 3.1	27.82 ± 2.26	27.87 ± 2.81	27.69 ± 1.13	0.999

A suggested role for vitamin D is participation of insulin synthesis and secretion thus reduced vitamin D levels is a possible risk factor for diabetes (19).

In the present study, levels of blood pressure, vitamin D, TG, and FBS were significantly higher in the patients than in the normal group. The study by Borzouei et al on 186 adults, revealed that people with vitamin D deficiency had a higher chance of metabolic syndrome development, with significantly higher waist size, systolic blood pressure, and FBS in the patients than in the healthy group (20). Roshanzamir et al found that HDL-C had a significant, direct correlation with vitamin D level (21). Ford et al evaluated serum levels of vitamin D and metabolic syndrome in 8421 adults and found a significant, inverse correlation between serum vitamin D and TG and FBS levels and waist size. An inverse relationship was also shown between serum vitamin D levels and metabolic syndrome (16). Besides, Moy and Bulgiba investigated the relation of vitamin D with the prevalence of metabolic syndrome. They showed that people with lower levels of vitamin D had higher incidences of metabolic syndrome (22). However, in some studies, no significant correlations were found between vitamin D deficiency and metabolic syndrome components (15,23,24). The disparate results can be attributed to the role of vitamin D in 3% expression of the human genome, which may help explain the increased prevalence of metabolic syndrome in patients with vitamin D deficiency (25).

Conclusion

The results of this study suggest that examining the serum levels of vitamin D allows screening people at risk for metabolic syndrome development, especially in high-risk individuals.

Limitations of our study

A limitation of this study was relatively small size studied population. Further investigation in this regard suggests.

Acknowledgments

This study is the result of a dissertation of Hamid Daemi (MD dissertation) numbered 1413 approved by the Shahrekord University of Medical Sciences. The authors hereby acknowledge the Research and Technology Vice-Chancellor at Shahrekord University of Medical Sciences, the colleagues, and all participants in the study.

Authors' contribution

HD, MM, and MMB conducted the research and contributed to the conception and design of the research. MAS and LM prepared the primary draft. HD contributed to the acquisition of data. MS contributed to the analysis of data. All authors contributed to the drafting of the manuscript and final approval of the manuscript.

Conflicts of interest

The authors declare that they have no competing interest.

Ethical considerations

Ethical issues (including plagiarism, misconduct, data fabrication, falsification, double publication or submission, redundancy) have been completely observed by the authors.

Funding/Support

This study supported and funded by the Research Deputy

of Shahrekord University of Medical Sciences (Grant # 2322).

