ORIGINAL PAPERS

Adv Clin Exp Med 2015, **24**, 2, 245–250
DOI: 10.17219/acem/41375

ISSN 1899–5276

Nada Yasein[1, A–C, E, F], Wejdan Shroukh[2, A–E], Razan Hijjawi[3, A–D]

Serum Vitamin D and the Metabolic Syndrome Among Osteoporotic Postmenopausal Female Patients of a Family Practice Clinic in Jordan

[1] Department of Family and Community Medicine, Faculty of Medicine, University of Jordan, Amman, Jordan
[2] Department of Pharmacy, University of Jordan, Amman, Jordan
[3] Department of Family and Community Medicine, Faculty of Medicine, Jordan University Hospital, Amman, Jordan

A – research concept and design; **B** – collection and/or assembly of data; **C** – data analysis and interpretation; **D** – writing the article; **E** – critical revision of the article; **F** – final approval of article; **G** – other

Abstract

Background. Vitamin D deficiency and insufficiency and the metabolic syndrome are two common health issues worldwide. The association between these two health problems is subject to debate.
Objectives. This study aims to investigate the association between vitamin D deficiency or insufficiency and the metabolic syndrome in a sample of osteoporotic postmenopausal women attending a family practice clinic in Amman – Jordan.
Material and Methods. This was an observational cross sectional study. It was carried out in the family practice clinic in Jordan University Hospital. The study included all postmenopausal osteoporotic women attending the clinic between June 2011 and May 2012, yielding a total of 326 subjects. The association between metabolic syndrome and serum vitamin D levels was investigated.
Results. Waist circumference, body mass index, triglycerides and fasting blood sugar were significantly higher among postmenopausal women with metabolic syndrome, but HDL cholesterol was significantly lower ($p < 0.05$). The prevalence of metabolic syndrome among all study participants was 42.9%. Triglycerides and LDL cholesterol were significantly higher among women deficiency or insufficiency ($p < 0.05$). The prevalence of vitamin D deficiency or insufficiency was 45.7%. Among patients with metabolic syndrome, the prevalence of vitamin D deficiency or insufficiency was 50.7%.
Conclusions. Findings of the current study suggest a lack of relationship between serum vitamin D and metabolic syndrome. However, a significant inverse relationship was found between serum vitamin D levels and both serum triglycerides and LDL levels (**Adv Clin Exp Med 2015, 24, 2, 245–250**).

Key words: metabolic syndrome, osteoporotic, postmenopausal.

The metabolic syndrome is another important health issue among postmenopausal women [3]. Studies from different parts of the world have revealed that the prevalence of the metabolic syndrome reaches as high as 41.5% among postmenopausal women [4, 5].

The association between vitamin D levels and the metabolic syndrome is the subject of considerable debate, and conflicting results have been found regarding this issue [2]. Some studies suggest that vitamin D deficiency could be a risk factor for the development of the metabolic syndrome [6–8]. On the other hand, there are studies that have shown a lack of any association between vitamin D levels and the metabolic syndrome [2, 9]. Further research is needed in this area.

Epidemiological studies have suggested that vitamin D deficiency could be related to individual components of the metabolic syndrome rather than being related to the syndrome itself. The findings of such studies suggest an inverse relationship between vitamin D levels and serum glucose or dyslipidemia [10–12].

To the authors' knowledge, little research has

been conducted in Jordan about the relationship between vitamin D levels and the metabolic syndrome, including its individual components. This study aims to investigate the association between vitamin D deficiency or insufficiency and the metabolic syndrome in a sample of osteoporotic postmenopausal female patients of a family practice clinic in Amman, Jordan.

Material and Methods

This was an observational cross-sectional study. It was carried out at the family practice clinic of Jordan University Hospital, the teaching hospital of Jordan University. The study included all the postmenopausal osteoporotic women fulfilling, the inclusion criteria described below, who were treated at the clinic period between June 2011 and May 2012, yielding a total of 326 subjects.

The research was approved and funded by the Deanship of Academic Research at Jordan University. All the subjects included provided verbal consent to participate in the study.

The inclusion criteria were as follows: 1) older than 40 years; 2) undergoing primary menopause [13]; 3) diagnosed with primary osteoporosis, confirmed by a recent dual-energy X-ray absorptiometry (DXA) scan followed by the appropriate appraisals to rule out secondary osteoporosis [14]; and 4) having a serum vitamin D measurement within the previous 3 months. The researchers required that all possible study subjects should have a recent vitamin D measurement regardless of the reason for which the test was performed.

