ejpmr, 2023,10(1), 18-22

SJIF Impact Factor 6.222

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Research Article

ISSN 2394-3211

EJPMR

ASSOCIATION BETWEEN SERUM 25-HYDROXYVITAMIN D CONCENTRATIONS AND METABOLIC SYNDROME IN THE MIDDLE-AGED INDIVIDUAL

Dr. Afsana Akhter[1]*, Dr. Nowrose Jahan[2], Dr. Kohinoor Akter[3], Dr. Sumi Dey[4], Dr. Purabi Barman[5] and Dr. Shahanaz Akter[6]

[1,5]Lecturer, Biochemistry, Sir Salimullah Medical College, Dhaka, Bangladesh.
[2]Professor, Department of Biochemistry, Sir Salimullah Medical College, Dhaka, Bangladesh.
[3]Lecturer, Biochemistry, Shaheed Suhrawardy Medical College, Dhaka, Bangladesh.
[4]Lecturer, Biochemistry, Jessore Medical College, Jessore, Bangladesh.
[6]Lecturer, Biochemistry, Mugda Medical College, Dhaka, Bangladesh.

***Corresponding Author: Dr. Afsana Akhter**

Lecturer, Biochemistry, Sir Salimullah Medical College, Dhaka, Bangladesh.

Article Received on 10/11/2022 **Article Revised on 30/11/2022** **Article Accepted on 21/12/2022**

ABSTRACT

Background: Metabolic syndrome (MetS) has become one of the most important threats to human health worldwide in both developed and developing countries. Vitamin D deficiency has been identified as a public health issue and it could be a risk factor for MetS. Epidemiological studies show that serum concentrations of vitamin D are inversely associated with MetS. **Objective:** This study aims to find out the association between serum 25-hydroxyvitamin D concentrations and metabolic syndrome in the middle-aged individual. **Methods:** This cross-sectional analytical study was carried out to find out the association between serum 25-hydroxy vitamin D concentrations and metabolic syndrome in the middle-aged individual. For this study, 90 subjects were recruited after fulfilling the inclusion and exclusion criteria. Study subjects were divided into two groups: 45 subjects with MetS and 45 subjects without MetS. **Results:** Baseline characteristics showed that BMI and WC were significantly higher in subjects with MetS than the subjects without MetS (27.89±4.13 vs. 23.53±3.47; p<0.001 and 94.09±8.76 vs. 87.78±8.68; p value: 0.001) respectively. Mean (±SD) of serum vitamin D was significantly lower in MetS subjects as compared to subjects without MetS (26.50±5.94 vs. 30.51±5.80; p value: 0.002). This study showed FPG was significantly higher in subjects with MetS than subjects without MetS. **Conclusion:** It can be concluded from that study that low vitamin D level may be associated with obesity and high WC, high SBP and high FPG. Thus, lower vitamin D status can be considered as increased risk of development of metabolic syndrome.

KEYWORDS: Metabolic syndrome, vitamin D concentrations, insulin resistance.

INTRODUCTION

Metabolic syndrome (MetS) is a cluster of vascular risk factors, correlated with chronic conditions, such as type 2 diabetes mellitus and cardiovascular disease.[1] The prevalence of MetS is increasing rapidly worldwide and it is estimated by the International Diabetes Federation that one quarter of the world's adult population has MetS.[2]

Vitamin D is a prohormone whose main function is to regulate calcium and phosphorus metabolism related to preserve bone mass.[3] Vitamin D is a lyophilic hormone synthesized in the skin by UV-mediated isomerization of 7-dehydrocholesterol and subsequently converted to active $1,25(OH)_2D_3$ by two consecutive hepatic and renal hydroxylation. Besides its role in calcium-phosphate regulation and bone metabolism, it has a potential role in the development of insulin resistance-related conditions, such as obesity, type 2 diabetes mellitus (T2DM), systemic hypertension and metabolic syndrome.[4]

Insulin resistance has been considered a possible mechanism underlying the metabolic syndrome.[5] Previous research suggests that low vitamin D levels are associated with insulin resistance (Chiu et al., 2004), β-cell dysfunction, and impaired insulin secretion and action (Chiu et al., 2004; Holick, 2002).[6,7] Vitamin D was found to play a role in the regulation of lipolysis.[8] This might therefore contribute to the development of the metabolic syndrome.

