Estimation of Pulmonary Function Tests in Pre and Post-menopausal Women

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Abstract

Objective: To ascertain if post-menopausal women are more susceptible to a decline in pulmonary functions (PFTs) as compared to premenopausal women.

Method: This cross-sectional comparative study was conducted at Physiology Department, FPGMI, Shaikh Zayed Hospital, Lahore from May 2019-May 2020. We recruited one hundred and twenty premenopausal women in age range of 40-50 years (group 1) and one hundred and twenty postmenopausal women with upper age limit of 55 years (group 2). After informed written consent, a detailed questionnaire regarding demographic data was recorded. Pulmonary functions were estimated by spirometry and compared between the two groups. Data were analyzed by SPSS version 20.

Results: Pulmonary functions were markedly declined in postmenopausal women as compared to premenopausal women. Percent predicted value for age for FEV1, FVC and FEV1/FVC in group 1 were 83.01±2.69%, 83.49±2.55% and 0.897 ±0.004% respectively. In group 2 these were 78.49±1.19%, 78.13±1.38% and 1.03 ±0.01% respectively. The differences between two groups were statistically significant (independent sample t test for FEV1 and FVC (p = 0.001 &0.002 respectively and Mann- Whitney U test for FEV1/FVC 0.0002)

Conclusion: It was concluded that pulmonary functions are compromised in post-menopausal women.

Keywords: Menopause, Pulmonary functions, spirometry.

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Introduction

Menopause is a natural physiological process resulting from gradual decline of primordial follicles due to aging and marks the end of a women's reproductive life.[1] It is defined as the permanent stoppage of menstrual cycles for minimum of 6 months, not less than 182 days since last menstrual period or fewer than 3 cycles in the last one year, or removal of both ovaries.[2]

Due to profound hormonal changes menopause is associated with low energy levels, hot flushes, disturbed sleep pattern, irritability and increased susceptibility to chronic conditions.[3]

Since sex hormonal receptors are also manifested in lung tissue, menopause is linked with increased risk of respiratory disorders.[4] A decline in lung function with menopause is likely related to decreasing estrogen levels.[5]

Estrogen and progesterone support pulmonary functions by alpha 2 adrenergic mediated bronchial smooth muscle relaxation and progesterone mediated central respiratory drive. These hormones also maintain bone mineral density maintaining thoracic cage and intrathoracic space.[6] Low levels of estrogen increase the risk of systemic inflammation as well as inflammation in the lungs.[7] The protective role of estrogen may be induced by synthesis of anti-inflammatory mediator secretory leukocyte protease inhibitor (SLPI) and inhibition of pro inflammatory interleukin(IL-33) synthesis

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in lung parenchyma by type II alveolar epithelial cells (AECII).[8] Due to its association with altered inflammatory responses, menopause can be a triggering factor for late onset asthma with increased exacerbations and poor response to anti-inflammatory treatments.[2] As estrogen receptors are also expressed in air way smooth muscles, estrogen causes bronchodilation by reducing intracellular calcium levels in air way smooth muscles through enhancement of cAMP signaling.[9] Postmenopausal women treated with estrogen as hormone replacement therapy have shown improvement in lung functions in terms of FEV1 and FVC.[10] Progesterone improves upper respiratory tract function and aids in breathing by enhancing the activity of pharyngeal dilator muscle. Estrogen up-regulates progesterone receptors, so combination of estrogen and progesterone enhances lung functions.[6]

Relation between respiratory fitness and reproductive aging and associated factors need further evaluation.[2] Future studies are required to illuminate the influence of menopause on lung function.[11] To our knowledge no data is available comparing pulmonary functions in pre and postmenopausal women in Pakistani population. The objective of this study was to find a link between lung function decline and menopause. As life expectancy is increasing far beyond menopause it is important to know how to maintain respiratory health in later life in a large and increasing number of women.

Material and Method

This cross sectional comparative study was carried out in physiology department, FPGMI, Shaikh Zayed Hospital, Lahore over a period of one year. The study was approved by Institutional Review Board Shaikh Zaid Hospital (IRB:1556). Post-menopausal and pre-menopausal subjects were recruited from relatives of patients coming to the in & out patients department of Shaikh Zayed Hospital, Lahore. Two hundred and forty women in the age range of 40 to 55 years were included in this study. Group 1included 120 self-reported healthy premenopausal women having regular menstrual cycles and age 40 years and above. Group 2 included 120 self-reported healthy postmenopausal women having no menstruation for last 12 months with maximum age of 55 years.