Osteoporosis was defined on the basis of assessments of bone mineral density (BMD). According to the WHO criteria, osteoporosis is defined as "a BMD that lies 2.5 standard deviations or more below the average value for young healthy women (a T-score of < –2.5 SD)") [15]. The BMD was measurements were carried out using a Lunar iDXA (GE Healthcare). Measurements were done at two sites: the lumbar spine (L1-L4), and the total hip.

Serum 25-hydroxy vitamin D levels were measured using the ARCHITECT 25-OH assay, which is a chemiluminescent microparticle immunoassay (CMIA) for the quantitative determination of 25-hydroxyvitamin D in human serum and plasma. The reference values are: less than 25 nmol/L is deficient; between 25 and 74 nmol/L is insufficient; more than 74 nmol/L is: normal.

The metabolic syndrome was diagnosed using the National Cholesterol Education Program, Adult Treatment Panel III. Subjects were considered to have the metabolic syndrome if they had 3 or more of the following abnormalities: abdominal obesity: (waist circumference > 88 cm), high blood pressure: (systolic blood pressure ≥ 135 mm Hg and/or diastolic blood pressure ≥ 85 mm Hg, or if they were on antihypertensive medications), hypertriglyceridaemia: (serum trigliceryde level ≥ 150 mg/dL), low HDL-cholesterol (< 50 mg/dL), high fasting blood glucose (≥ 110 mg/dL, or if they were on anti-diabetic medications) [16].

Data regarding DXA scan result, age, serum vitamin D, serum calcium, serum phosphorus, serum triglycerides, serum HDL, serum LDL and fasting blood sugar were extracted from the patient's' medical records by a trained research assistant. The research assistant measured the waist circumference, height and weight of each participant and calculated the body mass index [17]. Blood pressure was measured by a nurse at the clinic using a suitable cuff sphygmomanometer while the patient was in the sitting position. The mean of 3 readings separated by 1-min intervals was recorded.

The data were analyzed using SPSS 18 software (IBM Corporation, Chicago, USA). Simple descriptive statistics were used. An independent sample *t*-test was used to compare mean values. A p value of less than 0.05 was considered significant.

Results

Table 1 shows the clinical and biochemical data of the postmenopausal women with and without the metabolic syndrome. It was observed that waist circumference, body mass index, triglycerides and fasting blood sugar were significantly higher among postmenopausal women with the metabolic syndrome, but HDL cholesterol was significantly lower ($p < 0.05$). None of the other parameters showed any significant difference. The prevalence of the metabolic syndrome among all the study participants was 42.9%. Table 2 shows the clinical and biochemical data of postmenopausal women with and without vitamin D deficiency or insufficiency. Serum vitamin D was significantly lower among women with vitamin D deficiency or insufficiency, ($p = 0.000$). Triglycerides and LDL cholesterol were significantly higher among women with a deficiency or insufficiency ($p < 0.05$). The prevalence of vitamin D deficiency or insufficiency was 45.7%.

Table 3 shows the clinical and biochemical data of the metabolic syndrome among postmenopausal women with and without vitamin D deficiency. There was no significant difference between any of the parameters except for serum vitamin D, which was significantly lower among women with

Table 1. Clinical and biochemical data of postmenopausal women with and without the metabolic syndrome (n = 326), age (years)

Waist circumference (cm)	101.4 ± 11.8	90.9 ± 16.1	0.000
Body mass index (kg/m^2)	32.7 ± 5.3	28.9 ± 6.5	0.000
SBP (mm Hg)	131.1 ± 21.6	130.3 ± 20.6	0.754
DBP (mm Hg)	75.4 ± 10.5	74.5 ± 10.9	0.483
Vitamin D (ng/mL)	41.3 ± 31.3	42.5 ± 29.7	0.730
Calcium (mg/dL)	9.3 ± 0.8	9.3 ± 0.7	0.593
Phosphorus (mg/dL)	3.6 ± 0.7	3.6 ± 0.5	0.943
Lumbar spine T-score	2.8 ± 0.7	2.9 ± 0.6	0.300
Total hip T-score	2.2 ± 0.8	2.3 ± 0.7	0.198
Triglycerides (mg/dL)	162.6 ± 66.6	156.4 ± 42.3	0.000
HDL (mg/dL)	45.6 ± 10.8	56.2 ± 12.2	0.000
LDL (mg/dL)	123.1 ± 39.8	124.3 ± 34.1	0.770
Fasting blood sugar (mg/dL)	128.6 ± 54.3	98.2 ± 23.8	0.000

Table 2. Clinical and biochemical data of postmenopausal women with and without vitamin D deficiency or insufficiency (n = 326)