Low serum 25(OH)D levels have been linked to a range of non-skeletal health conditions in adults, including metabolic disorders and cardiovascular diseases.[9,10] Epidemiological studies show that serum concentrations of vitamin D are inversely associated with MetS.[11,12]

Vitamin D is a fat-soluble vitamin that may be trapped and saved in adipose tissue. Studies reported more storage of Vitamin D in adipose tissue and lower

bioavailability of endogenous Vitamin D in blood circulation of obese persons.[13] Serum 25-hydroxyvitamin D concentrations are low in obese adults (Zamboni et al., 1988; Yanoff et al., 2006) and linked to components of body composition, particularly body fat mass.[14–17] Supplementations with vitamin D has shown a positive outcome in reducing body fat mass in women regardless of their body mass index (BMI) levels.[18]

OBJECTIVE

General Objective

To elucidate the association between serum 25(OH)D and metabolic syndrome in the middle-aged individual.

Specific Objective

1. To measure anthropometric variables (BMI, WC) in the study subjects.
2. To measure systolic and diastolic blood pressure in the study subjects.
3. To estimate fasting plasma glucose and serum triglyceride and high-density lipoprotein cholesterol in the study subjects.
4. To determine serum 25(OH)D concentration in all study subjects.
5. To compare all variables among groups based on quartiles of serum 25(OH)D levels.

METHOD

Study design: It was a cross-sectional analytical study.

Study place and period: Department of Biochemistry of Sir Salimullah Medical College, Dhaka, Bangladesh. The study was done during the period of March'20 to July'21.

Study population: Study population included those subjects attending the outpatient department (OPD) of Endocrinology of Sir Salimullah Medical College.

Sampling technique: Purposive convenient sampling.

Inclusion criteria

- Age of the study subjects between 30 to 59 years.
- Both sexes.

Exclusion criteria

Participants with -

- History of existing or preexisting coronary heart disease.
- Those taking lipid lowering medications and vitamin D therapy.
- Chronic liver or renal disease, autoimmune disease, thyroid dysfunction and cancer.

Sample size: Total 90 subjects (45 for each group) were included for this study.

Study procedure

Subjects were selected from the outpatient department (OPD) of Endocrinology of Sir Salimullah Medical College and Mitford Hospital, Dhaka. Ethical permission was taken from the Ethical Review Committee of Sir Salimullah Medical College. After proper counselling aim, objectives, risk and procedure of the study were explained in details to all participants. Only voluntary candidates were recruited as research participants. They had the freedom to withdraw themselves from the study at any stage. Written informed consent was taken from all participants.

Research instruments

A structured questionnaire was prepared which included all the variables of interest of the study. It was pre-tested and corrected accordingly and used to gather required information.

Data collection and processing

Before collecting specimen, each patient was interviewed and relevant information was recorded systematically in a pre-designed standard data sheet and then data was checked and edited.

Data analysis

Continuous variables were expressed as mean values and standard deviation (SD), whereas categorical variables were described as counts and percentiles. Quartiles based on the values of 25(OH)D were created. Unpaired student t-test was used to compare the differences in serum 25(OH)D concentrations between participants with and without MetS. Logistic regression was used to estimate the odds ratios (ORs) and 95% CIs for each quartile of serum level of 25(OH)D compared with the highest quartile value. Other statistical methods include: Analysis of variance (ANOVA) test, Chi-square test were used.

RESULT

In this study, a total of 90 subjects were enrolled. Among them 45 were metabolic syndrome and 45 were without metabolic syndrome subjects.

Table I shows mean±SD of Age (years), Height (m), Weight (kg), BMI (kg/m2), WC (cm), SBP (mmHg), DBP (mmHg) in Group I and Group II. Subjects with MetS had higher Weight (kg), BMI (kg/m2), WC (cm), SBP (mmHg), DBP (mmHg) than those subjects without MetS.

Table I: Baseline characteristics of study subjects (N=90).

Variables	Group I (n=45)	Group II (n=45)	p-value
Age (years)	39.84±7.27	38.24±9.42	0.370
Height (m)	1.62±0.08	1.64±0.10	0.234
Weight (kg)	73.16±12.85	65.00±11.07	0.002
BMI (kg/m2)	27.89±4.13	23.53±3.47	<0.001
WC (cm)	94.09±8.76	87.78±8.68	0.001
SBP (mmHg)	115.67±14.64	105.78±10.76	<0.001
DBP (mmHg)	81.78±7.47	73.56±11.11	<0.001

Data were expressed as mean±SD. Unpaired student t-test was performed to compare between two groups. BMI=Body Mass Index, WC=Waist circumference,

SPB=Systolic blood pressure, DBP=Diastolic blood pressure

Table VI shows that out of 90 subjects, vitamin D insufficiency was found in 26 MetS subjects and 20 subjects without MetS, whereas vitamin D deficiency, was found in 6 MetS subjects and subjects without MetS had no vitamin D deficiency indicating significant association of vitamin D between two groups.

