

The effect of physical activity level on quality of life in women with postmenopausal osteoporosis

✉ Ayşegül Yaman¹, ✉ Oya Özdemir², ✉ Şule Gül³, ✉ Sevilay Karahan⁴, ✉ Yeşim Gökçe Kutsal²

¹Department of Physical Medicine and Rehabilitation, Ankara Etlik City Hospital, Ankara, Türkiye

²Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Hacettepe University, Ankara, Türkiye

³Department of Physical Medicine and Rehabilitation, Isparta City Hospital, Isparta, Türkiye

⁴Department of Biostatistics, Faculty of Medicine, Hacettepe University, Ankara, Türkiye

Cite this article as: Yaman A, Özdemir O, Gül Ş, Karahan S, Kutsal YG. The effect of physical activity level on quality of life in women with postmenopausal osteoporosis. *J Health Sci Med.* 2025;8(2):286-291.

Received: 05.01.2025

Accepted: 15.02.2025

Published: 21.03.2025

ABSTRACT

Aims: Physical activity increases and maintains bone mineral density (BMD) and reduces the risk of bone fractures. Several factors may affect quality of life (QoL) in postmenopausal osteoporosis (PMO). This study aimed to evaluate the effect of physical activity level on QoL in women with PMO.

Methods: Demographic and clinical characteristics were recorded in this cross-sectional study. Physiological parameters, including handgrip strength (HGS), one-leg standing time, and ability to squat down on the floor, were collected. The BMDs at L1-L4 total, femur neck (FN), and femur total (FT) were measured by dual-energy X-Ray absorptiometry device. Physical activity level was calculated as metabolic equivalent of task (MET) value using the International Physical Activity Questionnaire (IPAQ) and patients were classified as 'low, moderate and high'. The European Osteoporosis Foundation Quality of Life Questionnaire (QUALEFFO-41) was used to evaluate QoL.

Results: This study included 179 postmenopausal women with a mean age of 62.72 ± 7.83 years. The average values of HGS and one-leg standing time were determined as 24.6 ± 8.1 kg and 17.6 ± 27.6 seconds, respectively. According to the IPAQ categories, 66.5% of the participants had low level of physical activity, and the median IPAQ score was 2286 MET. The mean QUALEFFO-41 total score was found to be 46.2 ± 17.6 . All QUALEFFO-41 questionnaire subscores, IPAQ categories, and IPAQ MET scores were significantly correlated with one-leg standing time. Additionally, all QUALEFFO-41 questionnaire subscores were negatively correlated with the HGS but positively correlated with the IPAQ category. All subscores of QUALEFFO-41 were significantly higher in inactive patients, indicating a worse QoL.

Conclusion: Low physical activity levels in women with PMO negatively impact their QoL. Additionally, physical activity level correlates with muscle strength and balance. Thus, interventions to increase muscle strength, balance and physical activity levels should be included in the treatment to improve patients' QoL with PMO.

Keywords: Quality of life, physical activity levels, postmenopausal osteoporosis

INTRODUCTION

Osteoporosis is a globally prevalent health burden and its prevalence is predicted to rise as the global population ages.¹⁻⁵ The burden of osteoporosis considering epidemiological aspects, socioeconomics, and health-related quality of life (HRQoL) has been documented.^{2,4,6,7} It is well-known that osteoporosis is associated with increased fracture risk.^{2,3,8} Osteoporotic fractures impair the patient's quality of life (QoL) by leading to pain and causing loss of independence.^{3-6,8-10}

Previous studies indicated that independent of fragility fractures postmenopausal women with osteoporosis have worse QoL compared to the ones with normal bone mineral density (BMD).⁹⁻¹³ Nevertheless, it has also been reported that women with osteoporotic fracture(s) have poorer overall

QoL than those without a fracture.^{3,5,7,9-12,14-20} QoL is a crucial measure of people's health, thus identifying the risk factors is essential to halt its deterioration.³ Age, marital status, educational and financial status, functional impairment, severity of postural deformities, stage of the disease, and sedentary lifestyle are among the factors affecting the QoL of patients with postmenopausal osteoporosis (PMO).^{5,9,13-15,18,19,21,22}

Physical activity has long been considered a significant modifiable factor associated with BMD and fracture risk.²³⁻²⁵ Wee et al.²³ found that postmenopausal women with moderate physical activity levels on the International Physical Activity Questionnaire (IPAQ) scale had a lower likelihood of

