Journal of Health and Rehabilitation Research 2791-156X JHRR

For contributions to JHRR, contact at email: editor@jhrlmc.com

Original Article

Effects of Aerobic Exercise on Blood Pressure and Sleep Quality in Hypertensive Postmenopausal Female

Namra Saleem[1], Saba Rafique[2], Hafiza Neelam Muneeb[2], Ayesha Karim[3]*, Aneeqa Aqdas[4], Fatima Sher Ali[5]

[1]Women Health Physical Therapist, Riphah International University, Lahore, Pakistan.
[2]Senior Lecturer, RCRS, Riphah International University, Lahore, Pakistan.
[3]Lecturer, Department of Physical Therapy & Rehabilitation, School of Health Sciences, University of Management & Technology, Lahore, Pakistan.
[4]Lecturer, Hajvery University, Lahore, Pakistan.
[5]Visiting Lecturer, Lahore Institute of Science and Technology, Lahore, Pakistan.
Corresponding Author: Ayesha Karim, Lecturer; Email: ayesha.karim@umt.edu.pk

Conflict of Interest: None.

*Saleem N., et al. (2024). 4(2): **DOI**: https://doi.org/10.61919/jhrr.v4i2.885*

ABSTRACT

Background: Menopause is a significant phase in a woman's life, marked by hormonal changes that can lead to various health issues, including hypertension and sleep disturbances. Managing these conditions is crucial for improving the quality of life in postmenopausal women.

Objective: This study aimed to evaluate the combined effects of aerobic exercise and anti-hypertensive medication on blood pressure and sleep quality in hypertensive postmenopausal women.

Methods: This randomized controlled trial, registered at ClinicalTrials.gov (NCT05306929), was conducted at Al Mustafa Maternity Hospital in Lahore over six months. Forty-six hypertensive postmenopausal women aged 45-65 were selected using convenience sampling and randomized into two groups. Group A (n=23) received anti-hypertensive medication plus 30 minutes of moderate-intensity aerobic exercise five days a week for eight weeks. Group B (n=23) received only anti-hypertensive medication. Blood pressure was measured using an aneroid sphygmomanometer, and sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI) at baseline, and after 4 and 8 weeks. Data were analyzed using SPSS 25, employing the Shapiro-Wilk test, Friedman test, and Mann-Whitney test.

Results: Group A showed significant reductions in systolic blood pressure (SBP) from 153.29 ± 11.56 mmHg at baseline to 135.05 ± 10.25 mmHg at 4 weeks, and 125.29 ± 8.15 mmHg at 8 weeks ($p<0.001$). Diastolic blood pressure (DBP) decreased from 92.96 ± 4.55 mmHg at baseline to 84.76 ± 4.58 mmHg at 4 weeks, and 80.62 ± 3.85 mmHg at 8 weeks ($p<0.001$). In contrast, Group B showed less pronounced reductions in SBP and DBP. PSQI scores in Group A improved from 10.95 ± 4.85 at baseline to 9.14 ± 4.56 at 4 weeks, and 7.52 ± 4.12 at 8 weeks. However, the difference in sleep quality between the two groups was not statistically significant ($p>0.05$).

Conclusion: Aerobic exercise combined with anti-hypertensive medication significantly reduced blood pressure in hypertensive postmenopausal women compared to medication alone. Although sleep quality improved in both groups, the differences were not significant. These findings suggest that incorporating aerobic exercise into the treatment regimen for hypertensive postmenopausal women can enhance cardiovascular health.

Keywords: Menopause, Hypertension, Aerobic exercise, Blood pressure, Sleep quality, Postmenopausal women, Anti-hypertensive medication, Randomized controlled trial.

INTRODUCTION

Menopause, a natural and significant phase in a woman's reproductive cycle, entails substantial mental, physical, and social changes. The decline in hormone levels during this period has profound adverse impacts that should not be overlooked, manifesting in symptoms such as sleep disturbances, cardiovascular issues, mood swings, dyspareunia, and bone health problems, which collectively affect the quality of life for millions of women globally (1). The transition to menopause, whether surgically or naturally induced, involves a gradual or sudden reduction in estrogen levels, which significantly elevates cardiovascular and metabolic risks. Surgically induced menopause, in particular, markedly increases cardiovascular risk factors, leading to a higher prevalence of cardiac issues (2, 3).

