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Association Of Pulmonary Function With Functional Capacity And Sleep Quality In Postmenopausal Women

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ABSTRACT

Background: Menopause is associated with hormonal changes that affect multiple physiological systems, including the respiratory system. Declining estrogen levels accelerate deterioration in pulmonary function, contributing to reduced functional capacity and sleep quality in postmenopausal women. This review summarizes the current evidence regarding pulmonary function changes following menopause and their clinical implications.

Objective: To review and synthesize the available literature on pulmonary function in postmenopausal women and examine its association with functional capacity and sleep quality.

Methods: A narrative review of published studies evaluating pulmonary function in postmenopausal women was conducted. The included studies comprised observational, cross-sectional, longitudinal, and interventional designs. Key outcomes included spirometric parameters such as forced expiratory volume in one second (FEV_1), forced vital capacity (FVC), peak expiratory flow rate (PEFR), maximum voluntary ventilation (MVV), functional capacity and sleep quality.

Results: The reviewed literature consistently demonstrated a decline in pulmonary function following menopause, with significant reductions in FEV_1, FVC, PEFR, and MVV reported across studies. Menopause was associated with accelerated age-related decline in lung function, reduced functional capacity and sleep quality. Obesity further aggravate pulmonary impairment in postmenopausal women. Exercise-based interventions were found to improve respiratory muscle strength, pulmonary function, functional capacity, and health-related quality of life. However, most available evidence were derived from cross-sectional studies, limiting causal interpretation.

Conclusion: Current evidence suggests that menopause is associated with progressive deterioration in pulmonary function and reduced physical performance. Regular pulmonary assessment, lifestyle modification, and structured exercise programmes helps in preserve respiratory health and functional independence in postmenopausal women. Further well-designed longitudinal and interventional studies are required to better understand the underlying mechanisms and optimise rehabilitation strategies.

Keywords: Menopause; Postmenopausal women; Pulmonary function; Spirometry; FEV_1; FVC; Sleep quality; functional capacity.

INTRODUCTION

Menopause refers to the permanent cessation of menstruation resulting from the loss of ovarian follicular activity and the end of ovulation. According to the World Health Organization (WHO), menopause is considered natural only when it occurs without any medical or surgical intervention and is confirmed after 12 consecutive months of amenorrhea. The transition into menopause, along with its associated biological changes, can adversely affect overall health, quality of life (QOL), and well-being in middle-aged women. During this phase, hormonal fluctuations combined with ageing contribute to a range of biological, psychological, social, and physical challenges. These changes are often associated with a decline in exercise capacity in postmenopausal women, which is generally more pronounced compared to men. This gender difference in physical performance is attributed to hormonal alterations occurring during the postmenopausal period. Additionally, the type and severity of menopausal symptoms vary among individuals due to factors such as lifestyle, socioeconomic status, body composition, and psychological health. Evidence from the literature also indicates a progressive decline in the function of the musculoskeletal, respiratory, and cardiovascular systems in postmenopausal women.[1]

The non-reproductive stage of a woman's life begins with menopause, marking the permanent cessation of menstruation. This transition is often accompanied by several physical and physiological changes, including reduced energy levels, hot flushes, vaginal symptoms, insomnia, osteoporosis, and a higher risk of chronic diseases such as diabetes and cardiovascular disorders. Menopause is characterized by significant hormonal alterations within the hypothalamic–pituitary–gonadal axis. As ovarian production of 17β-estradiol declines, circulating levels of follicle-stimulating hormone (FSH) and luteinizing hormone (LH) increase. Reduced concentrations of 17β-estradiol have been linked to heightened systemic and pulmonary inflammation. Furthermore, inflammatory biomarkers such as C-reactive protein (CRP) and interleukin-6 (IL-6) are negatively associated with lung function parameters, including forced vital capacity (FVC) and forced expiratory volume in one second (FEV_1). These observations suggest that menopause contribute to an accelerated decline in lung function.[2]