Corresponding Author: Ayşegül Yaman, aysegulyaman06@gmail.com



This work is licensed under a Creative Commons Attribution 4.0 International License.

worsening BMD at the following 2 years. In a cross-sectional clinical study, Dallanezi et al.²⁴ assessed the level of physical activity using the IPAQ questionnaire in postmenopausal women with low BMD. They concluded that the rate of sedentary lifestyles was higher in osteoporotic women than in those with either osteopenia or normal BMD and the daily amount of time sitting was highest in the osteoporotic group. Conversely, Schöfl et al.²⁶ reported that habitual physical activity and exercise do not influence BMD in elderly postmenopausal women. A systematic review stated that the potential benefits of exercise in enhancing bone formation and reducing bone resorption biomarkers in individuals with osteoporosis.²⁷ Engaging in moderate to vigorous physical activity reduces the secretion of sclerostin and helps increase BMD.²⁵ Furthermore, increasing physical activity within an appropriate range may reduce the risk of hip fracture but not wrist fracture in older women.²⁸

This study aimed to determine the physical activity level of women with PMO and evaluate the relationship between physical activity and HRQoL.

METHODS

The study protocol was approved by the Hacettepe University Non-interventional Clinical Researches Ethics Committee (Date: 31.05.2016, Decision No: GO 16/209-02). Written informed consent was obtained from all participants before the study. The study was carried out according to the principles of the Declaration of Helsinki.

A total of 179 women aged over 50 years with a diagnosis of PMO based on the classification by the World Health Organization were included in this cross-sectional study. The exclusion criteria were as follows: conditions and/or drug use that may result in secondary osteoporosis, neurological disorders, vestibular diseases, malignancy, severe cardiopulmonary diseases and instrumentation in the spine and/or joints in the lower extremities.

Firstly, the patient's age, age for menopause and T-scores at the lumbar spine (L1-L4 total), femur neck (FN), and femur total (FT) measured by dual-energy X-Ray absorptiometry (DXA) (Hologic) were noted. Then, the participants were asked to complete the questionnaires.

The IPAQ is used to determine the patient's physical activity level in the metabolic equivalent of task (MET). The IPAQ included questions about the frequency, intensity, and duration of physical activity that participants had engaged in during their everyday lives over the past seven days. Three levels of physical activity have been assigned to the participants: low, moderate, and high. Participants with a moderate physical activity level engage in vigorous physical activity for 3 or more days a week, with at least 20 minutes per day, or they engage in walking or moderate-intensity physical activity for 5 or more days a week, with at least 30 minutes per day or 5 or more days of any combination of walking, moderate-intensity or vigorous intensity activities achieving a minimum of at least 600 MET-min/week. High physical activity levels are achieved by participating in at least 3 days of vigorous-intensity physical activity, accumulating at least

1500 MET minutes per week, or by engaging in a combination of vigorous physical activity, moderate-intensity physical activity, or walking for 7 or more days, achieving a total of at least 3000 MET minutes per week. Low-level physical activity included participants with the lowest activity levels and did not meet moderate or high physical activity criteria.

Quality of life was assessed by the European Osteoporosis Foundation Quality of Life Questionnaire (QUALEFFO-41), widely used as a disease-specific questionnaire in osteoporosis patients.^{29,30} The reliability and validity of its Turkish version have been demonstrated.³¹ It includes 41 questions and comprises 5 main domains: pain, physical function, social activity, general health, and mental health. The results were analyzed using the algorithm proposed by the International Osteoporosis Foundation, applying a scale from 0 to 100 where 0 represents the best and 100 represents the worst QoL.

Lastly, hand grip strength (HGS), one-leg standing time and the ability to squat on the floor were tested as physiological parameters. Jamar hydraulic hand dynamometer was used to measure the HGS while the participants were sitting on a chair with their elbows flexed at a 90° angle. It was repeated three times, resting 15 seconds between trials, and the mean value was recorded in kilograms. Then, the subjects were instructed to stand on their dominant foot and keep their eyes open, and the time to stand on one leg was measured. Finally, they were asked to squat vertically in a stable position and then rise again. The squat-on-the-floor test outcomes were marked as yes or no.

Statistical Analysis

The data analysis used IBM SPSS version 22.0 (IBM Corp., Armonk, NY, USA). For continuous variables, the mean, standard deviation (SD), or median (min-max) were utilized; for categorical variables, percentages and numbers were employed. The Kolmogorov-Smirnov test found the data to have a normal distribution, and the Pearson correlation was used to determine the relationship between the parametric variables. A p-value of 0.05 was taken into account. Since few patients had high activity levels, those with moderate and high activity levels were combined and compared with those with low activity levels.

