

Impact of Exercise on Post-menopausal Bone Health and Quality of Life-A Systemic Review

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KEYWORDS

Postmenopausal women, Osteoporosis, Quality of life, Bone health status, Bone mineral density, Exercises.

ABSTRACT

Background: Osteoporosis is a progressive disease commonly observed in postmenopausal women, characterized by a reduction in bone mass and density, which significantly heightens the risk of fractures. Conducted in accordance with PRISMA guidelines, it employed a comprehensive search strategy across PubMed, Google Scholar, and Embase. The review focused on randomized controlled trials (RCTs) investigating exercise interventions aimed at improving bone mineral density (BMD) and quality of life in postmenopausal osteoporotic women without a history of fractures. Study quality was assessed using the Cochrane Risk of Bias tool. The findings highlight that exercise interventions significantly enhance both BMD and overall quality of life in this population. The types of exercise interventions analyzed in the studies varied widely, including Tai Chi, high-intensity aerobic exercises, Modified Eight Section Brocade, progressive slow loading low-impact exercises, Pilates, and closed kinetic exercises. However, four studies were limited by small sample sizes, and three studies featured relatively short intervention durations. Due to the heterogeneity of the studies, a meta-analysis was not feasible. This highlights the need for further experimental trials with rigorous methodological designs to reduce the risk of bias and strengthen the evidence base. The existing evidence strongly supports the positive effects of exercise on the management of postmenopausal osteoporosis, highlighting the importance of further research to establish more conclusive findings.

INTRODUCTION

Menopause is the permanent end of menstruation and fertility, typically occurring after 12 months without a menstrual period, and is a natural part of aging for women, usually between the ages of 45 and 55. Menopause marks the end of reproductive capacity and often comes with various physical and emotional symptoms, including hot flashes, vaginal dryness, sleep disturbances, anxiety, and feelings of sadness or loss. These symptoms can impact daily life and overall well-being. However, effective management options such as lifestyle modifications, hormone replacement therapy (HRT), and non-hormonal medications are available to help alleviate these symptoms and improve quality of life.¹ Post menopause can be viewed as a multifaceted period in a woman's life, representing the first instance in decades where she is unable to conceive. After progressing through pre menopause, perimenopause, and menopause, women arrive at this concluding phase of their reproductive journey. Throughout the postmenopausal stage, hormonal fluctuations may persist, which can sometimes lead to the continuation of previous symptoms. Beyond hormonal changes, specialists have also pointed out the impact of external factors during this time.²

The World Health Organization estimated that by 2030, there would be approximately 1.2 billion women aged 50 and older. While menopause is a natural biological transition, it is a critical period that requires careful monitoring and management.³⁻⁵ Postmenopausal women often experience a decline in muscle mass, strength, and neuromuscular function due to ovarian degeneration and decreased estrogen secretion. These changes can hinder their ability to perform daily activities⁶⁻⁸ and significantly increase the risk of falls.^{9,10} Additionally, the rapid decline in estrogen levels—a hormone essential for maintaining bone density—leads to accelerated bone resorption, resulting in a marked decrease in bone mineral density (BMD). As a result, this significantly increases the risk of developing osteoporosis.¹¹ Osteoporosis is a chronic systemic skeletal disorder marked by reduced bone mass and the degradation of bone micro-architecture, resulting in greater bone fragility and an elevated risk of fractures.¹² Approximately 200 million women worldwide are estimated to be affected by osteoporosis.¹³ Every three seconds there is an osteoporotic fracture, and every 22 seconds there is a vertebral fracture.¹⁴ Recent research indicates that poor eating habits, sedentary lifestyles, and longer life expectancies are all associated with an increased risk of osteoporosis and concomitant fractures.¹⁴⁻¹⁶ Osteoporotic fractures are known to result in chronic pain, reduced physical function, and psychosocial challenges. Thus, preventing and treating osteoporosis and the fractures it causes is essential to enhancing the lives of those who are impacted.¹⁷⁻²² Exercise is an excellent way to enhance physical fitness as well as emotional and mental well-being. It is particularly beneficial for individuals experiencing poor balance, fear of falling, joint pain, and reduced muscle strength.^{23,24} When weight-bearing and non-weight-bearing exercises are combined with medicine, older adults with osteoporosis can significantly improve their bone mineral density and quality of life.²⁵ Patients with osteoporosis, especially postmenopausal women, benefit greatly from physical therapy in terms of their strength, balance, and quality of life. Nevertheless, publications that concentrate exclusively on exercise therapies for postmenopausal osteoporotic women who do not have fractures are scarce.²⁶ In high-risk populations, Senderovich and Kosmopoulos (2018) investigated how different forms of exercise could prevent osteoporosis and its correlation with fractures.²⁷ To avoid issues like fractures, healthcare providers should aggressively encourage women with postmenopausal osteoporosis to exercise and be physically active on a daily basis. Improved bone health and general quality of life are two outcomes that exercise can greatly improve. The purpose of this systematic review was to assess how exercise affected the quality of life and bone health of postmenopausal women.