Advancing age is associated with increased stiffness of the thoracic cage, the development of kyphosis, and a greater workload on the respiratory muscles, all of which contribute to an increase in the work of breathing. Age-related alterations in pulmonary function include reductions in forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC), along with increases in residual volume (RV) and functional residual capacity (FRC). Female sex hormones play a crucial role in maintaining respiratory health. Several studies have examined lung function across different phases of the menstrual cycle and reported improved pulmonary function during the luteal phase, which is attributed to elevated progesterone levels causing hyperventilation and relaxation of the bronchial smooth muscles. Furthermore, a strong association has been observed between female sex hormones and lung function in postmenopausal women. Evidence indicates that spirometric parameters, including FVC, FEV_1, and the FEV_1/FVC ratio, are significantly reduced after menopause, suggesting that hormonal changes contributes to the decline in pulmonary function.[3]

Increasing evidence shows that the menopausal transition is associated with more respiratory symptoms. A recent systematic review examined menopausal status in relation to lung function and obstructive lung disease found that five studies indicates postmenopausal women experience had reduced prebronchodilator lung function or faster lung function decline compared to menstruating women, even after adjustment for age. Natural menopause typically occurs around age of 51, but early menopause—usually aged between 40 and 44 & has been linked to several chronic conditions and negative health outcomes, such as osteoporosis, cardiovascular disease, and increased all-cause mortality.[6]

Menopause-related physiological changes can impact muscular mass, strength, and power. Chronic Obstructive Pulmonary Disease (COPD), individuals undergoing knee replacements, those in rehabilitation programs, and healthy persons have all undergone this test. One useful measure of lower limb muscular strength is the 6- minute walk test (6MWT) distance. The 6MWT is regarded as a physical performance assessment and is a useful alternative for assessing functional capacity.[8]

Sleep disturbances are among the most frequently reported problems experienced during menopause. Approximately 40% to 60% of menopausal women experience sleep-related symptoms, with frequent nighttime awakenings being the most common complaint. The prevalence of sleep disturbances reaches its highest level during the late perimenopausal stage and often persists into the postmenopausal period. Furthermore, the likelihood of developing severe sleep difficulties increases by approximately two to three-and-a-half times during the menopausal transition. Poor sleep quality not only affects overall quality of life but is also associated with a wide range of physical and psychological health problems.[10]

METHODS

Author and year	Design and Characterstics of participants (sample size)	Objective	Material and Method	Outcome measures	Result
Verma et al.[1], (2025)	Cross-sectional correlational study; 45 postmenopausal women were included.	To examine the association between exercise capacity, pulmonary function, skeletal muscle strength, and cardiac autonomic function in postmenopausal women.	Participants underwent pulmonary function testing, hand grip strength assessment, heart rate recovery assessment, and exercise capacity evaluation.	Exercise Capacity, Maximum Voluntary Ventilation (MVV), Hand Grip Strength (HGS), Heart Rate Recovery (HRR), Physical Activity Level.	Exercise capacity was positively correlated with MVV, weakly correlated with HGS, and showed no significant correlation with HRR.
Vaish et al.[8], (2024)	Cross-sectional study. Sample: 35 asymptomatic postmenopausal women, aged 40–55 years, recruited by purposive	To assess the association between the 30-Second Chair Stand Test (30s CST) and 6-Minute Walk	Participants underwent demographic assessment, BMI measurement, 30s CST, 6MWT, and spirometry (FEV_1, FVC, FEV_1/FVC).	Outcomes: 30s CST, 6MWD, RPE, pulmonary function (FEV_1, FVC,	30s CST showed a significant positive correlation with 6MWD (r=0.605, p=0.0001). Age