Journal of Health and Rehabilitation Research 2791-156X JHRR

Hypertension (HTN) emerges as a primary risk factor for heart failure, with studies indicating that its prevalence increases up to fourfold post-menopause. This is particularly crucial for women already suffering from HTN, as reaching post-menopausal status exacerbates vascular stiffness and cardiovascular complications, resulting in conditions such as left ventricular hypertrophy, dilated cardiomyopathy, and cardiovascular remodeling (4, 5). To mitigate menopause-related problems, many women resort to hormone replacement therapies (HRT), which, while alleviating symptoms, also elevate the risk of breast cancer and other side effects (6, 7). Additionally, pericardial fat accumulation, which correlates with higher body weight and BMI, increases the risks of type II diabetes, hypertension, and lipid abnormalities in post-menopausal women, further complicating cardiac health (8, 9).

Globally, hypertension stands as a leading cause of mortality and morbidity, contributing to 10.5 million deaths annually, with expectations of worsening trends. Despite the plethora of drugs available to manage blood pressure, a substantial portion of the hypertensive population fails to reach target levels, escalating cardiovascular risk. This challenge is compounded by limited awareness and inadequate screening (10). A study by the Journal of Hypertension in China reported that 49% of menopausal women experience hypertension (11). Aging is often accompanied by sleep disturbances, which heighten the risk of cardiovascular issues, hypertension, anxiety disorders, obesity, and other health problems. Poor sleep quality, coupled with obesity, can further aggravate coronary artery disorders and bone health issues (12). According to the American College of Cardiology, the risk of hypertension doubles in women post-menopause, and aerobic exercise can mitigate arterial stiffness and reduce blood pressure in these women (13).

Sleep plays a crucial role in optimizing neurological function and regulating biological processes, including metabolic rates, immune responses, hormonal balance, appetite cycles, and cardiovascular health (14, 15). The increasing prevalence of sleep disturbances globally has detrimental effects on health (16). The American Academy of Sleep Medicine (AASM) recommends physical activity as a non-pharmacological intervention for improving sleep hygiene and cycles (17). Aerobic exercise, characterized by repetitive and structured movements utilizing oxygen for energy, directly enhances cardiovascular capacity (18). Studies have shown that aerobic exercises have a more significant positive impact on sleep quality, especially in middle-aged women, compared to simpler activities like yoga (19).

In summary, aerobic exercises are effective in improving sleep quality and normalizing blood pressure in older adults. This study aims to evaluate the combined effects of aerobic exercise on blood pressure and sleep quality in hypertensive post-menopausal females, addressing a crucial aspect of health management in this demographic.

MATERIAL AND METHODS

This randomized controlled trial, registered at ClinicalTrials.gov (NCT05306929), was conducted at Al Mustafa Maternity Hospital in Ittefaq Town, Lahore, over six months following approval from the Research & Ethics Committee at Riphah International University, Lahore (Ref. No. REC/RCR & AHS/21/0521). The study employed convenience sampling to select 46 participants, with a calculated sample size of 23 postmenopausal women in each group. This calculation incorporated mean diastolic blood pressure values from prior data (mean 1: 91, mean 2: 84) and included a 10% attrition rate (20). Eligible participants were women aged 45 to 65, at least one year post-menopause with hypertension (BP ≤ 170/100), excluding those with sleep impairment from other diseases, cancer, use of antidepressants or sleeping pills, autoimmune disorders, recent myocardial infarction, recent surgery, and acute infections.

Informed consent was obtained from all participants, who were thoroughly informed about the study procedures. This single-blinded study involved the blinding of the assessor. Participants were randomized into two groups using the coin toss method. Group A received prescribed anti-hypertensive medication, while Group B, in addition to medication, engaged in aerobic exercises five days a week for eight weeks.

Aerobic exercises adhered to the 2010 WHO guidelines and recommendations from the American Heart Association (AHA) and the American College of Sports Medicine (ACSM), which advocate for 30 minutes of moderate-intensity aerobic exercise five times a week for adults (21, 22). Participants performed daily 30-minute sessions comprising brisk walking for 15 minutes, cycling at a moderate level (level 5/10) on an Apple fitness bike for 10 minutes, side steps for 1 minute, step-ups for 1 minute, and safe squats using a chair for 1 minute. The sequence included repetitions of side steps, step-ups, and squats for a total of 30 minutes per session. These exercises were based on protocols from a cardiac rehabilitation guide by Julian Bath, Gail Bohin, Christine Jones, and Eve Scarle (23).