Table II: Association of Vitamin D between two groups (N=90).

Vitamin D	Group I (n=45)	Group II (n=45)	p-value
Normal (≥30 ng/ml)	13(28.9%)	25(55.6%)	**0.005**
Insufficiency (21-29 ng/ml)	26(57.8%)	20(44.4%)	
Deficiency (≤ 20 ng/ml)	6(13.3%)	0(0.0%)	
Total	45(100.0%)	45(100.0%)	

Data were expressed as frequency and percentage

Chi-square test was performed to see the association between two groups

Table III: Correlation of serum Vitamin D with components of MetS (N=90).

Variables	Group I		Group II	
	r-value	p-value	r-value	p-value
Height (m)	0.076	0.621	-0.217	0.151
Weight (kg)	-0.011	0.945	-0.236	0.119
BMI (kg/m2)	-0.066	0.665	-0.198	0.192
WC (cm)	-0.487	**0.001**	-0.398	0.007
SBP (mmHg)	-0.323*	**0.030**	0.102	0.505
DBP (mmHg)	-0.083	0.589	-0.030	0.844

Correlations were determined by Pearson's correlation coefficient test.

Table IV shows correlation of serum Vitamin D with biochemical parametersbetween Group I and Group II. There was significant negative correlation of vitamin D with FPG in Group I.

Table IV: Correlation of serum Vitamin D with biochemical parameters (N=90).

Variables	Group I		Group II	
	r-value	p-value	r-value	p-value
FPG (mmol/L)	-0.813**	**0.000**	-0.193	0.203
TG (mg/dl)	0.079	0.604	-0.119	0.438
HDLC (mg/dl)	-0.127	0.405	0.021	0.889

Correlations were determined by Pearson's correlation coefficient test.

Figure 1 showing the correlation of Vitamin D with FPG between Group I and Group II. In the graph it is clearly visible that two variables are negatively and significantly correlated.

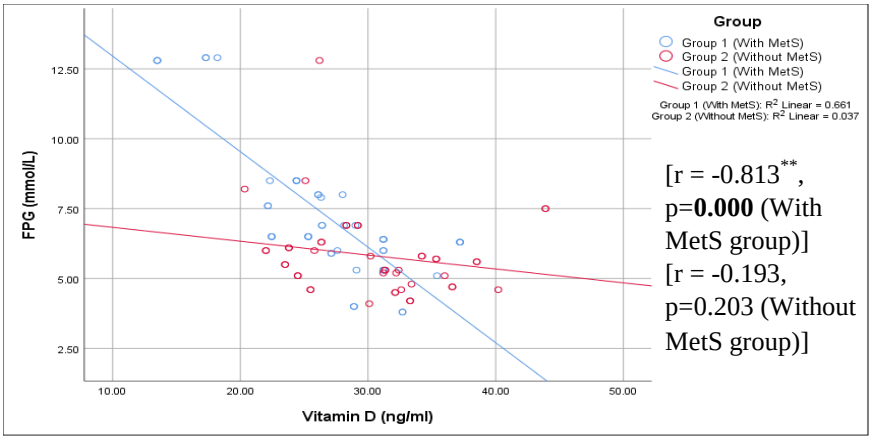

Figure-1: Correlation of Vitamin D with FPG between Group I and Group II.

Table V shows that there was no association between Vitamin D and baseline characteristics in Model 1. However, the relationship of BMI, FPG with Vitamin D became significant when FPG entered into model 2. Again, it was evident that Vitamin D was associated with height, BMI and FPG and these relationships remained significant even after TG and HDL-C entered into model 3.

Table-V: Multiple regression analysis of the relation of serum 25-hydroxyvitamin D levels with baseline characteristics and components of metabolic syndrome

