RESEARCH ARTICLE

Evaluation of pulmonary function tests and vitamin D level in pre and postmenopausal women

Saima Zareen, Faraz Ahmed Bokhari, Sibgha Zulfiqar

Abstract

Objective: To assess the increased risk of vitamin D deficiency in postmenopausal women, and its correlation with pulmonary function decline in both premenopausal and postmenopausal women.

Method: The cross-sectional, comparative study was conducted at the Physiology Department, Federal Postgraduate Medical Institute, Shaikh Zayed Hospital, Lahore, Pakistan, from May 2019 to May 2020. Healthy premenopausal women having regular menstrual cycles aged at least 40 years were placed in group 1, while healthy postmenopausal women having no menstruation for the preceding 12 months with maximum age 55 years were placed in group 2. Serum vitamin D levels were determined using enzyme-linked immunosorbent assay, and pulmonary functions by spirometry. Groups 1 and 2 were divided into hypovitaminosis and vitamin D-sufficient subgroups 1A, 1B, 2A and 2B. Data was analysed using SPSS 21.

Results: Of the 120 female subjects, 60(50%) were in each group. Mean age in years of group 1(premenopausal group) was 46.03±2.35. Mean age in years of group 2 (postmenopausal group) was 52.72±1.43. Mean body mass index was 23.0± 2.59kg/m^2 in group 1 compared to 24.14±2.76kg/m^2 in group 2. Mean serum vitamin D level was 42.91±16.94ng/ml in group 1, and 27.42±6.70ng/ml in group 2 (p=0.001). The percentage predicted value of age for forced expiratory volume in 1 second, forced vital capacity, and the ratio between the two in group 1 were 82.95±2.75%, 83.10±2.65% and 0.998±0.003% respectively. In group 2, the corresponding values were 79.48±1.20%, 79.12±1.40% and 1.004±0.010% (p<0.05). The values for forced expiratory volume in 1 second, forced vital capacity, and the ratio between the two were significantly different in subgroups 1B and 2B compared to 1A and 2A (p<0.05).

Conclusion: Vitamin D deficiency was found to be related to the deterioration of pulmonary functions in both premenopausal and postmenopausal groups.

Keywords: Menopause, Vitamin D, Pulmonary functions. (JPMA 75: 414; 2025)

DOI: https://doi.org/10.47391/JPMA.11432

Introduction

Menopause is a normal physiological non-reproductive phase characterised by persistent cessation of menstrual cycle due to permanent loss of ovarian functions.[1] Due to an altered activity of the hypothalamopituitary gonadal axis, follicle stimulating hormone (FSH) and luteinizing hormone (LH) are augmented in circulation, while oestrogen and progesterone are decreased. This leads to low energy levels, hot flushes, disturbed sleep pattern, irritability, increased levels of triglycerides (TGs) and low-density lipoproteins (LDLs), increased risk of obesity and cardiovascular diseases (CVDs).[2,3]

Since sex hormonal receptors are also present in lung tissue, menopause is linked with increased risk of respiratory disorders.[4] Oestrogen and progesterone support pulmonary functions by alpha-2 adrenergic-mediated bronchial smooth muscle relaxation. They maintain bone mineral density (BMD), maintaining the thoracic cage and intra-thoracic space.[5] The protective role of oestrogen may be induced by synthesis of anti-inflammatory mediator secretory leukocyte protease inhibitor (SLPI) and inhibition of pro-inflammatory interleukin-33 (IL-33) synthesis in lung parenchyma by type II alveolar epithelial cells (AECII).[6] Menopause can be a triggering factor for late onset asthma.[7]

Oestrogen regulates 1-alphs (α) hydroxylase that converts 25-hydroxy form of vitamin. D to 1-25 dihydroxy form. Oestrogen deficiency leads to vitamin D deficiency.[8]

Pulmonary functions are also influenced by vitamin D concentration in the body.[9] Maintaining vitamin D levels may provide protection against pneumonia, asthma and chronic obstructive pulmonary disease (COPD).[10] Taking vitamin D levels into consideration and its proper supplementation has been suggested as supportive in the prevention and treatment of conditions that tend to impair pulmonary functions.[11]

Menopause is a biological and unavoidable part of women's life, and most women suffer postmenopausal

Department of Physiology, Federal Postgraduate Medical Institute, Shaikh Zayed Medical Complex, Lahore, Pakistan.

Correspondence: Saima Zareen. e-mail: saimatahirdr@gmail.com

ORCID ID: 0000-0002-5162-1571

Submission complete: 08-12-2023 **1st Revision received:** 29-03-2024

Acceptance: 28-12-2024 **Last Revision received:** 27-12-2024

complications.[12]

The current study was planned to compare the pulmonary functions and vitamin D levels in postmenopausal women with premenopausal women, and to assess the relationship between vitamin D status and pulmonary function.