Women with history of hypertension and Heart disease, diabetes mellitus, tuberculosis, asthma, shortness of breath, cough, allergic rhinitis, COPD, on chemotherapy or on hormone replacement therapy, smokers, known bone and joint disease, obesity, use of systemic corticosteroids in last six months were not included in study.

After written consent demographic data was recorded. History, general physical and systemic examination was conducted and findings were noted. Height and weight were measured using measuring tape and digital weight machine. Body mass index of each subject was estimated using formula BMI = body weight (Kg) / height $(m)^2$.

Pulmonary function tests were performed on the participants using Spirolab III Diagnostic Colour Spirometer (made in Italy). Three acceptable values of FVC, FEV1 and FEV1/FVC were obtained using repeatability criteria (ATS criteria) i.e. the difference between the two largest values of FVC must be <150 ml and the difference between the two largest values of FEV1 must be <150 ml.[12] The percentage predicted values of PFTs for age were noted to rule out the effect of age and body mass index. (Normal range between 80-120 percent).[13]

The data was analyzed using IBM SPSS (Statistical Package for Social Sciences) version 20. Data were checked for normality of distribution by Shapiro Wilk's test. Data were considered to be normally distributed if p value was ≥ 0.05 and vice versa. The mean ± SD was given for normally distributed variables. The median and interquartile range (IQR) was given for non normally distributed variables. For quantitative variables with normal distribution independent sample t test was applied and Mann Whitney U test was applied on non normally distributed variables.

Results

Most of our study population was from urban areas (83.3% in group 1 & 88.3 % in group 2), and house wives (66.7% in group 1& 90 % in group 2). Group 1 was relatively more educated than group 2 (58% graduates verses 16 %). In Group 1 mean values of body mass index, percent predicted value of FEV1 and FVC were significantly normally distributed. Age and percent predicted value of FEV1/FVC were not normally distributed. In group 2 body mass index, percent predicted value of FEV1 and FVC were significantly normally distributed. Age and percent predicted value of FEV1/FVC were not normally distributed in both groups.

Independent sample t test applied on mean values of percent predicted value of FEV1 and FVC in group 1 and group 2 confirmed a statistically significant difference between group 1 and group 2.

Mann- Whitney U test was applied on percent predicted

Table 1: *Distribution of Demographic and Laboratory Data in Group 1(120 Premenopausal Women) & Group 2(120 Post menopausal Women)*

Parameters	Group1(120 premenopausal women)		Group2(120 postmenopausal women)	
	Mean ± SD	*p*- value	Mean ± SD	*p*- value
Age	46.13 ± 2.64	0.023*	54.12± 1.69	0.003**
BMI	23.99 ± 2.83	0.289	24.25± 2.59	0.359
FEV1 %	83.01 ± 2.69	0.079	78.49± 1.19	0.43
FVC%	83.49 ± 2.55	0.103	78.13±1.38	0.159
FEV1/FVC	0.897± 0.004	0.002*	1.03 ± 0.01	0.004**

*Distribution; not normally distributed (p value $\leqslant$ 0.05).

Table 2: *Independent Sample T Test for Pulmonary Function Tests between Group 1 and Group 2*

Characteristics	Groups	Mean ± SD	t-test value	Df	*p*- value
FEV1%	Group 1	83.01 ± 2.69	8.837	117	0.001**
	Group 2	78.49 ± 1.19			
FVC %	Group 1	83.59 ± 2.65	9.274	118	0.002**
	Group 2	78.13 ± 1.38			

**Significant difference between group 1 and group 2 at 0.01 level (2 tailed)

value for age of FEV1/FVC for comparing their mean values between group 1 and group 2 which showed a statistically significant difference between two groups.