	Model 1			Model 2			Model 3		
	OR	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Age (years)	.980	0.91-1.05	.565	1.055	0.97-1.15	.241	1.049	0.96-1.15	.319
Sex	1.664	0.54-5.18	.379	5.120	0.94-27.8	.059	5.727	0.94-35.05	.059
Height (m)	.000	0.00-158.37	.095	.000	0.00-1.44	.052	.000	0.00-0.04	**.037**
Weight (kg)	1.415	0.93-2.16	.108	1.810	0.97-3.40	.064	1.898	1.00-3.60	.050
BMI (kg/m2)	.321	0.10-1.06	.062	.150	0.03-0.88	**.035**	.135	0.02-0.80	**.027**
WC (cm)	.960	0.86-1.07	.471	1.051	0.91-1.22	.509	1.048	0.91-1.21	.524
SBP (mmHg)	.948	0.90-1.00	.064	.990	0.92-1.07	.794	.974	0.90-1.06	.541
DBP (mmHg)	1.036	0.96-1.12	.355	.999	0.92-1.09	.986	1.007	0.92-1.10	.885
FPG (mmol/L)				.195	0.08-0.51	**.001**	.202	0.08-0.52	**.001**
TG (mg/dl)							1.006	0.99-1.02	.465
HDLC (mg/dl)							1.044	0.72-1.52	.819

The analyses were first conducted including all variables except FPG, TG and HDL-C in the model 1, then repeated with FPG forced into the model 2 and again repeated with TG and HDL-C into the model 3.

DISCUSSION

It was evident from this study that the subjects with MetS had higher weight, BMI and waist circumferences than the subjects without MetS (Table I). Participants belonged to lower quartiles of vitamin D had significantly higher BMI and WC, indicating that low vitamin D had an association with obesity. Similar observation was reported with the studies conducted by Miñambres., et al., 2012. Several hypotheses have been proposed to explain this association. It has been suggested that obese subjects have less exposure to sunlight, an inadequate intake of vitamin D, and decreased bioavailability of vitamin D due to enhanced uptake and clearance by adipose tissue.[19,20]

The percentage of low vitamin D status (<30 ng/ml) was 52%. A study with a smaller sample (n=219) found that 60.3% had low vitamin D status (<30 ng/ml) (Caro et al., 2012), while in another study (n=4,090), 68.5% had low vitamin D status.[21]

A significant negative correlation between vitamin D and SBP was evident in MetS group but not in non-MetS group in the present study. No correlation was found between vitamin D and DBP in this study. Subjects belonged to lower quartiles of vitamin D had significantly higher SBP, but not DBP, indicating 25(OH)D is more closely associated to systolic (SBP) than to diastolic blood pressure (DBP). This was consistent with the finding of a study carried out by Nayak and Ramnanansingh, 2016 where 25(OH)D was more closely associated to systolic (SBP) than to diastolic blood pressure (DBP)[22]. One of meta-analyses showed that in phenotypic analyses high 25(OH)D concentrations were associated with decreased SBP but not with decreased DBP.[22]

In this study, negative correlation between vitamin D and FPG was evident in MetS group but not in non-MetS group. Subjects belonged to lower quartiles of vitamin D had significantly higher FPG, indicating 25(OH)D was inversely related to fasting plasma glucose. This finding was consistent with the study conducted by Sorkin et al., 2014. Paknahad, Ahmadivasmehjani and Maracy, 2015,[23] Varasteh and Khaajeh-Dalouie, 2010 and also Brock et al., 2012 observed an inverse association between vitamin D level and FBS.[23–26] They have suggested increased insulin secretion, insulin sensitivity, stimulation of insulin receptor expression, transport of glucose into target tissues and intracellular calcium regulation as possible mechanisms for vitamin D function. Correlation between vitamin D and FPG values was not observed in a study carried out by Chacko et al., 2011.[27]

CONCLUSION

It can be concluded from that study that low vitamin D level may be associated with obesity and high WC, high SBP and high FPG. Thus, lower vitamin D status can be considered as increased risk of development of metabolic syndrome.

REFERENCE

1. Grundy, S. M. Metabolic syndrome: a multiplex cardiovascular risk factor. *J Clin Endocrinol Metab*, 2007; **92:** 399–404.
2. O'Neill, S. & O'Driscoll, L. Metabolic syndrome: a closer look at the growing epidemic and its associated pathologies. *Obes Rev.*, 2015; **16:** 1–12.
3. Wolpowitz, D. & Gilchrest, B. A. The vitamin D questions: how much do you need and how should you get it? *ournal of the American Academy of Dermatology*, 2006; **54:** 301–317.