Subjects and Methods

The cross-sectional comparative study was conducted at the Physiology Department, Federal Postgraduate Medical Institute (FPGMI), Shaikh Zayed Hospital, Lahore, Pakistan, from May 2019 to May 2020. After approval from the institutional ethics review board, the sample size was calculated using the OpenEpi software, with 95% confidence interval (CI) and 90% power.[8] The sample was raised using convenience sampling technique from among attendants of inpatients and those coming to the outpatients department (OPD). Self-reported Healthy premenopausal women having regular menstrual cycles aged at least 40 years were placed in group 1, while self-reported healthy postmenopausal women having no menstruation for the preceding 12 months with maximum age 55 years were placed in group 2. Those with a history of hypertension (HTN), heart disease, diabetes mellitus (DM), tuberculosis (TB), asthma, chronic cough, shortness of breath, or allergic rhinitis were excluded. Additionally, those with COPD, current or recent chemotherapy or hormone replacement therapy (HRT) were also excluded, and so were smokers, women with known bone or joint diseases, obese and those having used vitamin D supplements or systemic corticosteroids in the preceding 6 months.

Data was collected after taking written informed consent from the participants. Demographic details and personal history were noted before carrying out a general physical and systemic examination of each subject. Height and weight were measured using commercially available measuring tape and digital weight machine. Body mass index (BMI) of each subject was estimated using the standard formula.

Serum vitamin D estimation was done by using human 25-hydroxy vitamin D (25[OH] vitamin D) enzyme-linked immunosorbent assay (ELISA) kit (Catalogue No: VD220B, Calbiotech, Inc.,1935 Cordell Court, El Cajon, CA 92020, USA). Analysis was based on the principle of solid phase ELISA. Groups 1 and 2 were divided into hypovitaminosis subgroups 1A and 2A (≤30ng/ml), and vitamin D-sufficient subgroups 1B and 2B (>30ng/ml).

Pulmonary function tests (PFTs) were performed using MIR Spirolab 3(Medical International Research, Via del Maggiolino, 125,00155 Rome, Italy). Three acceptable values of forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1) and FEV1/FVC ratio were obtained using the repeatability American Thoracic Society (ATS) criteria.[13] The percentage predicted values of PFTs for age were noted to rule out the effect of age and BMI.

Data was analysed using SPSS 21. Data normality was checked using Shapiro Wilk's test. Normally distributed variables were expressed as mean±standard deviation. Median and interquartile range (IQR) were used for non-normally distributed variables. For quantitative variables with normal distribution, independent sample t test was used, while Mann Whitney U test was used for non-normally distributed variables. Chi-square test was used as appropriate. P<0.05 was considered significant.

Results

Of the 120 female subjects, 60(50%) were in each group. Mean age in years of group 1(premenopausal group) was 46.03±2.35. Mean age in years of group 2 (postmenopausal group) was 52.72 ± 1.43. Mean BMI was 23.0±2.59kg/m^2 in group 1 compared to 24.14±2.76kg/m^2 in group 2. In group 1, 50(83.3%) women belonged to urban areas, 40(66.7%) were housewives and 53(88.3%) were married. In group 2, the corresponding values were 53(88.3%), 54(90%) and 59(98.3%). Vitamin D levels were not significantly affected by residential status, occupation and marital status (p>0.05). Mean serum vitamin D level was 42.91±16.94ng/ml in group 1 and 27.42±6.70ng/ml in group 2 (p=0.001). Mean FEV1 and FVC values in group 1 were significantly higher than in group 2 (Table 1).

The percentage predicted value of age for FEV1, FVC, and FEV1/FVC ratio in group 1 were 82.95±2.75%, 83.10±2.65% and 0.998±0.003% respectively. In group 2, the corresponding values were 79.48±1.20%, 79.12±1.40% and 1.004±0.010% (p<0.05).

In group 1, 15(25%) women were vitamin D-deficient/insufficient in subgroup 1A, while 45(75%) were vitamin D-sufficient in subgroup 1B. The corresponding

Table-1: Intergroup comparison of vitamin D levels and pulmonary function tests.

Characteristics	Mean±SD	t-test	Df	*p*- value
Vitamin D				
Group 1	42.91±16.94	6.58	118	<0.001**
Group 2	27.42±6.70			
FEV1%				
Group 1	82.95±2.75	8.927	118	<0.001**
Group 2	79.48±1.20			
FVC %				
Group 1	83.10±2.65	10.261	118	<0.001**
Group 2	79.12±1.40			

**Significant difference at p=0.01 (2 tailed); SD: Standard deviation, Df: Degree of freedom, FEV1: Forced expiratory volume in 1 second, FVC: Forced vital capacity.