Data collection utilized the Pittsburgh Sleep Quality Index (PSQI) to assess sleep quality, a tool with proven validity and strong test-retest reliability (24, 25). Blood pressure was measured using an aneroid sphygmomanometer, known for its accuracy and reliability in clinical settings (26). Measurements were recorded at baseline, and at the end of the 4th and 8th weeks of the intervention.

Ethical considerations aligned with the Declaration of Helsinki, ensuring participants' rights and well-being were safeguarded throughout the study. Data analysis was conducted using SPSS version 25. The Shapiro-Wilk test was employed to assess the

Journal of Health and Rehabilitation Research 2791-156X JHRR

normality of the data, revealing non-normal distribution ($p < 0.05$), prompting the use of non-parametric tests. The Friedman test was applied to analyze changes over time within each group, comparing baseline, 4th week, and 8th week data. Differences between groups were evaluated using the Mann-Whitney test. This robust methodological approach ensured the reliability and validity of the study findings.

RESULTS

The results of this study demonstrated significant improvements in both blood pressure and sleep quality among hypertensive postmenopausal women who engaged in aerobic exercise in addition to their prescribed anti-hypertensive medication. In Group A, which combined anti-hypertensive medication with aerobic exercises, the mean systolic blood pressure (SBP) decreased from 153.29 mmHg at baseline to 135.05 mmHg at the 4th week, and further to 125.29 mmHg by the 8th week (Table 2). In contrast, Group B, which only took anti-hypertensive medication, showed a less pronounced reduction in SBP, with mean values decreasing from 154.00 mmHg at baseline to 148.19 mmHg at the 4th week, and to 147.43 mmHg at the 8th week (Table 2). The differences in SBP between the two groups at both the 4th and 8th weeks were statistically significant ($p < 0.001$) as evidenced by the Mann-Whitney test results (Table 5).

Table 1: Demographic and Clinical Characteristics of Both Groups

Variable	Group	Mean	Minimum	Maximum
Age (years)	Anti-HTN + Aerobics	52.91	45.00	65.00
	Anti-HTN	56.38	45.00	65.00
SBP Baseline (mmHg)	Anti-HTN + Aerobics	153.29	129.00	170.00
	Anti-HTN	154.00	133.00	170.00
SBP 4th Week (mmHg)	Anti-HTN + Aerobics	135.05	115.00	147.00
	Anti-HTN	148.19	138.00	165.00
SBP 8th Week (mmHg)	Anti-HTN + Aerobics	125.29	110.00	138.00
	Anti-HTN	147.43	140.00	167.00
DBP Baseline (mmHg)	Anti-HTN + Aerobics	92.96	84.00	100.00
	Anti-HTN	93.52	79.00	100.00
DBP 4th Week (mmHg)	Anti-HTN + Aerobics	84.76	76.00	92.00
	Anti-HTN	91.05	89.00	95.00
DBP 8th Week (mmHg)	Anti-HTN + Aerobics	80.62	75.00	86.00
	Anti-HTN	91.33	85.00	96.00
PSQI Baseline	Anti-HTN + Aerobics	10.95	3.00	20.00
	Anti-HTN	9.24	3.00	20.00
PSQI 4th Week	Anti-HTN + Aerobics	9.14	3.00	18.00
	Anti-HTN	8.81	3.00	20.00
PSQI 8th Week	Anti-HTN + Aerobics	7.52	3.00	17.00
	Anti-HTN	8.19	3.00	19.00

Table 2: Test of Normality: Shapiro-Wilk

Variable	P value
4th Week Systolic BP	0.205
4th Week Diastolic BP	0.000
8th Week Systolic BP	0.186
8th Week Diastolic BP	0.010
PSQI 4th Week Score	0.004
PSQI 8th Week Score	0.000

Journal of Health and Rehabilitation Research 2791-156X JHRR

Table 3: Friedman ANOVA Test for Group A (Medicine Group)

Variable	Mean Rank	P value
	Baseline	4th Week
SBP	8.79	7.50
DBP	5.48	4.57
PSQI	2.40	2.10

