

This journal is the official publication of Bangladesh Society of Physiologists (BSP)
 Web URL: www.banglajol.info/index.php/JBSP

Abstracted /indexed in Index Copernicus, Director of Open Access Journal, HINARI Index Medicus for South East Asia Region, Google Scholar, 12OR, infobse index, Open J gate, Cite factor, Scientific indexing services

pISSN-1983-1213; e-ISSN-2219-7508

Article

Article information:

Received: Sep. 2025

Accepted: Dec. 2025

DOI: <https://doi.org/10.3329/jbsp.v20i2.86977>

Corresponding author:

Rahnuma Hossain, Department of Physiology, National Medical College, Dhaka, Bangladesh. Email: rahnuma.hossain1@gmail.com

Cite this article:

Hossain R, Ferdousi S, Sultana S, Afroz S. Inverse Relationship Spirometric Lung Functions with Serum Cortisol Level in Post-Menopausal Women. J Bangladesh Soc Physiol 2025;20(2): 52-57.

This article is open access licensed under CC BY NC SA which allows readers copy, distribute, display, and perform the work and make derivative works based on it only for noncommercial purposes.



Inverse relationship of spirometric lung functions with serum cortisol level in post-menopausal women

Rahnuma Hossain¹, Sultana Ferdousi², Shamima Sultana², Sharmin Afroz²

1. Department of Physiology, National Medical College, Dhaka, Bangladesh

2. Department of Physiology, Bangladesh Medical University, Dhaka, Bangladesh

Abstract

Background: Post-menopausal women experience hormonal changes that may result in accentuated decline in pulmonary functions as assessed by spirometry. Cortisol, a stress related glucocorticoid, has been implicated in systemic inflammation but its relation with lung functions in this population remains under explored. **Objective:** To observe the relationship of spirometric lung functions with serum cortisol in post-menopausal women. **Methods:** This cross-sectional study was conducted on 80 post-menopausal women (age:52-60 years) with different duration of menopause (2-12 years). Lung functions (FVC, FEV₁, FEV₁/FVC, PEFr and FEF_{25-75%}) were estimated by a computer-based spirometer (Spiro-tech, India) and early morning serum cortisol level was measured by Automated Analyzer method. Spearman's rank correlation test was used for statistical analysis. **Results:** The spirometric measurements showed reduction in FVC, FEV₁, PEFr and FEF_{25-75%} and an increase in FEV₁/FVC ratio in the participants. In this study, significant negative correlations of the percentage of predicted values of FVC, FEV₁ and FEF_{25-75%} were observed with serum cortisol level (p<0.01, p<0.01 and p<0.05 respectively). FEV₁/FVC ratio exhibited positive and PEFr showed negative correlation with serum cortisol level in this group of participants but both the relations were statistically non-significant. **Conclusion:** Spirometric lung functions were inversely related with serum cortisol level in post-menopausal women.

Keywords: Post-menopause, spirometric lung functions, cortisol

Introduction

Menopause represents a critical transition of women's life marked by permanent cessation of menstruation and a decline in ovarian hormones.¹ The hormonal shift is associated with diverse menopausal symptoms as well as increased risk of chronic conditions including cardiovascular, metabolic, osteoporotic and respiratory disorders.²⁻⁴ Evidence suggests that surpassing the age-related changes, lung function deteriorates more rapidly after menopause as observed by spirometric lung function test.^{3,5-6} However, findings remain inconsistent across studies.⁷⁻⁸

On the other hand, cortisol, a glucocorticoid under the regulation of hypothalamic pituitary adrenal (HPA) axis is acknowledged for its role in inflammation, immunity and stress.⁹ Menopause itself is stressful and menopausal women especially with exaggerated menopausal symptoms are often associated with dysregulated HPA axis resulting in elevated cortisol level.¹⁰⁻¹² Excess cortisol level has been linked to impaired inflammatory and immune responses resulted in systemic inflammation including pulmonary dysfunctions.¹⁰⁻¹⁴ Though, the precise impact of cortisol on lung mechanics is still not well documented. Previous studies showed effect of sex hormones on respiratory health in post-menopausal women.^{5-6,15} However, the relationship of spirometric lung functions and serum cortisol level in post-menopausal women remains largely unexplored and inconclusive.

This study therefore aimed to assess the relationship of lung functions with serum cortisol level in post-menopausal women and to provide insight into whether cortisol may serve as a potential biomarker for respiratory health in this population.