Parameters	**Deficient or insufficient vitamin D (n = 173)**	**Normal vitamin D (n = 153)**	**p**
Age (years)	63.6 ± 8	62.4 ± 7.2	0.167
Waist circumference (cm)	95.5 ± 15.1	95.2 ± 15	0.852
Body mass index (kg/m^2)	30.8 ± 5.9	30.3 ± 6.7	0.494
SBP (mm Hg)	130.4 ± 20.3	130. 5 ± 21.7	0.958
DBP (mm Hg)	75.8 ± 11	74 ± 10.4	0.127
Vitamin D (ng/mL)	19.1 ± 6.4	63.3 ± 28.1	0.000
Calcium (mg/dL)	9.2 ± 0.7	9.3 ± 0.7	0.423
Phosphorus (mg/dL)	3.5 ± 0.5	3.6 ± 0.6	0.075
Lumbar spine T-score	2.8 ± 0.7	2.9 ± 0.6	0.381
Total hip T-score	2.3 ± 0.8	2.2 ± 0.8	0.784
Triglycerides (mg/dL)	144.3 ± 63.4	129. 3 ± 54.5	0.024
HDL (mg/dL)	51.4 ± 13.6	52 ± 12.1	0.645
LDL (mg/dL)	128.4 ± 35.2	119.6 ± 37.7	0.033
Fasting blood sugar (mg/dL)	113.3 ± 43.3	109.6 ± 42.3	0.443

vitamin D deficiency or insufficiency (p = 0.000). Among the entire study group, the prevalence of vitamin D deficiency or insufficiency was 50.7%.

Discussion

This study investigates the possibility of an association between serum vitamin D levels and the metabolic syndrome and its components in a sample of postmenopausal osteoporotic women.

The prevalence of the metabolic syndrome found in the current study (42.9%) was higher than what was reported by Marjani and Moghasemi in their studies (31%) [2, 3], and much higher than the prevalence found by Jeon et al. (13.5%) [18]. This might be explained by the fact that all the women in the current study are osteoporotic, bearing in mind that some studies suggest an association between osteoporosis and the metabolic syndrome [19, 20]. Waist circumference, body mass index, triglycerides and fasting blood sugar were significantly higher among women with the metabolic syndrome, and serum HDL was significantly lower. This is consistent with results reported by Yasein et al. and Isordia-Salas et al. [21, 22]. Since

Table 3. Clinical and biochemical data of postmenopausal women with the metabolic syndrome, with and without vitamin D deficiency (n = 140)

Parameters	Deficient or insufficient vitamin D (n = 69)	Normal vitamin D (n = 71)	p
Age (years)	63.6 ± 8.1	62.8 ± 7.5	0.560
Waist circumference (cm)	100.5 ± 13.7	102.1 ± 9.6	0.401
Body mass index (kg/m^2)	32.9 ± 5.6	32.5 ± 5.1	0.645
SBP (mm Hg)	128.5 ± 19.1	133.6 ± 24.1	0.172
DBP (mm Hg)	75.1 ± 10.6	75.7 ± 10.6	0.774
Vitamin D (ng/mL)	18 ± 6.4	66 ± 28	0.000
Calcium (mg/dL)	9.2 ± 1	9.4 ± 0.6	0.078
Phosphorus (mg/dL)	3.5 ± 0.6	3.7 ± 0.8	0.082
Lumbar spine T-score	2.8 ± 0.7	2.8 ± 0.6	0.928
Total hip T-score	2.2 ± 0.8	2.2 ± 0.8	0.794
Triglycerides (mg/dL)	171 ± 67.9	155 ± 64.9	0.158
HDL (mg/dL)	44.8 ± 11	46.5 ± 10.6	0.354
LDL (mg/dL)	128.4 ± 36.5	118.6 ± 42.8	0.146
Fasting blood sugar (mg/dL)	128 ± 51.5	129.4 ± 58.2	0.885

all these parameters are considered components of the metabolic syndrome, it is not surprising to find their values significantly higher among metabolic syndrome patients (except for serum HDL, which was significantly lower) [23].

The prevalence of vitamin D deficiency or insufficiency (45.7%) was close to that reported by Holick et al. (52%) and to results from a multinational study on osteoporotic postmenopausal women including 18 countries, which reported a prevalence of 48.7% for serum vitamin D < 25 ng/ /mL-1, and a prevalence of 63.9% for serum vitamin D < 30 ng/mL-1 [24]. However, it was less than what was reported by Bruyere et al. (79.6%) [25] and higher than the results from Gorgan (Iran) by Marjani and Moghasemi (30%) [2, 24, 25].