References

1. Eckel RH. The Metabolic Syndrome. In: Fauci AS, Braunwald E, Kasper Dl, Hauser SL, Longo DL, Jamson L, editors. Harrisons Internal medicine. New York: Mc Graw Hill; 2012.
2. Labazi H, Trask AJ. Coronary microvascular disease as an early culprit in the pathophysiology of diabetes and metabolic syndrome. Pharmacol Res. 2017;123:114-21. doi: 10.1016/j.phrs.2017.07.004.
3. Santilli F, D'Ardes D, Guagnano MT, Davi G. Metabolic syndrome: Sex-related cardiovascular risk and therapeutic approach. Curr Med Chem. 2017;24:2602-27. doi: 10.2174/0929867324666170710121145.
4. Ebrahimi-Mamaghani M, Arefhosseini S, Golzarand M, Aliasgarzadeh A, Vahed-Jabbary M. Long-term effects of processed Berberis vulgaris on some metabolic syndrome components. Iranian J Endocrinolog Metabol. 2009;11:12-8.
5. Alexander CM. The coming of age of the metabolic syndrome. Am Diabetes Assoc. 2003;12:42-6. doi: 10.2337/diacare.26.11.3180.
6. Desai M, Jellyman JK, Ross MG. Epigenomics, gestational programming and risk of metabolic syndrome. Int J Obes (Lond). 2015;39:633-41. doi:10.1038/ijo.2015.13.
7. Chiu KC, Chu A, Go VLW, Saad MF. Hypovitaminosis D is associated with insulin resistance and β cell dysfunction. Am J Clin Nutr. 2004;79:820-5.
8. Godala MM, Materek-Kusmierkiewicz I, Moczulski D, Rutkowski M, Szatko F, Gaszynska E, et al. The risk of plasma vitamin A, C, E and D deficiency in patients with metabolic syndrome: a case-control study. Adv Clin Exp Med. 2017;26:581-6. doi: 10.17219/acem/62453.
9. Alkhatatbeh MJ, Abdul-Razzak KK, Khasawneh LQ, Saadeh NA. High prevalence of vitamin D deficiency and correlation of serum vitamin D with cardiovascular risk in patients with metabolic syndrome. Metab Syndr Relat Disord. 2017;15:213-9. doi: 10.1089/met.2017.0003.
10. Hassan-Smith ZK, Hewison M, Gittoes NJ. Effect of vitamin D deficiency in developed countries. Br Med Bull. 2017;122:79-89. doi: 10.1093/bmb/ldx005.
11. Reis JP, Von Muhlen D, Kritz-Silverstein D, Wingard DL, Barrett-Connor E. Vitamin D, parathyroid hormone levels, and the prevalence of metabolic syndrome in community-dwelling older adults. Diabetes Care. 2007;30:1549-55. doi: 10.2337/dc06-2438.
12. Yoon H, Young Bae N, Young Gi M, Yeon Park B, Min Seong J. The association between serum ferritin and 25-hydroxyvitamin D and metabolic syndrome in Korean women: the Korea National Health and Nutrition Examination Survey 2010-2012. J Clin Biochem Nutr. 2017;61:60-6. doi: 10.3164/jcbn.16-115.
13. Detection EPO. Evaluation and treatment of high blood cholesterol in adults. Executive summary of the third report of The National Cholesterol Education Program (NCEP) Expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel III). JAMA. 2001;285: 2486-97. doi:10.1001/jama.285.19.2486s.
14. Azizi F, Salehi P, Etemadi A, Zahedi-Asl S. Prevalence of metabolic syndrome in an urban population: Tehran lipid and glucose study. Diabetes Res Clinic Pract. 2003;61:29-37. doi: 10.1016/S0168-8227(03)00066-4.
15. Soltani Z, Khamse M, Chiti H, Valizadeh M, Mazloomzadeh S. Plasma 25 (OH) Vitamin-D level and metabolic syndrome risk factors among physicians of Zanjan. ZUMS J. 2015;23:64-73.
16. Ford ES, Ajani UA, McGuire LC, Liu S. Concentrations of serum vitamin D and the metabolic syndrome among US adults. Diabetes Care. 2005;28:1228-30. doi: 10.2337/diacare.28.5.1228.
17. Hoseinnejad A, Maghbuli Z, Mirzaie K, Karimi F, Larijani B. Relation of vitamin D3 level with metabolic syndrome among Iranian adult populations. Iran J Diabetes Lipid. 2009;9:383-9.
18. Park HY, Lim Y-H, Kim JH, Bae S, Oh S-Y, Hong Y-C. Association of serum 25-hydroxyvitamin D levels with markers for metabolic syndrome in the elderly: a repeated measure analysis. J Korean Med Sci. 2012;27:653-60. doi: 10.3346/jkms.2012.27.6.653.
19. Esteghamati A, Aryan Z, Esteghamati A, Nakhjavani M. Vitamin D deficiency is associated with insulin resistance in nondiabetics and reduced insulin production in type 2 diabetics. Horm Metab Res. 2015;47:273-9. doi: 10.1055/s-0034-1389903.
20. Borzouei S, Esna Ashari F, Kiani SJ, Kaveh MR, Goodarzi MT, Bahrami S, et al. The relationship between serum 25-hydroxyvitamin D levels and metabolic syndrome. J Hamadan Univ Med Sci. 2013;20:25-31.
21. Roshanzamir F, Mehrabani H, Meshkibaf M, Mahmoodi M, Bizhani R, Khorshid A. Comparing the amount of 25-hydroxy vitamin D 3 concentrated in serum of normal and overweight/obese women and its relation to metabolic syndrome. J Fasa Univ Med Sci. 2014;4:194-200.
22. Moy F-M, Bulgiba A. High prevalence of vitamin D insufficiency and its association with obesity and metabolic syndrome among Malay adults in Kuala Lumpur, Malaysia. BMC Public Health. 2011;11:735. doi: 10.1186/1471-2458-11-735.
23. Majumdar V, Nagaraja D, Christopher R. Vitamin D status and metabolic syndrome in Asian Indians. Int J Obes. 2011;35:1131-4. doi: 10.1038/ijo.2010.232.
24. Hjelmeseth J, Hofso D, Aasheim ET, Jenssen T, Moan J, Hager H, et al. Parathyroid hormone, but not vitamin D, is associated with the metabolic syndrome in morbidly obese women and men: a cross-sectional study. Cardiovasc Diabetol. 2009;8:7. doi: 10.1186/1475-2840-8-7.
25. Zadeh-Vakili A, Tehrani FR, Daneshpour MS, Zarkesh M, Saadat N, Azizi F. Genetic polymorphism of vitamin D receptor gene affects the phenotype of PCOS. Gene. 2013;515:193-6. doi: 10.1016/j.gene.2012.11.049.

Copyright © 2018 The Author(s); Published by Nickan Research Institute. This is an open-access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.