RESULTS

The mean age of the participants was 62.7±7.8 years. It has been found that 66.5% of the patients had low level of physical activity. The demographic characteristics, T scores, physiological parameters, IPAQ and QUALEFFO-41 scores are given in **Table 1**. While HGS and one-leg standing time were significantly higher in individuals with moderate to high activity levels compared to those with low activity level, the ability to squat on floor was found to be similar (**Table 2**). Among physiological parameters, only one-leg standing time correlated with IPAQmet values ($r=-0.153$, $p=0.041$).

All subscores of QUALEFFO-41 were significantly higher in patients with low activity level indicating a worse QoL (**Table 2**). Besides, all subscores were negatively correlated with HGS and one-leg standing time (**Table 3**).

Table 1. The demographic features, clinical properties, physiological parameters and quality of life scores of the patients

n=179	
Age (years) (mean±SD)	62.7±7.8
Age for menopause (years) (mean±SD)	45.7±5.6
Body-mass index (kg/m ²) (mean±SD)	27.32±4.82
Handgrip strength (HGS) (kg) (mean±SD)	24.60±8.07
One leg standing time (s) (mean±SD)	17.60±27.62
Ability to squat down on the floor (yes)	150 (83.8%)
Bone densitometry (mean±SD)	
Femoral neck T score	-1.98±0.77
Femur total T score	-1.65±0.85
Lumbar L1-L4 total T score	-2.96±0.67
Physical activity level IPAQ MET (median)	
Low-level physical activity	66.5%
Moderate-level physical activity	22.9%
High-level physical activity	10.6%
QUALEFFO-41 scores	
Pain (mean±SD)	47.10±28.27
Physical function (mean±SD)	33.15±21.16
Social function (mean±SD)	67.76±22.18
General health perception (mean±SD)	60.75±20.29
Mental function (mean±SD)	50.95±18.08
QUALEFFO-41 total score (mean±SD)	46.17±17.63

SD: Standard deviation, HGS: Handgrip strength, IPAQ: International Physical Activity Questionnaire, MET: Metabolic equivalent of task, QUALEFFO-41: The European Osteoporosis Foundation Quality of Life Questionnaire

Table 2. Physiological parameters and quality of life scores according to physical activity level

	Low-level physical activity	Moderate and high-level physical activity	p-value
One-leg standing time	14.61±18.79	25.52±39.27	0.041
Handgrip strength (HGS) (kg)	23.34±7.58	27.07±8.50	0.003
Ability to squat down on the floor			
Yes	97	53	0.288
No	22	7	
QUALEFFO-41 scores			
QUALEFFO-41 pain	53.15±25.76	35.38±28.79	<0.001
QUALEFFO-41 physical function	38.14±21.52	22.86±16.61	<0.001
QUALEFFO-41 social function	74.51±18.69	53.54±23.01	<0.001
QUALEFFO-41 general health perception	65.27±19.08	51.89±19.38	<0.001
QUALEFFO-41 mental function	54.30±16.76	44.23±18.96	0.001
QUALEFFO-41 total score	51.13±16.19	36.01±16.53	<0.001

HGS: Handgrip strength, QUALEFFO-41: The European Osteoporosis Foundation Quality of Life Questionnaire

DISCUSSION

Postmenopausal osteoporosis and fragility fractures deteriorate HRQoL to varying degrees. Women with a history of bone fractures, especially a femoral neck fracture, have a lower overall QoL than females without fractures.^{5,7,9,11}

Table 3. Relationship between balance and grip strength with quality of life

	Time to balance on one leg	Handgrip strength
QUALEFFO-41 pain	r=-0.156* p=0.037	r=-0.261* p<0.001
QUALEFFO-41 physical function	r=-0.331* p<0.001	r=-0.451* p<0.001
QUALEFFO-41 social function	r=-0.447* p<0.001	r=-0.273* p<0.001
QUALEFFO-41 general health perception	r=-0.280* p<0.001	r=-0.355* p<0.001
QUALEFFO-41 mental function	r=-0.301* p<0.001	r=-0.308* p<0.001
QUALEFFO-41 total score	r=-0.378* p<0.001	r=-0.435* p<0.001