Table 4: Mann-Whitney Test Comparing Both Groups at Baseline, 4th and 8th Weeks

Variable	Group	N	Mean Rank	z	P value
Baseline SBP	Group A	21	21.69	-0.101	0.920
	Group B	21	21.31		
Baseline DBP	Group A	21	22.74	-0.659	0.510
	Group B	21	20.26		
4th Week SBP	Group A	21	28.64	-3.810	0.000
	Group B	21	14.36		
4th Week DBP	Group A	21	29.90	-4.505	0.000
	Group B	21	13.10		
8th Week SBP	Group A	21	32.00	-5.561	0.000
	Group B	21	11.00		
8th Week DBP	Group A	21	31.88	-5.523	0.000
	Group B	21	11.12		
PSQI Baseline	Group A	21	19.62	-0.996	0.319
	Group B	21	23.38		
PSQI 4th Week	Group A	21	20.93	-0.303	0.762
	Group B	21	22.07		
PSQI 8th Week	Group A	21	22.29	-0.418	0.676
	Group B	21	20.71		

The results of this study demonstrated significant improvements in both blood pressure and sleep quality among hypertensive postmenopausal women who engaged in aerobic exercise in addition to their prescribed anti-hypertensive medication. In Group A, which combined anti-hypertensive medication with aerobic exercises, the mean systolic blood pressure (SBP) decreased from 153.29 mmHg at baseline to 135.05 mmHg at the 4th week, and further to 125.29 mmHg by the 8th week (Table 2). In contrast, Group B, which only took anti-hypertensive medication, showed a less pronounced reduction in SBP, with mean values decreasing from 154.00 mmHg at baseline to 148.19 mmHg at the 4th week, and to 147.43 mmHg at the 8th week (Table 2). The differences in SBP between the two groups at both the 4th and 8th weeks were statistically significant ($p < 0.001$) as evidenced by the Mann-Whitney test results (Table 5).

Similarly, the diastolic blood pressure (DBP) in Group A showed a significant reduction from a mean of 92.96 mmHg at baseline to 84.76 mmHg at the 4th week, and further to 80.62 mmHg by the 8th week (Table 2). In comparison, Group B's mean DBP decreased from 93.52 mmHg at baseline to 91.05 mmHg at the 4th week, and to 91.33 mmHg at the 8th week (Table 2). The statistical analysis confirmed that the reductions in DBP in Group A were significantly greater than those in Group B at both the 4th and 8th weeks ($p < 0.001$) (Table 5).

Regarding sleep quality, assessed by the Pittsburgh Sleep Quality Index (PSQI), Group A showed a marked improvement. The mean PSQI score in Group A decreased from 10.95 at baseline to 9.14 at the 4th week, and further to 7.52 by the 8th week (Table 2). Conversely, Group B exhibited a smaller reduction in PSQI scores, with the mean decreasing from 9.24 at baseline to 8.81 at the 4th week, and to 8.19 by the 8th week (Table 2). Although both groups showed improvement, the reduction in PSQI scores was more significant in Group A, indicating better enhancement of sleep quality due to the aerobic exercise regimen.

The Friedman test used to analyze the changes within Group A over time showed statistically significant improvements in SBP, DBP, and PSQI scores from baseline to the 4th and 8th weeks ($p < 0.001$ for all comparisons) (Table 4). The Mann-Whitney test confirmed the superiority of the combined intervention of aerobic exercise and anti-hypertensive medication over medication alone, highlighting significant differences between the two groups in SBP and DBP at both the 4th and 8th weeks ($p < 0.001$) (Table 5).

Overall, the findings underscore the beneficial effects of incorporating aerobic exercise into the treatment regimen for hypertensive postmenopausal women. The combination of anti-hypertensive medication and regular aerobic exercise led to more substantial reductions in both systolic and diastolic blood pressure, as well as greater improvements in sleep quality, compared to medication alone. These results suggest that aerobic exercise is a valuable adjunct therapy for managing hypertension and enhancing sleep quality in this population.

DISCUSSION

The current study demonstrated significant differences between the two groups regarding systolic and diastolic blood pressure over an eight-week period, with p-values less than 0.05. Notably, sleep quality did not differ significantly between the groups, with p-values greater than 0.05 over the same period. Within-group analyses revealed significant changes across all variables over the eight weeks. The mean ranks of all variables were higher in the non-exercise group, indicating that systolic blood pressure, diastolic blood pressure, and PSQI scores decreased in the exercise group during the study.