Objectives

The main objective of this review was to assess the impact of exercise on bone health and quality of life in post-menopausal women.

METHODOLOGY & MATERIALS

Study Design:

The PRISMA guidelines were followed in conducting this review. The review consisted of 5 steps: (1) problem identification; (2) literature searching; (3) data review and evaluation; (4) data synthesis and analysis; and (5) data presentation.

Search Method:

This review systematically assessed the effectiveness of exercises in improving bone mineral density (BMD) and quality of life (QoL) among postmenopausal women with osteoporosis but no history of fractures. A comprehensive search of PubMed, Google Scholar, and Embase was conducted using the PICO model to structure the clinical question. Only randomized controlled trials (RCTs) involving postmenopausal women aged 45–70 years were included, focusing on exercise interventions and their impact on BMD and QoL. Studies involving women with fractures were excluded to emphasize osteoporosis prevention. Titles, abstracts, and references were screened, yielding no additional studies beyond the initial search. The review highlights the importance of structured exercise regimens in managing osteoporosis and improving outcomes in this population.

Data collection:

We conducted a systematic review, extracting data from studies on postmenopausal osteoporosis through a structured database search. Studies were screened by exclusion criteria, with key details like design, participants, outcomes, and duration critically analyzed. This process aimed to assess the effectiveness of exercise in improving bone health and quality of life (QoL) in postmenopausal women with osteoporosis.

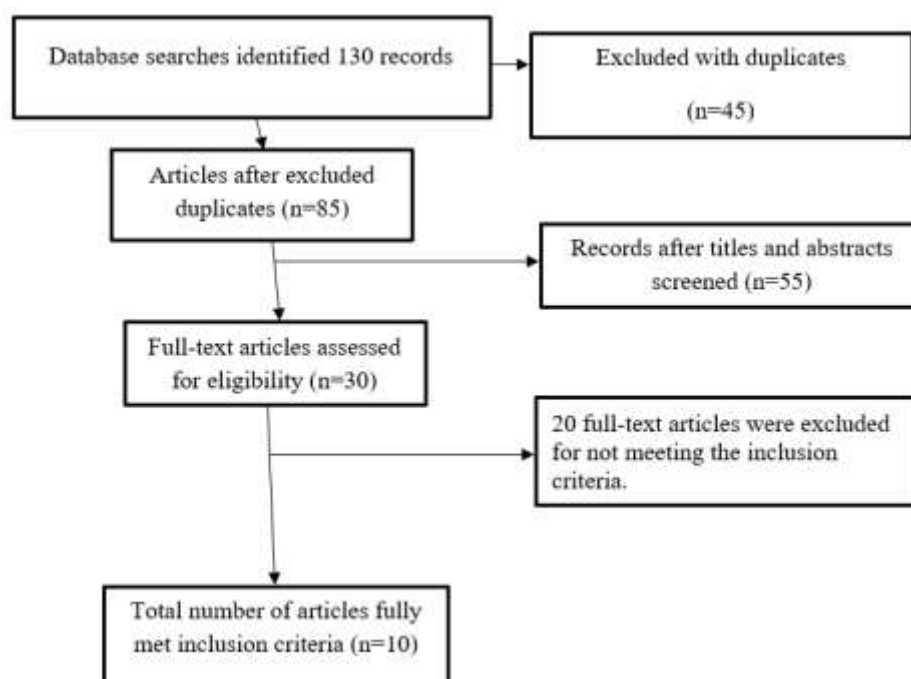


Figure 1. Flow chart of systematic review of literature selection process for the present research

RESULT

This review included 10 randomized controlled trials with a total of 661 participants, featuring a factorial design. Sample sizes ranged from 16 to 198, with an average participant age of 60.4 years. (Table 1).