Women who had vitamin D deficiency or insufficiency were found to have a significantly higher level of serum triglycerides and serum LDL. Vacek et al. found a similar association between serum vitamin D and triglycerides [26]. In another study by Martins et al., the prevalence of low serum 25-hyrdoxy vitamin D was higher in patients with hypertriglyceridemia [12]. Anderson et al. found that hyperlipidemia was more prevalent among their study participants who had vitamin D deficiency at baseline [7]. Moreover, Yin et al. found that the vitamin D deficiency group in their study had significantly greater serum triglycerides, and both the deficiency and the insufficiency groups had higher serum LDL levels [27]. One suggested mechanism for the relationship between vitamin D and serum lipids (including both triglycerides and serum LDL) is that the binding of vitamin D to its receptors inhibits adipogenesis, resulting in a negative association between vitamin D levels and lipid levels [28–30].

Women with the metabolic syndrome were investigated separately with regard to their serum vitamin D status. In this group of patients, the prevalence of vitamin D deficiency or insufficiency (50.7%) was greater than what was reported by Marjani and Moghasemi (32.26%) [2]. Again, this might be attributable to the osteoporotic nature of the current study sample, taking into consideration that low serum levels of vitamin D are common among osteoporotic women [23].

No significant differences were found in any of the studied parameters (including the components of the metabolic syndrome) except for serum vitamin D which – obviously – was found to be significantly lower among the vitamin D deficient or insufficient group. This study's findings indicate a lack of association between serum vitamin D status and the metabolic syndrome – a result found in other studies [2, 9]. However, further research is needed in this area.

The current study has several limitations. First, the research was conducted on patients of a single family practice clinic which might limit the ability to generalize its results to the entire population of postmenopausal osteoporotic women. Second, the cross sectional design of the study cannot confirm a causation relationship. Third, serum vitamin D was measured only at a single point in time,

and may not reflect the patients' long term vitamin D status.

The findings of the current study suggest a lack of relationship between serum vitamin D and the metabolic syndrome. However, a significant inverse relationship was found between serum vitamin D levels and both serum triglycerides and LDL levels. This highlights the importance of screening for vitamin D deficiencies and insufficiencies as part of the treatment of other disorders, such as dylipidemia, to decrease cardiovascular diseases and risks.

References

[1] **Lee JH, O'Keefe JH, Bell D, Hensrud DD, Holick MF:** Vitamin D deficiency an important, common, and easily treatable cardiovascular risk factor? J Am Coll Cardiol 2008, 9, 52, 1949–1956.

[2] **Marjani A, Moghasemi S:** Serum vitamin D and metabolic syndrome among postmenopausal women in Gorgan. Biomed Res 2012, 23, 275–280.

[3] **Marjani A, Moghasemi S:** The Metabolic Syndrome among Postmenopausal Women in Gorgan. Int J Endocrinol 2012, 2012, 953627.

[4] **Chedraui P, Hidalgo L, Chavez D, Morocho N, Alvarado M, Huc A:** Quality of life among postmenopausal Ecuadorian women participating in a metabolic syndrome screening program. Maturitas 2007, 20, 56, 45–53.

[5] **Ding QF, Hayashi T, Zhang XJ, Funami J, Ge L, Li J:** Risks of CHD identified by different criteria of metabolic syndrome and related changes of adipocytokines in elderly postmenopausal women. J Diabetes Complications 2007, 21, 315–319.

[6] **Reis JP, von Muhlen D, Miller ER:** Relation of 25-hydroxyvitamin D and parathyroid hormone levels with metabolic syndrome among US adults. Eur J Endocrinol 2008, 159, 41–48.

[7] **Anderson JL, May HT, Horne BD, Bair TL, Hall NL, Carlquist JF:** Relation of vitamin D deficiency to cardiovascular risk factors, disease status, and incident events in a general healthcare population. Am J Cardiol 2010, 106, 963–968.

[8] **Adams JS, Hewison M:** Update in vitamin D. J Clin Endocrinol Metab 2010, 95, 471–478.

[9] **McGill AT, Stewart JM, Lithander FE, Strik CM, Poppitt SD:** Relationships of low serum vitamin D3 with anthropometry and markers of the metabolic syndrome and diabetes in overweight and obesity. Nutr J 2008, 7, 4.

[10] **Scragg R, Sowers M, Bell C:** Serum 25-hydroxyvitamin D, diabetes, and ethnicity in the Third National Health and Nutrition Examination Survey. Diabetes Care 2004, 27, 2813–2818.

[11] **Karhapaa P, Pihlajamaki J, Porsti I, Kastarinen M, Mustonen J, Niemela O:** Diverse associations of 25-hydroxyvitamin D and 1,25-dihydroxy-vitamin D with dyslipidaemias. J Intern Med 2010, 268, 604–610.