Methods

Study participants & settings

This cross-sectional study was carried out in 2024 in the Department of Physiology, the then Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka.

Study participants & sampling

For this study, 80 apparently healthy post-menopausal women with history of permanent amenorrhea for at least 12 consecutive months (age: 52-60 years & BMI: 18.2-26.5 kg/m²) were selected. They were permanent residents of Dhaka city and were enrolled purposively according to selection criteria.

Exclusion criteria

The subjects with history of cardiovascular disorders, respiratory disorders, arthritis, psychiatric disorders, malignancy, diabetes mellitus, thyroid disorders, renal insufficiency liver diseases, abnormal vaginal bleeding, history of taking oral contraceptive pills (OCP) or hormone replacement therapy (HRT), surgical menopause and smokers were excluded from the study.

Data collection procedures

After taking history and informed written consents, the participants' baseline characteristics were documented and instructions for the biochemical test methods were provided. The preliminarily selected post-menopausal women were invited to visit the Department of Physiology, the then BSMMU following an over-night fast and between 8 to 9 am. Then 3ml of venous blood was collected and tests for fasting blood glucose, serum creatinine, serum alanine aminotransferase and serum thyroid stimulating hormone were done for screening purpose. The subjects who were finally enrolled based on the selection criteria, were asked to report to the Department of Physiology, after an over-night fast and between 8 to 9 am in the morning. Then 2 ml venous blood was collected in the Department of Biochemistry and Molecular Biology, the then BSMMU for estimation of serum cortisol level. After a break, a training session on procedures of spirometric lung function test was conducted in the Department of Physiology for maximum cooperation and accurate results.

For the spirometric lung function test, they were instructed to take their meal by 9:00 pm, to have a sound sleep in the previous night and to take light breakfast in the morning without tea or

coffee. They were requested to attend to the Respiratory Physiology Laboratory, Department of Physiology, the then BSMMU between 8-9 a.m. After arrival, the participants were allowed to take a brief rest and their name, age, height and weight were recorded in the computer. Then, spirometric lung function test (FVC, FEV₁, FEV₁/FVC, PEFR and FEF_{25-75%}) was performed by a computer-based spirometer (Spiro-tech, India). The maneuvers for each parameter were repeated three times and the best value for each parameter was noted. Data were used for statistical analysis.

Statistical analysis

All data were expressed as mean \pm SD. For statistical analysis, Shapiro Wilk test and Spearman's rank correlation coefficient test were done by using SPSS version 25 and p value <0.05 was considered as statistical significance.

Results

All the subjects were post-menopausal women with history of permanent amenorrhea for at least 12 months. The average age of the participants was 55.65 \pm 2.71 years and duration of menopause 6.61 \pm 2.51 years. In this study, percentage of predicted values (%) of FVC, FEV₁, FEV₁/FVC, PEFR and FEF_{25-75%} were shown in Table II. In addition, serum cortisol level was presented in Table I and it was within the normal physiological range. On correlation analysis, FVC, FEV₁ and FEF_{25-75%} were significantly and negatively correlated with serum cortisol in the post-menopausal women (p<0.01 and <0.05) (Table III). While, FEV₁/FVC was positively and PEFR was negatively correlated with serum cortisol level in the participants but both the values were statistically non-significant (p>0.05) (Table III).

Table I: Serum cortisol level of the subjects (N=80)

Variables	Values
S. cortisol (nmol/L)	313.80 \pm 152.20 (162.20 - 615.60)

Data were expressed as Mean \pm SD. Values in parentheses indicate ranges. N= total number of the subjects.

Table II: FVC, FEV₁, FEV₁/FVC, PEFR and FEF_{25-75%} of the subjects (N=80)

Variables	Percentage of predicted value (%)
FVC	77.51 \pm 16.67 (39 - 124)
FEV ₁	77.35 \pm 16.64 (41 - 125)
FEV ₁ /FVC	121.72 \pm 8.43 (93 - 133)
PEFR	59.70 \pm 17.62 (27 - 101)
FEF _{25-75%}	109.02 \pm 37.49 (40 - 194)

Data were expressed as mean \pm SD. Values in parentheses indicate ranges. FVC: Forced vital capacity, FEV₁: Forced expiratory volume in 1st second, FEV₁/FVC%: Ratio of FEV₁ and FVC, PEFR: Peak expiratory flow rate, FEF_{25-75%}: Forced mid expiratory flow or forced expiratory flow rate in the middle half of FVC. N= number of total subjects.