Every study evaluated quality of life using a different methodology. The SF-36 Quality of Life questionnaire, the Shortened Osteoporosis Quality of Life Questionnaire (SOQLQ), Qualeffo 41, and the Assessment of Quality of Life (AoQL) were among the measurement instruments.^{28,29,32,34,36} All studies employed standard validated tools.

Different types of exercises were used across the studies. In one study, Tai Chi exercises were administered to 42 participants in the experimental group.³⁶ In another study, the Modified Eight-section of the Eight-section Brocade (MESE) exercise, also known as "jolt the back," was provided to 50 participants across two experimental groups.³⁰ Short-term step aerobic exercises were introduced in one study, with 24 participants in the experimental group and 22 in the control group.²⁸ Another study involved partially supervised exercises targeting hip bone strength, muscle strength, and balance. Lastly, progressive load training for the quadriceps muscle was applied to 43 participants in the experimental group and 42 in the control group.³⁴

In one study, 16 participants in the control group were instructed in a relatively low-load, at-home exercise regimen, whereas 12 people in the intervention group received high-intensity progressive resistance training.³⁵ Another study had the intervention group performing low-intensity rehabilitative exercises, while the control group received an instructional booklet for home exercises.³² In another study, the control group performed open kinetic exercise whereas the experimental group performed closed kinetic chain exercises.³³ One study provided squat exercises with maximum strength training for the experimental group, while the control group received standard care.³¹ Another study reported using Pilates exercises, which included nine different movements such as positioning, stretching, and breathing exercises, incorporating balls and bands.²⁹

The length and duration of the exercise interventions ranged from 10 weeks to 12 months. The selected studies varied in time frames of weeks and months. Three trials reported intervention durations of 52 weeks, 12 weeks, and 18 weeks,^{28,31,34} while four studies reported durations of 4 months, 6 months, 8 months, and 9 months.^{32,33,35,36}

Five studies incorporated group exercise sessions combined with a partially supervised home exercise program, while the control groups in these studies received no instructions and were not encouraged to alter their physical activities, daily living routines, or social habits.^{28,31,34,36,37}

In another study, small group exercise activities were supervised by physiotherapists, while the control group followed a very low-load, home-based exercise program.³⁵ Additionally, one study provided small group rehabilitative training led by experts and supplemented with a pictorial protocol, whereas the control group received an instructional exercise booklet.³² Three studies reported supervised training sessions for the intervention group, which occurred either twice or three times per week.^{29,31,33} In another study, the control group was asked to adhere to the current exercise guidelines.³¹ For a study evaluating the effects of kinetic exercises, the control group performed open-chain kinetic exercises,³³ while in a study conducted in Turkey, the control group was asked to follow a home exercise program.²⁹

Outcomes:

a. Primary Outcome

- **Bone mineral density:** The effect of exercise on bone mineral density (BMD) was assessed in seven studies.^{28,30,31,33,35-37} In six of these studies, the intervention group's BMD significantly improved as compared to the control group.^{28,30,31,33,35,36} However,

Wen et al. (2017)³⁷ found that the intervention group that engaged in brief aerobic exercise did not significantly enhance their BMD.

- **Quality of life:** Five studies assessed the effectiveness of exercises on the quality of life in postmenopausal women with osteoporosis.^{28,29,32,34,36} These studies all found that regular exercise significantly improved quality of life.

b. Secondary outcomes

Two studies found that balance capacity improved following exercise interventions.^{30,34} Liu et al. (2015)³⁰ also reported a notable decrease in persistent back discomfort levels after the intervention. Teixeira et al. (2010)³⁴ examined fall risk and discovered a marked decline in the intervention group that participated in progressive muscular strength exercises. Additionally, Wen et al. (2016)³⁷ reported improvements in functional fitness after short-term step aerobic exercises. Two studies indicated significant enhancements in pain levels and functional status.^{29,32} Lastly, one study reported notable improvements in outcomes such as one-repetition maximum (1RM), rate of force development (RFD), and bone mineral content.³¹