Table-2: Intergroup comparison of vitamin D levels and pulmonary function tests.

	Mean±SD	Mann-Whitney U test	Asymptomatic sig. (2- tailed)
FEV1 %			
1A	79.054±1.141	143.00	<0.001**
1B	80.173±0.960		
FVC%			
1A	78.46±1.139	122.00	<0.001**
1B	80.18±1.11		
FEV1/FVC			
1A	1.007±0.010	238.50	<0.001**
1 B	0.999±0.007		
FEV1 %			
2A	79.73±1.27	143.0	<0.001**
2B	84.02±2.23		
FVC%			
2A	80.20±1.36	122.0	<0.001**
2B	84.06±2.24		
FEV1/FVC			
2A	0.994±0.003	238.5	<0.001**
2B	0.999±0.02		

numbers in group 2 were 37(61.7%) and 23(38.3%). The predicted values of FEV1, FVC and FEV1/FVC ratio were significantly different in subgroups 1B and 2B compared to 1A and 2A (p<0.05) (Table 2).

Discussion

To the best of our knowledge, the current study is the first to evaluate the status of lung functions and vitamin D in menopausal women, and to draw comparison with premenopausal women.

A slightly higher BMI was noted in postmenopausal group compared to premenopausal women in the current study, which I was in accordance with earlier studies.[14] This can be attributed to the decline in oestrogen levels that affects fat distribution in the body.

The current study showed that vitamin D deficiency was more prevalent in postmenopausal women, which has been reported in a previous study.[15] However one study[16] documented significantly increased prevalence of vitamin D deficiency in premenopausal women, and attributed it to the fact that in India, the young population spend more time indoors, leading to limited sun exposure compared to the elderly population.

In the current study, mean percent predicted value of FEV1 was lower in postmenopausal group than in premenopausal group, which was in line with earlier findings.[4] Similarly, in the current study the mean percent predicted value of FVC was lower in the postmenopausal group, which was in accordance with earlier studies.[7,17] The comparison of mean percent predicted value of FEV1/FVC indicated a restrictive pattern of lung function decline in group 2. In accordance with earlier studies,[7,18] the finding showed evidence that menopause at an early age leads to reduced pulmonary functions in a restrictive pattern. In contrast, one study[4] suggested that menopause leads to a decline in pulmonary functions in an obstructive pattern.

Percent predicted value for age of FEV1 and FVC in the current subgroups 1A and 2A was significantly lower compared to subgroups 1B and 2B. Percent predicted value for age of FEV1/FVC showed a restrictive pattern of lung function decline in hypovitaminosis D subgroups. This showed that both premenopausal and postmenopausal women with sufficient vitamin D levels had better lung functions compared to those with hypovitaminosis. To our knowledge, no documented data is available comparing pulmonary functions in vitamin D-deficient and vitamin D-sufficient premenopausal and postmenopausal women.

The current study has limitations of a small sample size, which was due to paucity of resources and time. Besides, data was collected from a single tertiary care hospital. Further, exposure to sunlight and dietary source of vitamin D was not measured. Also, the cross-sectional study design with collection of a single blood sample in winters, with low sun exposure, may have affected the generalisability of the findings. The study was conducted in 2019-20, but could not be published because of delay in the approval of the thesis. Replication of the current findings after overcoming the limitations may give a better perspective on the matter. Adequately powered, interventional and randomised controlled trials (RCTs) are recommended to check if vitamin D supplementation would improve lung function markers in premenopausal and postmenopausal women with compromised lung function.

Conclusion

Postmenopausal women were found to be at a significantly increased risk of developing vitamin D deficiency as well as decline in pulmonary functions. There also existed a significant relationship between diminished lung functions and vitamin D deficiency in both premenopausal and postmenopausal women.

Disclaimer: The text is based on an MPhil thesis.

Conflict of Interest: None.

Source of Funding: None.

References

1. Santoro N, Roeca C, Peters BA, Neal-Perry G. The Menopause Transition: Signs, Symptoms, and Management Options. J Clin Endocrinol Metab 2021;106:1-. doi: 10.1210/clinem/dgaa764
2. Talaulikar V. Menopause transition: Physiology and symptoms. Best Pract Res Clin Obstet Gynaecol 2022;81:3-7. doi: 10.1016/j.bpobgyn.2022.03.003