Table 3: *Mann- Whitney U Test between Group 1 and Group 2*

FEV1/ FVC	Mean ± SD	Min.	Max.	Mann-Whitney U test	Asymp. Sig. (2-tailed)
Group 1	0.897 ± 0.004	0.97	1.00		
Group 2	1.03 ± 0.01	0.98	1.03	1012.0	0.0002**

**Significant difference between group 1 and group 2 at 0.01 level (2 tailed)

Discussion

Menopause is a normal physiological phase in the life of women leading to persistent cessation of menstrual cycle due to permanent loss of ovarian functions. Menopause is linked with decline in serum concentrations of progesterone and estrogen which may lead to increased risk of respiratory disorders. In our study, pulmonary functions were measured in premenopausal and postmenopausal women.

This project was undertaken to evaluate the status of lung functions in menopausal women and whether it differed from premenopausal females.

Mean BMI of premenopausal women was 23.99 ± 2.83 whereas that in postmenopausal women was 24.25 ± 2.59. Although BMI of both groups was within normal range as per inclusion criteria but a slightly higher BMI was noted in postmenopausal group. This is in accordance with the work of Noh et al.,2019.[14] They documented BMI in premenopausal group 22.35 ± 3.17 whereas 23.47 ± 2.99 in postmenopausal group and they attributed it to decline in estrogen levels affecting fat distribution in the body.

In this study, mean percent predicted value of FEV1 was noted to be lower in postmenopausal group (78.49 ± 1.19) than in premenopausal group (83.01±2.69). This difference in mean values was found to be statistically significant on applying independent sample t test with p value 0.001. It is in accordance with the findings of Memoalia et al., 20184 who documented significantly better percent predicted value of FEV1 in premenopausal as compared to postmenopausal women (124.85 versus 72.40%, p value < 0.0001). It may be due to decreased levels of estrogen and progesterone in postmenopausal women.[15] These results are however not in line with those of Triebner et al., 2017[3] who found no statistically significant association between FEV1 and menopause. This difference may be due to differences in geographical, environmental, nutritional and anthropometric parameters and sample size tested.[4] Similarly, in this study mean percent predicted value of FVC was noted to be lower in postmenopausal group (78.13 ± 1.38) as compared to premenopausal group (83.49 ± 2.55). This difference in mean values was found to be statistically significant on applying independent sample t test with p value of 0.002. These results are in accordance with Triebner et al., 2017[3] and Amaral et al., 2016[16] who noted a rapid decline in FVC in postmenopausal women as compared to premenopausal women. Similarly, Memoalia et al., 2018[4] documented FVC 3.27 ± 0.64 in premenopausal women as compared to 2.83 ± 0.78 in postmenopausal women concluding a statistically significant decline in postmenopausal women (p value 0.00). However, this study did not confirm the results of study conducted by Campbell et al., 2020[11] who documented that FVC has no significant difference between pre and postmenopausal groups (p value 0.353). This difference may be due to differences in ethnicity,

nutritional and anthropometric parameters and relatively small sample size compared to Amaral et al., 2016[16]. Mean percent predicted value of FEV1/FVC in group 1 was 0.897 ± 0.004 as compared to 1.03±0.01 in group 2 (indicating a restrictive pattern of lung function decline). These means were compared between group 1 and group 2 by Mann- Whitney U test. It showed a statistically significant difference between two groups with Mann- Whitney U value of and 1012.0 p value of 0.0002. These results are in accordance with Triebner et al., 2017[3] suggesting more marked decline for FVC than for FEV1, showing a restrictive pattern. These results are also consistent with Campbell et al., 2020[17] showing evidence that menopause at an early age leads to reduced pulmonary functions in a restrictive pattern. This is in contrast to the results of Memoalia et al., 2018[4]. They documented a significantly higher percent predicted value for age in premenopausal women as compared to that of postmenopausal women (93.24% vs. 62.15%, $P < 0.0001$) suggesting obstructive pattern.

Conclusion

Based on the results of this study it is concluded that postmenopausal women have a significantly increased risk of decline in pulmonary functions.