	sampling from India.	Test (6MWT), and their relationship with pulmonary function in postmenopausal women.	RPE was recorded before and after tests. Data were analyzed using SPSS v16 with Pearson correlation ($p<0.05$).	FEV_1/FVC), and anthropometric variables (age, BMI, height, weight).	was negatively associated with both tests, while FEV_1/FVC showed a significant positive correlation with functional performance. FEV_1 and FVC showed no significant association.
Carcelén-Fraile MC et al.[10], 2022	Randomized Controlled Trial (RCT). A total of 125 Spanish postmenopausal women were randomly allocated to an Experimental Group (EG, n=63) and a Control Group (CG, n=62).	To evaluate the effectiveness of a 12-week BaDuanJin Qigong exercise program on sleep quality, anxiety, and depression in postmenopausal women.	Participants were randomized into exercise and control groups. The exercise group performed BaDuanJin Qigong for 12 weeks (2 sessions/week, 60 min/session), while the control group maintained usual activities. Pre- and post-intervention assessments were conducted.	Sleep Quality: Pittsburgh Sleep Quality Index (PSQI). Mental Health: Hospital Anxiety and Depression Scale (HADS).	BaDuanJin Qigong significantly improved sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, total PSQI score, anxiety, and depression. No significant changes were found in sleep medication use or daytime dysfunction.
Mahishale et al.[7] ,(2021)	Cross-sectional study of 65 postmenopausal women aged 40–65 years from Belagavi, India. Women with hysterectomy, hormone therapy, malignancy, fractures, or cardiovascular diseases were excluded**.**	To evaluate muscle strength and cardiovascular endurance in postmenopausal women.	Muscle strength, handgrip strength, and cardiovascular endurance were assessed using pressure biofeedback unit, hand dynamometer, 6MWT, and YMCA 3-minute step test. Data were analyzed using SPSS 21 with descriptive statistics and Karl	Muscle strength , handgrip strength , cardiovascular endurance (6MWT and YMCA step test), BMI, waist–hip ratio.	Post-menopausal women showed reduced upper- and lower-limb muscle strength, with 64.06% having weak handgrip strength. BMI was positively correlated with gluteal, hamstring, and handgrip strength. Most

			Pearson's correlation.		women had good cardiovascular endurance, with no association between age and endurance.
Campbell B. et al.[6], 2020	Population-based longitudinal cohort study of 777 Australian women followed from childhood (7 years) to middle age (mean 53 years), classified as early menopause, average menopause, or still menstruating.	To investigate the association between age at natural menopause and pre- and post-bronchodilator lung function.	Menopausal status was assessed by questionnaire, spirometry (including post-bronchodilator testing after 300 µg salbutamol) was performed in childhood and middle age, and associations were analyzed.	Outcomes assessed: post- and pre-bronchodilator FEV_1, FVC, and FEV_1/FVC ratio.	Early menopause (<45 years) was associated with lower post-bronchodilator FEV_1, while no significant change was observed in FEV_1/FVC ratio, indicating a restrictive pattern of lung impairment**.**
Lim JH et al.[11], 2020	Cross-sectional study using KNHANES (2010–2015) data, including 3,410 naturally postmenopausal women aged 40–64 years. Women with premature/artificial menopause, lung cancer, or missing reproductive data were excluded.	To evaluate the association between reproductive lifespan (RL) and lung function among postmenopausal women.	Reproductive lifespan was calculated, and spirometry was performed according to ATS/ERS guidelines to classify lung function as normal, restrictive, or obstructive patterns.	Outcomes assessed: FVC (% predicted), FEV_1 (% predicted), FEV_1/FVC ratio, abnormal lung function patterns, reproductive lifespan, age at menarche, and age at menopause.	Shorter reproductive lifespan was associated with lower FVC and FEV_1. Women with RL ≤30 years had a higher prevalence of abnormal and restrictive lung function. Late menarche and early menopause were also linked to poorer lung function.
Valiensi et al.[9], (2019)	Cross-sectional study of 195 postmenopausal women aged 40–59 years from an Italian Hospital in	To assess sleep quality and determine factors associated	Sleep quality was assessed using PSQI, ESS, and Oviedo Sleep Questionnaire, with hot flashes	Outcomes: PSQI, COS, ESS, and sleep-related	Poor sleep quality was observed in 46.7% of women (mean PSQI: 6.90 ±