These findings align with previous research, such as the study by Wong et al. on the impact of stair climbing exercises on hypertensive postmenopausal females, which showed significant reductions in both systolic and diastolic blood pressure in the exercise group ($p < 0.05$) (27). Similarly, Amirabbas Monazzami et al. found that aerobic training significantly improved sleep quality in postmenopausal women with breast cancer, suggesting that exercise can have a positive impact on sleep (28). Son et al. also reported that 12 weeks of combined resistance and aerobic exercises reduced arterial stiffness and blood pressure in postmenopausal women, further supporting the beneficial effects of aerobic exercise on cardiovascular health (29).

Liliana C. et al.'s study on exercise programs combined with anti-hypertensive drugs indicated that physical activity significantly improved blood pressure values over a two-year follow-up, consistent with the present study's findings (30). However, Chris Noone's meta-analysis in 2020 partially disagreed, highlighting the variability in exercise effects depending on the study parameters and populations examined (31).

Zar et al.'s RCT in 2017 found that regular exercise improved most sleep components in postmenopausal women, except for certain aspects like falling asleep duration and morning dysfunction, which is in partial alignment with the current study's results (32). Al Sharmin et al.'s pilot study also showed improved sleep quality after eight weeks of exercise, further corroborating the current study's observations (33). Nevertheless, a systematic review by Dolezal BA et al. noted that while most studies reported positive changes in sleep quality due to exercise, the effects varied significantly, with some studies not showing improvements in postmenopausal women (34).

Kianian T et al. concluded that aerobic exercises significantly improved sleep quality, contrasting with the present study where sleep quality did not differ significantly between groups (35). Zehua Chen et al.'s meta-analysis on Pilates and exercise effects on sleep quality found no significant improvement in sleep among postmenopausal women, similar to the current study's findings (36). M. Ezati et al. observed that while mild aerobic exercise did not significantly change sleep duration, more intense aerobic activity over eight weeks improved all aspects of sleep quality, partially agreeing with the current study (37).

Loiza et al. found that exercise training significantly reduced blood pressure in postmenopausal women, with combined exercises having a greater effect on systolic and diastolic blood pressure than aerobic training alone, echoing the significant reductions observed in the current study after eight weeks of aerobic activities ($p < 0.05$) (39).

The strengths of this study included its randomized controlled design and the robust within-group analyses demonstrating the efficacy of combined aerobic exercise and anti-hypertensive medication. However, limitations included potential non-compliance with exercise routines and anti-hypertensive medication, budget constraints, and a lack of time for exercise among postmenopausal women. These factors may have influenced the results.

Recommendations for future research include allocating more resources for larger studies, comparing different exercise regimes combined with pharmacological therapies to determine their effects on blood pressure and other cardiorespiratory parameters in postmenopausal women. Additionally, studies should explore varying intensities, frequencies, and durations of exercise to better understand their impacts on this population.

CONCLUSION

In conclusion, the study found pronounced reductions in blood pressure values in postmenopausal women who engaged in aerobic exercises alongside anti-hypertensive medication compared to those who only took medication. However, while sleep quality improved in both groups, the differences were not statistically significant, suggesting that factors beyond exercise might influence sleep quality in postmenopausal women.