4. Bell, N. H. *et al.* Evidence for alteration of the vitamin D-endocrine system in obese subjects. *J Clin Invest*, 1985; **76:** 370–373.
5. Reaven, G. M. Role of insulin resistance in human disease. *Diabetes*, 1988; **37:** 1595–1607.
6. Chiu, K. C., Chu, A., Go, V. L. W. & Saad, M. F. Hypovitaminosis D is associated with insulin resistance and β cell dysfunction. *Am J Clin Nutr*, 2004; **79:** 820–825.
7. Holick, M. F. Vitamin D: the underappreciated D-lightful hormone that is important for skeletal and cellular health. *Curr Opin Endocrinol Diabetes Obes*, 2002; **9:** 87–98.
8. Zemel, M. B., Shi, H., Greer, B., Dirienzo, D. & Zemel, P. C. Regulation of adiposity by dietary calcium. *The FASEB Journal*, 2000; **14:** 1132–1138.
9. Ford, E. S. Prevalence of the metabolic syndrome defined by the International Diabetes Federation among adults in the US. *Diabetes Care*, 2005; **28:** 2745–2749.
10. Kayaniyil, S. *et al.* Prospective association of 25 (OH) D with metabolic syndrome. *Clin Endocrinol (Oxf)*, 2014; **80:** 502–507.
11. Lakka, H. M. *et al.* The metabolic syndrome and total and cardiovascular disease mortality in middle-aged men. *JAMA*, 2002; **288:** 2709–2716.
12. Munoz-Aguirre, P., Denova-Gutierrez, E., Flores, M., Salazar-Martinez, E. & Salmeron, J. High vitamin D consumption is inversely associated with cardiovascular disease risk in an urban Mexican population. *PLoS One*, 2016; **11:** 11.
13. Cheng, S. *et al.* Adiposity, cardiometabolic risk, and vitamin D status: the Framingham Heart Study. *Diabetes*, 2010; **59:** 242–248.
14. Zamboni, G., Soffiati, M., Giavarina, D. & Tato, L. Mineral metabolism in obese children. *Acta Paediatr*, 1988; **77:** 741–746.
15. Yanoff, L. B. *et al.* The prevalence of hypovitaminosis D and secondary hyperparathyroidism in obese Black Americans. *Clin Endocrinol (Oxf)*, 2006; **64:** 523–529.
16. Liel, Y., Ulmer, E., Shary, J., Hollis, B. W. & Bell, N. H. Low circulating vitamin D in obesity. *Calcif Tissue Int.*, 1988; **43:** 199–201.
17. Danescu, L. G., Levy, S. & Levy, J. Vitamin D and diabetes mellitus. *Endocrine*, 2009; **35:** 11–17.
18. Salehpour, A. *et al.* A 12-week double-blind randomized clinical trial of vitamin D 3 supplementation on body fat mass in healthy overweight and obese women. *Nutr J.*, 2012; **11:** 1–8.
19. Wortsman, J., Matsuoka, L. Y., Chen, T. C., Lu, Z. & Holick, M. F. Decreased bioavailability of vitamin D in obesity. *Am J Clin Nutr.*, 2000; **72:** 690–693.
20. Earthman, C. P., Beckman, L. M., Masodkar, K. & Sibley, S. D. The link between obesity and low circulating 25-hydroxyvitamin D concentrations: considerations and implications. *Int J Obes*, 2012; **36:** 387–396.
21. Suarez-Mart\'\inez, E. B. *et al.* Importance of Vitamin D and Vitamin D Levels Status in Puerto Ricans. *J Health Care Poor Underserved*, 2013; **24:** 38–47.
22. Nayak, S. B. & Ramnanansingh, T. G. Evaluation of vitamin D relationship with type 2 diabetes and systolic blood pressure. *BMJ Open Diabetes Res Care*, 2016; **4:** 1.
23. Bonakdaran, S., Varasteh, A. & Khaajeh-Dalouie, M. Serum 25 hydroxy vitamin D3 and laboratory risk markers of cardiovascular diseases in type 2 diabetic patients. *Iranian Journal of Endocrinology and Metabolism*, 2010; **11:** 504–509.
24. Sorkin, J. D., Vasaitis, T. S., Streeten, E., Ryan, A. S. & Goldberg, A. P. Evidence for threshold effects of 25-hydroxyvitamin D on glucose tolerance and insulin resistance in black and white obese postmenopausal women. *J Nutr*, 2014; **144:** 734–742.
25. Paknahad, Z., Ahmadivasmehjani, A. & Maracy, M. R. Association of Serum 25-hydroxyvitamin D concentration and Markers of Metabolic Syndrome in adult women. *J Res Health Sys*, 2015; **11:** 641–650.
26. Brock, K. *et al.* Vitamin D and metabolic syndrome in immigrant East Asian women living in Sydney, Australia: a pilot. *J Metab Syndr*, 2012; **1:** 1–4.
27. Chacko, S. A. *et al.* Serum 25-hydroxyvitamin D concentrations in relation to cardiometabolic risk factors and metabolic syndrome in postmenopausal women. *Am J Clin Nutr.*, 2011; **94:** 209–217.