Table 1: Summary of the published articles

Reference	Study design	Sample size (n)	Mean age	Type of exercise	Duration	Outcome	Findings
Bolton et.al., ²⁸ , 2011, Australia	RCT	n= 37	EG:60.3 CG:56.3	Partially guided exercises focusing on enhancing hip bone density, muscle strength, and balance.	52 weeks 10-minute warm-up, 10-minute cool-down, and 40 minutes of resistance training, impact loading, and balance exercises.	BMDDEXA Quality of life is assessed using the Assessment of Quality of Life (AoQL) and the SF-36 questionnaire.	No significant change in hip BMD was seen in either group, but the experimental group showed increased BMD and improved quality of life.
Kucukca kir et al., ²⁹ , 2012, Turkey	RCT	n= 67	EG:56.6 CG:56.3	Pilates exercises include nine different modalities, utilizing exercise bands and 26-inch diameter exercise	Twice a week for one year	Pain-Visual analog scale. Functional status- six minutes walking and sit to stand test. QOL using the	Significant improvement was seen in all parameters except Qualeffo leisure activities and SF-36 physical

				balls as supportive equipment.		Qualeffo-41 questionnaire and the SF-36.	and emotional role limitations.
Liu et.al., ³⁰ , 2015, China	Factorial design	n=198	EG:61.87 EG:62.29 CG:83.23 CG:61.45	Modified Eightsection Brocade (MESE) exercise. It comprises 8 sections, with the first 7 involving body twists and the 8th, called "Jolt body to keep all illnesses away," aimed at promoting health.	12 months Exercises were performed 7 times each session, three times a day	BMDDEXA Chronic back pain is measured with VAS. Balance and motility- 3 feet Up and Go test and One Leg Stance.	BMD in the MESE Ca group significantly increased compared to the MESE group (P < 0.05). MESE exercises benefited the body.
Mosti et al., ³¹ , 2013, Norway	RCT	n= 16	EG:61.9 CG:66.7	Squat exercise and maximum strength exercises	12 weeks 3 times in a week	BMDDEXA Physical capacity is measured by 1-repetition maximum (1RM), Rate of Force Development (RFD), bone mineral content, and serum bone metabolism markers.	All parameters significantly improved in the experimental group.
Paolucci et al., ³² , 2014, Rome	RCT	n= 60	EG: 65.6 CG:65.6	Progressive slow repetitive exercises include low-impact aerobic training, postural exercises, and muscle	6 months 1 hour, 3 times a week, in small groups of 5 patients.	Pain-VAS McGill Pain Questionnaire QOL is assessed using the Shortened Osteoporosis QOL Questionnaire	The experimental group experienced less pain, better quality of life, and lower disability compared

				strengthening for the hips, trunk, hands, and knees.		re (SOQLQ), while functional impairment/disability is measured with the Oswestry Disability Questionnaire (ODQ).	to the control group.
Thabet et al., ³³ , 2017, Saudi Arabia	RCT	n=40	51-58 years blocks and surgery	Closed kinetic chain exercises include leg presses in a horizontal position, bicycling, and using the Stairmaster for cycling.	4 months 40 minutes with a 5-minute break between each exercise.	BMDDEXA	BMD increased significantly in the experimental group (P < 0.0001).
Teixeira et al., ³⁴ 2009 Brazil	RCT	n=85	EG:62.78 CG:63.1	Training with increasing loads for the quadriceps includes a 5-10 minute treadmill warm-up, stretching, functional exercises in sequence, and strengthening exercises.	18 weeks The exercises were performed twice a week throughout the 18-week treatment duration.	Quality of life is measured using the SF-36, balance with the Berg Balance Scale, and functional mobility through the Timed Up and Go test.	Significant differences between the groups were discovered for the SF-36, with the experimental group scoring higher on the Berg Balance Scale and the Timed Up and Go test.
Watson et al., ³⁵ , 2015 Australia	RCT	n= 28	EG: 65.3 CG:66.7	High-intensity progressive resistance training	8 months 30-minute supervised home-based exercise program,	BMDDEXA Back extensor strength is measured using a handheld	The experimental group showed significant improvements in

					conducted twice a week.	dynamometer, while functional performance is assessed with the Timed Up and Go test.	femoral neck and lumbar spine bone mineral density, as well as in back extensor strength and functional performance.
Wayne et. Al., ³⁶ 2012, Boston	RCT	n= 84	EG: 60.4 CG:58.8	Tai Chi program	9 months For the first month, there are two classes per week; after that, there is only one class per week for eight months.	BMDDEXA Quality of life-SF 36	The experimental group exhibited a more pleasant quality of life (P = 0.05), and there was a significant difference in femoral neck BMD changes between the experimental group (+0.04%) and control group (-0.98%; P = 0.05).
Wen et.al., ³⁷ 2017, Taiwan	RCT	n= 46	EG:57.5 CG:58.8	Short term step aerobic exercises	10 weeks 90 minutes per session, three sessions per week.	BMDDEXA	No significant change in BMD in both groups.