Journal of Health and Rehabilitation Research 2791-156X JHRR

REFERENCES

1. Gemmell L, Webster K, Kirtley S, Vincent K, Zondervan K, Becker C. The management of menopause in women with a history of endometriosis: a systematic review. Human reproduction update. 2017;23(4):481-500.
2. Farahmand M, Tehrani FR, Khomami MB, Noroozzadeh M, Azizi F. Surgical menopause versus natural menopause and cardio-metabolic disturbances: A 12-year population-based cohort study. Journal of endocrinological investigation. 2015;38(7):761-7.
3. Abbas SZ, Sangawan V, Das A, Pandey AK. Assessment of cardiovascular risk in natural and surgical menopause. Indian journal of endocrinology and metabolism. 2018;22(2):223.
4. Rossi R, Grimaldi T, Origliani G, Fantini G, Coppi F, Modena MG. Menopause and cardiovascular risk. Pathophysiology of haemostasis and thrombosis. 2017;32(5-6):325-8.
5. Mattioli AV, Sciomer S, Moscucci F, Maiello M, Cugusi L, Gallina S, et al. Cardiovascular prevention in women: a narrative review from the Italian Society of Cardiology working groups on 'Cardiovascular Prevention, Hypertension and peripheral circulation'and on 'Women Disease'. Journal of Cardiovascular Medicine. 2019;20(9):575-83.
6. Naftolin F, Friedenthal J, Nachtigall R, Nachtigall L. Cardiovascular health and the menopausal woman: the role of estrogen and when to begin and end hormone treatment. F1000Research. 2019;8.
7. Sandvei MS, Vatten LJ, Bjelland EK, Eskild A, Hofvind S, Ursin G, et al. Menopausal hormone therapy and breast cancer risk: effect modification by body mass through life. European journal of epidemiology. 2019;34(3):267-78.
8. Wu Y, Zhang A, Hamilton DJ, Deng T. Epicardial fat in the maintenance of cardiovascular health. Methodist DeBakey cardiovascular journal. 2017;13(1):20.
9. González N, Moreno-Villegas Z, González-Bris A, Egido J, Lorenzo Ó. Regulation of visceral and epicardial adipose tissue for preventing cardiovascular injuries associated to obesity and diabetes. Cardiovascular diabetology. 2017;16(1):1-11.
10. Forouzanfar MH, Liu P, Roth GA, Ng M, Biryukov S, Marczak L, et al. Global burden of hypertension and systolic blood pressure of at least 110 to 115 mm Hg, 1990-2015. Jama. 2017;317(2):165-82.
11. Song L, Shen L, Li H, Liu B, Zheng X, Zhang L, et al. Age at natural menopause and hypertension among middle-aged and older Chinese women. Journal of Hypertension. 2018;36(3):594-600.
12. Cheng M, Lei X, Zhu C, Hou Y, Lu M, Wang X, et al. The association between poor sleep quality and anxiety and depression symptoms in Chinese patients with coronary heart disease. Psychology, Health & Medicine. 2021:1-10.
13. Bittner V. Menopause, age, and cardiovascular risk: a complex relationship. American College of Cardiology Foundation Washington, DC; 2009. p. 2374-5.
14. Panel: CC, Watson NF, Badr MS, Belenky G, Bliwise DL, Buxton OM, et al. Joint consensus statement of the American Academy of Sleep Medicine and Sleep Research Society on the recommended amount of sleep for a healthy adult: methodology and discussion. Journal of Clinical Sleep Medicine. 2015;11(8):931-52.
15. Medic G, Wille M, Hemels ME. Short-and long-term health consequences of sleep disruption. Nature and science of sleep. 2017;9:151.
16. Jaiswal SJ, Owens RL, Malhotra A. Raising awareness about sleep disorders. Lung India: official organ of Indian Chest Society. 2017;34(3):262.
17. Sateia MJ, Buysse DJ, Krystal AD, Neubauer DN, Heald JL. Clinical practice guideline for the pharmacologic treatment of chronic insomnia in adults: an American Academy of Sleep Medicine clinical practice guideline. Journal of Clinical Sleep Medicine. 2017;13(2):307-49.
18. Lin Y-Y, Lee S-D. Cardiovascular benefits of exercise training in postmenopausal hypertension. International journal of molecular sciences. 2018;19(9):2523.
19. Rubio-Arias JÁ, Marín-Cascales E, Ramos-Campo DJ, Hernandez AV, Pérez-López FR. Effect of exercise on sleep quality and insomnia in middle-aged women: a systematic review and meta-analysis of randomized controlled trials. Maturitas. 2017;100:49-56.
20. Lv N, Xiao L, Simmons ML, Rosas LG, Chan A, Entwistle M. Personalized hypertension management using patient-generated health data integrated with electronic health records (EMPOWER-H): six-month pre-post study. Journal of medical Internet research. 2017;19(9):e311.
21. World Health Organization t. Global recommendations on physical activity for health: World Health Organization; 2010.
22. Haskell WL, Lee I-M, Pate RR, Powell KE, Blair SN, Franklin BA, et al. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Circulation. 2007;116(9):1081.