3. Vitale SG, Caruso S, Rapisarda AMC, Cianci S, Cianci A. Isoflavones, calcium, vitamin D and inulin improve quality of life, sexual function, body composition and metabolic parameters in menopausal women: result from a prospective, randomized, placebo-controlled, parallel-group study. Prz Menopauzalny 2018;17:32-8. doi: 10.5114/pm.2018.73791
4. Memoalia J, Anjum B, Singh N, Gupta M. Decline in Pulmonary Function Tests after Menopause. J Menopausal Med 2018;24:34-40. doi: 10.6118/jmm.2018.24.1.34
5. Karia AK, Kedar KV, Munje RP. Effect of Menopause on Pulmonary Functions: An Analysis. J South Asian Feder Menopause Soc 2017;5:16-8. Doi: 10.5005/jp-journals-10032-1098
6. Holtrop M, Heltshe S, Shabanova V, Keller A, Schumacher L, Fernandez L, et al. A Prospective Study of the Effects of Sex Hormones on Lung Function and Inflammation in Women with Cystic Fibrosis. Ann Am Thorac Soc 2021;18:1158-66. doi: 10.1513/AnnalsATS.202008-1064OC
7. Triebner K, Matulonga B, Johannessen A, Suske S, Benediktsdóttir B, Demoly P, et al. Menopause Is Associated with Accelerated Lung Function Decline. Am J Respir Crit Care Med 2017;195:1058-65. doi: 10.1164/rccm.201605-0968OC
8. Dean AG, Sullivan KM, Soe MM. OpenEpi: Open Source Epidemiologic Statis tics for Public Health, Version: 3.01. [Online] 2013 [Cited 2024 December 28]. Available from URL: https://www.openepi.com/Menu/OE_Menu.htm
9. Nolasco R, Moreira LD, Bocalini DS, Fronza FC, Marin RV, Lazaretti-Castro M. Effects of vitamin D supplementation on pulmonary function in postmenopausal women following an aquatic exercise program. Arch Endocrinol Metab 2017;61:28-35. doi: 10.1590/2359-3997000000211
10. Fu L, Fei J, Tan ZX, Chen YH, Hu B, Xiang HX, et al. Low Vitamin D Status Is Associated with Inflammation in Patients with Chronic Obstructive Pulmonary Disease. J Immunol 2021;206:515-23. doi: 10.4049/jimmunol.2000964
11. Alavi Foumani A, Mehrdad M, Jafarinezhad A, Nokani K, Jafari A. Impact of vitamin D on spirometry findings and quality of life in patients with chronic obstructive pulmonary disease: a randomized, double-blinded, placebo-controlled clinical trial. Int J Chron Obstruct Pulmon Dis 2019;14:1495-501. doi: 10.2147/COPD.S207400
12. Khandehroo M, Tehrani H, Mahdyzadeh M, Tavakoli B, Peyman N. The Effect of Menopause On Women's Health: A Systematic Review. Res Sq 2022. doi: 10.21203/rs.3.rs-1118042/v1 [Preprint]
13. Graham BL, Steenbruggen I, Miller MR, Barjaktarevic IZ, Cooper BG, Hall GL, et al. Standardization of Spirometry 2019 Update. An Official American Thoracic Society and European Respiratory Society Technical Statement. Am J Respir Crit Care Med 2019;200:e70-88. doi: 10.1164/rccm.201908-1590ST.
14. Kim JY, Lee DW, Lee KH, Min A, Ryu HS, Lee HB, et al. Prognostic role of body mass index is different according to menopausal status and tumor subtype in breast cancer patients. Breast Cancer Res Treat 2019;176:453-60. doi: 10.1007/s10549-019-05249-1
15. Fondjo LA, Sakyi SA, Owiredu WKBA, Laing EF, Owiredu EW, Awusi EK, et al. Evaluating Vitamin D Status in Pre- and Postmenopausal Type 2 Diabetics and Its Association with Glucose Homeostasis. Biomed Res Int 2018;2018:9369282. doi: 10.1155/2018/9369282
16. Kumar A, Gupta R, Mangal N, Parveen R. Lowest Deficiency of Vitamin D & Vitamin B12 in Indian Old Population and Postmenopausal Women. Indian J Public Health Dev 2020;11:1027-33. doi: 10.37506/ijphrd.v11i7.10225
17. Amaral AF, Strachan DP, Gómez Real F, Burney PG, Jarvis DL. Lower lung function associates with cessation of menstruation: UK Biobank data. Eur Respir J 2016;48:1288-97. doi: 10.1183/13993003.00412-2016
18. Moriarty LF, Plucinski MM, Marston BJ, Kurbatova EV, Knust B, Murray EL, et al. Public Health Responses to COVID-19 Outbreaks on Cruise Ships - Worldwide, February-March 2020. MMWR Morb Mortal Wkly Rep 2020;69:347-52. doi: 10.15585/mmwr.mm6912e3

Author Contribution:

SZ: Design, drafting, final approval and agreement to be accountable for all aspects of the work.

FAB & SZ: Supervision, design, drafting, final approval and agree to be accountable for all aspects of the work.