*RCT=Randomized control trial, EG=Experimental group, CG=Control group, BMD=bone mineral density, QOL= Quality of life *Some studies did not report the mean age of the participants in the EG and CG group, therefore age range is reported.

Risk of Bias:

All of the studies stated that subjects were assigned to the experimental or control groups at random, and none of them mentioned selection bias. The topic of allocation concealment was covered in three research.^{32,34,35} Three of the trials blinded the result assessors, but none of the investigations blinded the participants.^{28,34,36} The sample sizes in four of the studies were 37, 16, 40, and 28 participants^{28,31,33,35} and short treatment durations of 10 weeks,³⁷ 12 weeks,³¹ and 18 weeks.³⁴ A higher attrition rate of 33% was reported in Paolucci et al. (2014),³² while other studies lower attrition rates of 11% and 7%.^{29,30}

DISCUSSION

In order to assess the effect of exercise on post-menopausal women's bone health and quality of life, a systematic evaluation of original research studies from 2009 to 2019 was carried out. Ten studies were identified and analyzed, with seven focusing on bone mineral density (BMD). Six of these found that exercise significantly improved BMD.^{28, 30, 31, 33, 35, 36} One study noted improvements in femoral neck BMD, though it was limited by a small sample size and lack of blinding, suggesting Tai Chi as a potential treatment despite the short treatment duration.³⁶ Liu et al.³⁰ demonstrated that the Modified Eight Section of the Eight Section Brocade significantly improved BMD in the lumbar spine and left proximal femur, with low attrition and side effects. Another study indicated that partially supervised strengthening exercises improved hip BMD, though it had a small sample size and incomplete data.²⁸ Watson's research³⁵ found that high-intensity progressive resistance training improved BMD in the femoral neck and whole body, despite a small sample and high compliance. Furthermore, a comparison of closed and open kinetic exercises revealed positive effects on femoral BMD, suggesting a complementary approach to osteoporosis treatment.³³ Another study found maximal strength exercises (MSME) improved lumbar spine and femoral neck BMD, although it cautioned against MSME for patients with severe osteoporosis due to fracture risk.³¹

In contrast, Wen et al. (2017)³⁷ found no significant differences in BMD between intervention and control groups after a brief group-based aerobics program, attributing the negative results to the short 10-week duration despite high compliance.

Five studies assessed the impact of exercise on the quality of life in postmenopausal women with osteoporosis, all reporting significant improvements. The tools used for assessment included the SF-36 Quality of Life Questionnaire, the Assessment of Quality of Life (AoQL), the Shortened Osteoporosis Quality of Life Questionnaire (SOQLQ), and Qualeffo 41,^{28, 29, 32, 34, 36} all of which are validated instruments. Paolucci et al.³² used the SOQLQ to assess quality of life during a group exercise rehabilitation program, finding no adverse effects. However, this study had high attrition and poor compliance. Bolton et al.²⁸ used the SF-36 and AoQL, reporting improvements in mental health but cautioning against bias due to small sample size and poor adherence. Teixeira et al.³⁴ demonstrated significant improvements across all subscales using the SF-36, with a rigorous methodology and high adherence, indicating a low risk of bias. Wayne et al.³⁶ also found improvements in quality of life after Tai Chi activities, although the study was limited by a small sample size, short treatment period, and lack of blinding. Kucukcakir et al.²⁹ employed Pilates and found significant improvements in various parameters, except for a few subscales, with good compliance over a year-long follow-up.

According to the systemic studies, indicate that exercise positively impacts the quality of life of postmenopausal osteoporotic women. However, due to the small number of studies, further research with sound methodologies is needed to reinforce these findings. The systematic review highlights that exercise interventions improve both quality of life and bone health. Given the variability in the types of exercises, the need for standardized exercise guidelines for postmenopausal osteoporotic women is critical.

LIMITATIONS

This review highlights limitations, including reliance on BMD as a sole indicator of bone health, exclusion of non-English studies, unclear randomization methods, insufficient allocation concealment, lack of participant blinding, and data heterogeneity that precluded meta-analysis.

CONCLUSION

Exercise significantly improves bone mineral density (BMD) in postmenopausal women with osteoporosis, as shown in this review. While evidence on its impact on quality of life is limited, a structured exercise protocol tailored to this group is urgently needed, particularly in Bangladesh. Integrating such programs into primary healthcare could reduce fracture risks and improve long-term outcomes.

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