Journal of Health and Rehabilitation Research 2791-156X JHRR

23. Bath J, Bohin G, Jones C, Scarle E. Cardiac rehabilitation: a workbook for use with group programmes: John Wiley & Sons; 2009.
24. Manzar MD, BaHammam AS, Hameed UA, Spence DW, Pandi-Perumal SR, Moscovitch A, et al. Dimensionality of the Pittsburgh Sleep Quality Index: a systematic review. Health and quality of life outcomes. 2018;16(1):1-22.
25. Backhaus J, Junghanns K, Broocks A, Riemann D, Hohagen F. Test–retest reliability and validity of the Pittsburgh Sleep Quality Index in primary insomnia. Journal of psychosomatic research. 2002;53(3):737-40.
26. Ma Y, Temprosa M, Fowler S, Prineas RJ, Montez MG, Brown-Friday J, et al. Evaluating the accuracy of an aneroid sphygmomanometer in a clinical trial setting. American journal of hypertension. 2009;22(3):263-6.
27. Wong A, Figueroa A, Son W-M, Chernykh O, Park S-Y. The effects of stair climbing on arterial stiffness, blood pressure, and leg strength in postmenopausal women with stage 2 hypertension. Menopause. 2018;25(7):731-7.
28. Monazzami A, Momenpour R, Alipoor E, Yari K, Payandeh M. The Effects of Concurrent Training on the Body Composition, Quality of Life, and Sleep Quality of Postmenopausal Women with Breast Cancer. J Kermanshah Univ Med Sci. 2020;24:101186.
29. Son W-M, Pekas EJ, Park S-Y. Twelve weeks of resistance band exercise training improves age-associated hormonal decline, blood pressure, and body composition in postmenopausal women with stage 1 hypertension: a randomized clinical trial. Menopause. 2020;27(2):199-207.
30. Baptista LC, Amorim AP, Valente-dos-Santos J, Machado-Rodrigues AM, Veríssimo MT, Martins RA. Functional status improves in hypertensive older adults: the long-term effects of antihypertensive therapy combined with multicomponent exercise intervention. Aging clinical and experimental research. 2018;30(12):1483-95.
31. Noone C, Leahy J, Morrissey EC, Newell J, Newell M, Dwyer CP, et al. Comparative efficacy of exercise and anti-hypertensive pharmacological interventions in reducing blood pressure in people with hypertension: a network meta-analysis. European Journal of Preventive Cardiology. 2020;27(3):247-55.
32. Zar A, Alavi S, Ahmadi F, Rezaie F, Mirghaderi F. Effects of physical activity and exercise on sleep quality in postmenopausal women. Ù Ø¬ Ù Ù Ø²Ù Ø § Ù Ø Ù Ø § Ù Ø § Û Û Ù Ù Ø § Ø²Ø § Û Û Ø § Û Ø±Ø § Ù. 2017;20(4):19-24.
33. Al-Sharman A, Khalil H, El-Salem K, Aldughmi M, Aburub A. The effects of aerobic exercise on sleep quality measures and sleep-related biomarkers in individuals with Multiple Sclerosis: A pilot randomised controlled trial. NeuroRehabilitation. 2019;45(1):107-15.
34. Dolezal BA, Neufeld EV, Boland DM, Martin JL, Cooper CB. Interrelationship between sleep and exercise: a systematic review. Advances in preventive medicine. 2017;2017.
35. Kianian T, Navidia A, Aghamohamadi F, Saber S. Comparing the effects of aerobic and anaerobic exercise on sleep quality among male nonathlete students. Nursing and Midwifery Studies. 2017;6(4):168-73.
36. Chen Z, Ye X, Shen Z, Chen G, Chen W, He T, et al. Effect of pilates on sleep quality: a systematic review and meta-analysis of randomized controlled trials. Frontiers in neurology. 2020;11:158.
37. Ezati M, Keshavarz M, Barandouzi ZA, Montazeri A. The effect of regular aerobic exercise on sleep quality and fatigue among female student dormitory residents. BMC Sports Science, Medicine and Rehabilitation. 2020;12:1-8.
38. Amalia L, Fitriana LA, Darmawati I, Nasution LA, Anggadiredja K, Setiawan I, et al. The Effect of Aerobic Exercises on Estradiol Plasma, Quality of Sleep, and Cognitive Function in Menopausal Women. Malaysian Journal of Medicine & Health Sciences. 2021;17.
39. Loaiza-Betancur AF, Chulvi-Medrano I, Díaz-López VA, Gómez-Tomás C. The effect of exercise training on blood pressure in menopause and postmenopausal women: A systematic review of randomized controlled trials. Maturitas. 2021;149:40-55.