[12] **Martins D, Wolf M, Pan D, Zadshir A, Tareen N, Thadhani R:** Prevalence of cardiovascular risk factors and the serum levels of 25-hydroxyvitamin D in the United States: data from the Third National Health and Nutrition Examination Survey. Arch Intern Med 2007, 167, 1159–1165.

[13] **Utian WH:** Ovarian function, therapy-oriented definition of menopause and climacteric. Exp Gerontol 1994, 29, 245–251.

[14] **Premaor MO, Compston JE:** Testing for secondary causes of osteoporosis. BMJ 2010, 341, c6959.

[15] Prevention and management of osteoporosis. World Health Organ Tech Rep Ser 2003, 921, 1–164, back cover.

[16] 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) final report. Circulation 2002, 106, 3143–3421.

[17] Obesity: preventing and managing the global epidemic. Report of a WHO consultation. World Health Organ Tech Rep Ser 2000, 894, i–xii, 1–253.

[18] **Jeon YK, Lee JG, Kim SS, Kim BH, Kim SJ, Kim YK:** Association between bone mineral density and metabolic syndrome in pre- and postmenopausal women. Endocr J 2011, 58, 87–93.

[19] **Tanko LB, Christiansen C, Cox DA, Geiger MJ, McNabb MA, Cummings SR:** Relationship between osteoporosis and cardiovascular disease in postmenopausal women. J Bone Miner Res 2005, 20, 1912–1920.

[20] **Hwang DK, Choi HJ:** The relationship between low bone mass and metabolic syndrome in Korean women. Osteoporos Int 2010, 21, 425–431.

[21] **Yasein NA, Irshaid YM, Barghouti FF, Shroukh WA, Halaseh LJ**: Use of Antihypertensive Medications among Elderly Patients with Metabolic Syndrome Attending Family Practice Clinic. International Medical Journal 2013, 20, 132–135.

[22] **Isordia-Salas I, Santiago-German D, Rodriguez-Navarro H, Almaraz-Delgado M, Leanos-Miranda A, Anaya--Gomez F:** Prevalence of metabolic syndrome components in an urban Mexican sample: comparison between two classifications. Exp Diabetes Res 2012, 2012, 202540.

[23] **Lips P, Hosking D, Lippuner K, Norquist JM, Wehren L, Maalouf G:** The prevalence of vitamin D inadequacy amongst women with osteoporosis: an international epidemiological investigation. J Intern Med 2006, 260, 245–254.

[24] **Holick MF, Siris ES, Binkley N, Beard MK, Khan A, Katzer JT:** Prevalence of Vitamin D inadequacy among postmenopausal North American women receiving osteoporosis therapy. J Clin Endocrinol Metab 2005, 90, 3215–3224.

[25] **Bruyere O, Malaise O, Neuprez A, Collette J, Reginster JY:** Prevalence of vitamin D inadequacy in European postmenopausal women. Curr Med Res Opin 2007, 23, 1939–1944.

[26] **Vacek JL, Vanga SR, Good M, Lai SM, Lakkireddy D, Howard PA:** Vitamin D deficiency and supplementation and relation to cardiovascular health. Am J Cardiol 2012, 109, 359–363.
[27] **Yin X, Sun Q, Zhang X, Lu Y, Sun C, Cui Y:** Serum 25(OH)D is inversely associated with metabolic syndrome risk profile among urban middle-aged Chinese population. Nutrition Journal 2012, 11, 1–7.
[28] **Jorde R, Grimnes G:** Vitamin D and metabolic health with special reference to the effect of vitamin D on serum lipids. Prog Lipid Res 2011, 50, 303–312.
[29] **Blumberg JM, Tzameli I, Astapova I, Lam FS, Flier JS, Hollenberg AN:** Complex role of the vitamin D receptor and its ligand in adipogenesis in 3T3-L1 cells. J Biol Chem 2006, 281, 11205–11213.
[30] **Kong J, Li YC:** Molecular mechanism of 1,25-dihydroxyvitamin D3 inhibition of adipogenesis in 3T3-L1 cells. Am J Physiol Endocrinol Metab 2006, 290, 916–924.

Address for correspondence:

Nada A. Yasein
Department of Family and Community Medicine
Faculty of Medicine, University of Jordan, Jordan University Hospital
PO Box 13834
Amman 11942
Jordan
Tel.: +962 65 35 50 00/23 440
E-mail: nyasein_85@hotmail.com

Conflict of interest: None declared

Received: 14.10.2013
Revised: 25.06.2014
Accepted: 12.01.2015