Table III: Correlation analysis of FVC, FEV₁, FEV₁/FVC, PEFR and FEF_{25-75%} with serum cortisol level in the subjects (N=80)

Dependent variable (% of predicted value)	Independent variable (Serum cortisol, nmol/L)	
	r value	p value
FVC	-0.481	<0.01*
FEV ₁	-0.480	<0.01*
FEV ₁ /FVC	0.123	0.278
PEFR	-0.217	0.053
FEF _{25-75%}	-0.241	0.031*

Statistical analysis was done by Spearman's rank correlation coefficient test. FVC: Forced vital capacity, FEV₁: Forced expiratory volume in first second, PEFR: Peak expiratory flow rate, FEF_{25-75%}: Forced mid expiratory flow rate or forced expiratory flow in the middle half of FVC; *p 0.01, *p 0.05; ns: non-significant; N= total number of the subjects.

Discussion

The present study investigated the relationship of spirometric lung functions with serum cortisol level in post-menopausal women. In this study, physiological rise of serum cortisol level in early morning was noted in the post-menopausal women, which was consistent with the findings of other researchers.¹⁰⁻¹² The correlation analysis revealed significant negative correlation of FVC, FEV₁ and FEF_{25-75%} with serum cortisol level in the post-menopausal women.

This observation indicates an inverse relationship of spirometric lung functions with serum cortisol level in post-menopausal women. It is evident that lung ventilation become reduced when cortisol rises. The influence of sex hormones on lung functions in post-menopausal women was investigated previously.^{2-3, 5-6, 15} Studies have suggested that neuroendocrine hormones i.e., cortisol, may affect the respiratory system and the potent mechanism could be inflammation.^{2-3, 13-14, 16} The persistently elevated cortisol, though within physiological limits, leads to a pro-inflammatory milieu in the body by releasing inflammatory cytokines and adversely affects cardiovascular system, bone, blood sugar, immunity etc.^{11-12, 17-20} While cortisol has protective impact on respiratory system by its effect on immune responses, elevated cortisol level can be detrimental on the lung volumes and small airways patency by bronchoconstriction and altered inflammatory and immune mechanisms in post-menopausal women.^{13-14, 18-20} Generalized muscle weakness, dysregulated glucose metabolism and bone resorption due to elevated cortisol may also lead to potential changes in pulmonary mechanics.^{11, 21-22} So, in post-menopausal women, who are already at higher risk, elevated serum cortisol level could be a potent risk factor for respiratory dysfunction and an effective biomarker to identify respiratory as well as overall systemic inflammation in this group of population.

Conclusion

According to the results of this study, it may be concluded that spirometric lung functions are inversely related to serum cortisol level in post-menopausal women.

Ethical issue

The study protocol was first approved by the departmental ethical and academic committee and then further reviewed and approved by Institutional Review Board (IRB) of BSMMU, Dhaka.

Conflict of interest: None

Acknowledgments

Department of Biochemistry and Molecular Biology, the then BSMMU.

References

1. WHO. 2022. Menopause Fact Sheets. <https://www.who.int/news-room/fact-sheets/detail/menopause>.
2. Macsali F, Svanes C, Bjorge L, Omenaas ER, Real FG. 2012. Respiratory health in women: from menarche to menopause. *Expert Rev Respir Med.* 6(2):187-200; quiz 201-2. DOI: 10.1586/ers.12.15.
3. Triebner K, Matulonga B, Johannessen A, Suske S, Benediktsdottir B, Demoly P, Dharmage SC, Franklin KA, Aymerich JG, Blanco JAG, Heinrich J, Holm M, Jarvis D, Jogi R, Lindberg E, Rovira JMM, Agirre NM, Pin I, Hensch NP, Puggini L, Raheison C, Ramos JLS, Schlunssen V, Sunyer J, Svanes C, Hustad S, Leynaert B, Real FG. 2017. Menopause is associated with accelerated lung function decline. *Am J Respir Crit Care Med.* 195(8):1058-1065. DOI: 10.1164/rccm.201605-0968OC.
4. McCarthy M, Raval AP. 2020. The peri-menopause in a women's life: a systemic inflammatory phase that enables later neurodegenerative disease. *J Neuroinflammation.* 17(1):317. DOI: 10.1186/s12974-020-01998-9.
5. Memoalia J, Anjum B, Singh N, Gupta M. 2018. Decline in Pulmonary Function Tests after menopause. *J Menopausal Med.* 2018; 24(1):34-40. DOI: 10.6118/jmm.2018.24.1.34.