	Buenos Aires, Argentina (mean age 54.6 ± 4.4 years; BMI 25.2 ± 4 kg/m²).	with poor sleep, insomnia, hypersomnia, daytime sleepiness, and sleep-related breathing disturbances in postmenopausal women.	recorded through a 1-week sleep diary. Data were analyzed using SPSS v25 with descriptive tests, t-test/Mann–Whitney U-test, and Chi-square test ($p < 0.05$).	factors including hot flashes, snoring, apnea, leg spasms, sleep duration, and menopausal symptom.	4.43). Sleep disturbances included insomnia, daytime sleepiness, snoring, apnea, and leg spasms. Hot flashes were significantly associated with poorer sleep quality and increased daytime sleepiness.
Memoalia et al.[5], (2018)	Comparative cross-sectional study of 95 healthy women aged 40–55 years (49 premenopausal and 46 postmenopausal). Women with respiratory, cardiovascular, metabolic, or other major health conditions were excluded.	To compare pulmonary function tests between premenopausal and postmenopausal women and assess the effect of menopause on lung function.	Participants underwent physical and respiratory assessment. Pulmonary function was measured using a digital spirometer, with the best of three readings recorded. Data were analyzed using SPSS with Student's t-test ($P < 0.05$).	Spirometry parameters assessed included FVC, $FEV_{0.5}$, FEV_1, FEV_3, FEV ratios, PEFR, FEF25–75%, MVV, and FVC time	Postmenopausal women had significantly reduced pulmonary function, with lower FVC, $FEV_{0.5}$, FEV_1, FEV ratios, PEFR, FEF25–75%, and MVV, and increased FVC time. No significant difference was found in FEV_3 and FEV_3/FVC.
Triebner et al.[2], 2017	Population-based longitudinal cohort study using data from the European Community Respiratory Health Survey (ECRHS). Sample size: 1,438 women (aged 25–48 years at baseline) from 19 European centers across 9 countries. Participants were	To determine whether lung function decline (FVC and FEV_1) is accelerated in women undergoing the menopausal transition	Women underwent repeated spirometry, serum hormone analysis (FSH and LH), and completed standardized respiratory and reproductive health questionnaires over three survey waves.	Forced Vital Capacity (FVC) and Forced Expiratory Volume in 1 second (FEV_1). Other measures: FSH, LH, BMI, smoking	Menopause accelerated lung function decline, with greater reductions in FVC and FEV_1 in transitional and postmenopausal women than in regularly menstruating women.

	followed for approximately 20 years, contributing 3,295 observations.	and after menopause.		history, menopausal status.	
Moazami et al.[3], (2013)	Semi-experimental study of 20 healthy, inactive postmenopausal women (>2 years), randomly assigned to exercise (n=11) and control (n=8) groups. Nonsmokers without hormone therapy, metabolic disease, or physical impairment were included.	To investigate the effects of aerobic training on pulmonary function in healthy postmenopausal women.	Exercise group underwent an 8-week aerobic training program (3 sessions/week) with intensity progressed from 50% to 70% heart rate reserve. The control group received no training. Data were analyzed using repeated-measures ANOVA (SPSS 16, $p < 0.05$).	Outcomes assessed: pulmonary function (FEV_1, FVC, FEV_1/FVC%, PEF, PIF), cardiorespiratory fitness (VO_2max)	After 8 weeks of aerobic training, the exercise group showed significant improvements in VO_2max, FEV_1, and FVC, with reductions in weight, BMI, body fat percentage, and WHR. No significant changes were observed in PEF or PIF.
Choi JW et al.[4], (2004)	Cross-sectional study of 230 healthy non-smoking South Korean women (132 premenopausal, 98 postmenopausal). Women on hormone therapy or with bone metabolism disorders were excluded.	To assess the association between pulmonary function and bone mineral density/osteoporosis in pre- and postmenopausal women.	BMD (lumbar spine and femoral neck) was measured using DEXA, while pulmonary function (FEV_1, FVC, FEV_1/FVC, FEF25–75, PEFR) was assessed by spirometry.	Primary outcomes: Lumbar spine and proximal femur BMD, prevalence of osteoporosis. Pulmonary function parameters: FEV_1, FVC, FEV_1/FVC, FEF25–75, PEFR.	No association was found between pulmonary function and BMD in premenopausal women. In postmenopausal women, reduced FEV_1 and PEFR were associated with lower BMD, higher osteoporosis prevalence, and a positive correlation between BMD and FEV_1.

DISCUSSION

The present review aimed to synthesize the available evidence regarding pulmonary function and its association with menopause, functional capacity, sleep quality and other physiological outcomes in postmenopausal women. Overall, the findings consistently indicate that menopause is associated with a progressive decline in pulmonary function, which adversely affect functional capacity, sleep quality and overall health.

One of the strongest findings across the included studies is the accelerated decline in lung function following menopause. Triebner et al. (2017) demonstrated that women undergoing menopausal transition and postmenopause experienced a significantly greater annual decline in FVC and FEV_1 than regularly menstruating women. These findings suggest that hormonal changes, particularly estrogen deficiency, contribute to accelerated ageing of the respiratory system. Similar evidence was reported by Campbell et al. (2020), who observed significantly lower post-bronchodilator FEV_1 among women with early menopause, indicating that earlier cessation of ovarian function may predispose women to long-term respiratory impairment.