Conflict of Interest: *None*

References

1. Rathnayake N, Lenora J, Alwis G, Lekamwasam S. Prevalence and severity of menopausal symptoms and the quality of life in middle-aged women: a study from Sri Lanka. Nursing Research and Practice. 2019 Jul 1; 1-9.
2. Triebner K, Johannessen A, Puggini L, Benediktsdóttir B, Bertelsen RJ, Bifulco E, Dharmage SC, Dratva J, Franklin KA, Gíslason T, Holm M. Menopause as a predictor of new-onset asthma: a longitudinal Northern European population study. Journal of Allergy and Clinical Immunology. 2016 Jan 1;137(1):50-57.
3. Triebner K, Matulonga B, Johannessen A, Suske S, Benediktsdóttir B, Demoly P, Dharmage SC, Franklin KA, Garcia-Aymerich J, Gullon Blanco JA, Heinrich J. Menopause is associated with accelerated lung function decline. American journal of respiratory and critical care medicine. 2017 Apr 15;195(8):1058-1065.
4. Memoalia, J, Anjum, B, Singh, N. Gupta, M. Decline in Pulmonary Function Tests after Menopause. Journal of Menopausal Medicine. 2018 Apr 30;24(1):34-40.
5. Triebner K, Accordini S, Calciano L, Johannessen A, Benediktsdóttir B, Bifulco E, Demoly P, Dharmage SC, Franklin KA, Garcia-Aymerich J, Blanco JA. Exogenous female sex steroids may reduce lung ageing after menopause: A 20-year follow-up study of a general population sample (ECRHS). Maturitas. 2019 Feb 1; 120:29-34.
6. Karia AK, Kedar KV, Munje RP. Effect of Menopause on Pulmonary Functions: An Analysis. Journal of SAFOMS. 2017 Jan;5(1):16-8.
7. Zhao R, Xu Z, Zhao M. Effects of oestrogen treatment on skeletal response to exercise in the hips and spine in postmenopausal women: a meta-analysis. Sports Medicine. 2015 Aug ;45(8):1163-1173.
8. Draijer C, Hylkema MN, Boorsma CE, Klok PA, Robbe P, Timens W, Postma DS, Greene CM, Melgert BN. Sexual maturation protects against development of lung inflammation through estrogen. American journal of physiology-lung cellular and molecular physiology. 2016 Jan 15;310(2):L166-174.
9. Sathish V, Freeman MR, Long E, Thompson MA, Pabelick CM, Prakash YS. Cigarette smoke and estrogen signaling in human airway smooth muscle. Cellular Physiology and Biochemistry. 2015;36(3):1101-1015.
10. Tsao YC, Lee YY, Chen JY, Yeh WC, Chuang CH, Yu W, Li WC. Gender-and age-specific associations between body fat composition and C-reactive protein with lung function: a cross-sectional study. Scientific reports. 2019 Jan 23 ;9(1):1-9.
11. Campbell B, Bui DS, Simpson JA, Lodge CJ, Lowe AJ, Bowatte G, Leynaert B, Real FG, Thomas PS, Giles GG, Johns DP. Early age at natural menopause is related to lower post-bronchodilator lung function. A longitudinal population-based study. Annals of the American Thoracic Society. 2020 Apr;17(4):429-37.
12. Graham BL, Steenbruggen I, Miller MR, Barjaktarevic IZ, Cooper BG, Hall GL, Hallstrand TS, Kaminsky DA, McCarthy K, McCormack MC, Oropez CE. Standardization of spirometry 2019 update. An official American thoracic society and European respiratory society technical statement. American journal of respiratory and critical care medicine. 2019 Oct 15;200(8):70-88.
13. Noh HM, Han J, Kim YJ, Jung JH, Roh YK, Song HJ. Sex differences in the relationship between cognitive impairment and overweight or obesity in late life: A 3-year prospective study. Medicine. 2019 Mar 15; 98(9): 33-38.
14. Mrazkova H, Lischke R, Herget J. Influence of gender on ischemia-reperfusion injury in lungs in an animal model. Physiological research. 2016 Nov 1;65(6):53-59.

15. Amaral AF, Strachan DP, Real FG, Burney PG, Jarvis DL. Lower lung function associates with cessation of menstruation: UK Biobank data. European Respiratory Journal. 2016 Nov 1;48(5):1288-1297.
16. Haynes JM, Kaminsky DA, Stanojevic S, Ruppel GL. Pulmonary function reference equations: a brief history to explain all the confusion. Respiratory care. 2020 Jul 1;65(7):1030-8.

Authors Contribution

ZS, SM, BAF: Conceptualization of Project
SM, ZS, RS: Data Collection
ZS, ZH, SM: Literature Search
RS, ZS: Statistical Analysis
ZS, SM: Drafting, Revision
ZS, SM: Writing of Manuscript