6. Karia AK, Kedar KV, Munje RP. 2017. Effect of menopause on pulmonary functions: An analysis. *Journal of SAFOMS*. 5(2): 99-101. DOI: 10.50005/jp-journals-10032-1115.
7. Songur N, Aydin ZD, Ozturk O, Sahin U, Khayri U, Bircan A, Akkaya A. 2010. Respiratory symptoms, pulmonary function, and reproductive history: Isparta Menopause and Health Study. *J Womens Health (Larchmt)*.19(6):1145-54. DOI: 10.1089/jwh.2009.1715.
8. Jung WJ, Kim YS, Jung JY, Jung EY, Kim SK, Chang J. 2012. The effect of menopause on the lung function among Korean women; the fourth Korean National Health and Nutrition Examination Survey (KHANES IV). *ERS Journal*. 40(s56): 3965.
9. Hall JE, Hall EM. 2021. *Text Book of Medical Physiology*. 14th ed. USA. Elsevier. Chap 82, Female physiology before pregnancy and female hormone. p 883-885.
10. Woods NF, Carr MM, Tao EY, Taylor HJ, Mitchell ES. 2006. Increased urinary cortisol level during the menopausal transition. *Menopause*; 13(2): 212-221. DOI: 10.1097/01.gme.0000198490.57242.2e.
11. Cagnacci A, Cannoletta M, Caretto S, Zanin R, Xholli A, Volpe A. 2011. Increased cortisol level: a possible link between climacteric symptoms and cardiovascular risk factors. *Menopause*.18(3):273-278. DOI: 10.1097/gme.0b013e3181f31947.
12. Cagnacci A, Xholli A, fontanessi F, Neri I, Facchinetti F, Palma F. 2022. Treatment of menopausal symptoms: concomitant modifications of cortisol. *Menopause*. 29(1): 23-27. DOI: 10.1097/GME.0000000000001875.
13. Hodge MX, Henrique AR, Kodavanti UP. 2021. Adrenergic and glucocorticoid receptors in the pulmonary health effects of air pollution. *Toxics*; 9(6): 132. DOI: 10.3390/toxics9060132.
14. Amratia DA, Viole H, Ioachimescu OC. 2022. Glucocorticoid therapy in respiratory illness: bench to bedside. *J Investig Med*; 70(8): 1662- 1680. DOI: 10.1136/jim-2021-002161
15. Polly ZA, Begum S, Ferdousi S, Begum N, Ali T, Begum A. 2011. Relationship of FEF_{25%-75%}, PEFr and SVC with estrogen and progesterone level in post-menopausal women. *JBSP*. 6(2):116-121. DOI: 10.3329/jbsp.v6i2.9761.
16. Gibbs J, Ince L, Mattews L, Mei J, Yang N, Saer B, Begley N., Poolman T, Pariollaud M, Farrow S, DeMayo F, Hussell T, Worthen GS, Ray D & Loudon A. 2014. An epithelial circadian clock controls pulmonary inflammation and glucocorticoid action. *Nat Med* ;20(8): 919-926. DOI: 10.1038/nm. 3599.
17. Kapoor E. 2021. Menopause symptoms and cortisol response. *Menopause*. 29(1): 6-7. DOI: 10.1097/GME.0000000000001907.
18. Straub RH. 2007. The complex role of estrogen in inflammation. *Endocr Rev*; 28(5): 521-574. DOI: 10.1210/er.2007-0001.
19. Topete DC, Cidlowski JA. 2015. One hormone, two actions: Anti- and pro-inflammatory effects of glucocorticoids. *Neuroimmunomodulation*; 22(1-2): 20-32. DOI: 10.1159/000362724.
20. Strehl C, Ehlers L, Gaber T, Buttgerit F. 2019 . Glucocorticoid: all-rounders tackling the versatile players of the immune system. *Front. Immunol*; 10: 1744. DOI: 10.3389/fimmu.2019.01744.
21. Kuo T, Harris CA, Wang JC. 2016. *Mol Cell Endocrinol*; 380 (1-2): 79 – 88. DOI: 10.1016/j.mce.201303.003
22. Sato AY, Peacock M, Bellido T. (2018). Glucocorticoid excess in bone and muscle. *Clin Rev Bone Miner Metab*; 16 (1): 33-47. DOI: 10.1007/s12018-018-9242-3.