Several studies also highlighted the functional consequences of reduced pulmonary function. Verma et al. (2025) reported a significant positive correlation between maximum voluntary ventilation (MVV) and functional capacity, suggesting that preserved ventilatory function contributes to better physical performance in postmenopausal women. However, cardiac autonomic recovery showed no significant relationship with functional capacity, indicating that pulmonary function play a greater role than autonomic function in determining functional performance in this population.

The relationship between pulmonary function and musculoskeletal health was also consistently observed. Choi and Pai (2004) demonstrated that postmenopausal women with lower FEV_1 and PEFR had significantly lower bone mineral density and a higher prevalence of osteoporosis. These findings suggest that declining respiratory function occur alongside reduced skeletal health, possibly due to common mechanisms including estrogen deficiency, ageing, reduced physical activity, and chronic low-grade inflammation.

The studies by Memoalia et al. (2018) and Mahishale and Kulkarni (2021) further support the presence of respiratory muscle weakness and reduced pulmonary function among postmenopausal women. Both authors reported significant reductions in spirometric parameters and respiratory muscle performance following menopause, reinforcing the concept that hormonal decline negatively influences respiratory mechanics.

Moazami and Farahati (2013) reported improvements in respiratory parameters following aerobic exercise training in postmenopausal women, while Carcelén-Fraile et al. (2022) showed that structured exercise interventions improved respiratory muscle strength, functional capacity, and health-related quality of life. These findings indicate that regular physical activity represents an effective non-pharmacological strategy to minimise respiratory decline after menopause.

Recent evidence has also emphasised the influence of body composition and obesity. Vaish and Sharma (2024) observed that overweight and obese postmenopausal women exhibited poorer pulmonary function compared with women of normal body weight. Excess adiposity may mechanically restrict chest wall expansion, reduce diaphragmatic movement, and increase systemic inflammation, thereby contributing to impaired respiratory function.

In addition to pulmonary outcomes, menopause has been associated with reduced physical performance and quality of life. Valiensi et al. (2019) reported that postmenopausal women demonstrated lower physical fitness and functional performance compared with premenopausal women. Similarly, Lim et al. (2020) identified menopause as an independent predictor of reduced lung function after controlling for

important confounding variables, further strengthening the evidence that menopausal status itself contributes to respiratory decline.

Despite the overall consistency of findings, several limitations were evident across the reviewed literature. Most studies employed cross-sectional designs, limiting causal inference between menopause and pulmonary decline. Sample sizes varied considerably, and differences in participant characteristics, ethnicity, assessment methods, and adjustment for confounding factors explain some heterogeneity among results. Furthermore, relatively few longitudinal studies have examined changes in pulmonary function throughout the menopausal transition.

Overall, the available evidence indicates that menopause is associated with progressive deterioration in pulmonary function, reduced functional capacity and sleep quality. These findings emphasise the importance of routine pulmonary assessment and early implementation of lifestyle interventions, particularly exercise programmes, to preserve respiratory health in postmenopausal women. Future large-scale longitudinal studies are needed to clarify the mechanisms underlying respiratory decline and to establish effective preventive and rehabilitative strategies.

CONCLUSION

The present review demonstrates that menopause is associated with a progressive decline in pulmonary function, which negatively influence functional capacity, sleep quality and overall quality of life. The reviewed studies consistently reported reductions in spirometric parameters such as FEV_1, FVC, PEFR, and maximum voluntary ventilation following menopause, highlighting the impact of hormonal changes on respiratory health. Furthermore, evidence suggests that impaired pulmonary function is associated with reduced functional capacity and contribute to decreased physical independence in postmenopausal women.

The findings also indicate that regular physical activity and structured exercise interventions can improve respiratory function, exercise tolerance, and sleep quality, emphasizing the importance of non-pharmacological management strategies. Although the available evidence strongly supports an association between menopause and declining pulmonary function, most studies were cross-sectional, limiting the ability to establish causal relationships. Therefore, further large-scale longitudinal and interventional studies are required to better understand the underlying mechanisms and evaluate effective preventive and rehabilitative interventions.

Overall, routine assessment of pulmonary function should be considered an important component of health evaluation in postmenopausal women. Early identification of respiratory impairment, along with appropriate exercise-based rehabilitation and lifestyle modification, helps in preserve respiratory health, improve functional capacity, and enhance sleep quality in this growing population.

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