QUALEFFO-41: The European Osteoporosis Foundation Quality of Life Questionnaire

Vertebral fractures were also found to be specifically linked to decreased physical domain of HRQoL and pain.^{3,5,32} Several studies have shown that pain was associated with poor QoL in women with osteoporosis and pain intensity negatively affects HRQoL in women with osteoporosis with or without a vertebral fracture.^{3,9} It was detected that women with osteoporosis exhibit a lower QoL in various QUALEFFO-41 subscales, regardless of bone fractures.^{5,9-11,13,15,33} A systematic review indicated that individuals with osteoporosis who did not have a vertebral fracture had clinically significant declines in the domains of physical role, general health, vitality, and mental health, as well as the mental component summary score SF36. Using QUALEFFO-41, pain and physical function were worse in these patients.¹² Similarly, Godala et al.¹⁹ concluded that osteoporosis patients have a lower QoL than healthy controls in all subscores of QUALEFFO-41. Furthermore, they stated that the QUALEFFO-41's 'mental function' domain received the worst score. Rizzo reported that compared to persons with normal BMD, subjects with osteoporosis scored lower on the QUALEFFO questionnaire regarding physical and social function.³³ Singh et al.¹⁸ indicated that significant differences were observed in the three domains of QUALEFFO-41, consisting of pain, physical, and social function among normal BMD, osteopenic, and osteoporotic postmenopausal women. Postmenopausal women with osteopenia and osteoporosis had a lower QoL than women with normal BMD. Ciubean et al.¹⁰ showed that women with PMO had considerably lower scores in all SF-36 domains except for the energy/fatigue dimension. Between osteoporotic women with and without fragility fractures, they noticed statistical significance in terms of leisure/social activities, mental function, and total score of QUALEFFO-41. However, no significant difference was found between the two groups in SF-36 domains except the pain domain.¹⁰ According to Bączyk et al.,⁵ the normal BMD group showed higher QoL (QUALEFFO-41) regarding pain, social function, health perception, and mental function than osteoporotic and osteopenic women. Additionally, they found a significant difference in pain, physical function, and total QUALEFFO-41 scores between osteoporotic women with fractures and those without fractures. Similarly, a significant difference in pain and total QUALEFFO-41 scores were also detected among osteopenic women between those with fractures and without

fractures. In the study of de Oliveira Ferreira et al,¹⁶ women with PMO had lower QoL scores in both of the SF-36 and QUALEFFO-41 subscores. Furthermore, the overall QoL was also considerably lower in women with vertebral fractures than in those without fractures. Pamuk et al.¹⁵ reported that a substantial difference was observed between the patients with and without osteoporosis in all subgroup scales of QUALEFFO-41.

In most of the above-mentioned studies, the factors which deteriorate QoL were also investigated. In a study evaluating the factors that predict QoL in postmenopausal women with osteoporosis, it has been determined that marital, educational and financial status have a statistically significant effect on QoL.⁹ Pamuk et al.¹⁵ indicated that parameters such as age, education level, employment status, income level, exercise habit, and activity level had a significant impact on QoL, based on QUALEFFO-41 outcomes. According to Bączyk et al.,⁵ secondary and higher education, self-perceived back deformity, prior fractures, reduced height, and anxiety were the related factors for total QUALEFFO-41. In the study by Rizzo et al.,³³ high BMI and high FRAX score were identified as the main variables associated with deterioration in QoL. De Oliveira Ferreira et al.¹⁶ demonstrated that a sedentary lifestyle and a BMI above 25 were associated with a lower QoL, whereas paid work was linked to a higher QoL. According to Singh et al.,¹⁸ BMI significantly influences the physical and social function dimensions of QoL for women who are osteopenic or osteoporotic. Miyakoshi et al.²¹ suggested that decreased lean muscle mass, increased thoracic kyphosis, and generalized muscle weakness could be linked to a lower QoL in osteoporosis patients.

In this study, women with PMO were evaluated for the impact of their physical activity level on their QoL. Patients with low level physical activity had significantly higher QUALEFFO-41 subscores, indicating a lower QoL. Previous studies investigating the relationship between physical activity level and QoL in patients with osteoporosis have similar findings. Stanghelle et al.³ determined that lower levels of HRQoL were significantly related to poorer levels of physical function assessed by walking speed, and higher pain levels. Walking speed was highly correlated with four of the six subscales of the QUALEFFO-41 (except pain and mood). In another study, it has been determined that those who performed exercises for osteoporosis had significantly better scores in all subgroups of the QUALEFFO-41 except the mental function than patients who did not exercise.³⁴ In accordance with these studies, Pamuk et al.¹⁵ reported that postmenopausal women with osteoporosis who exercised regularly and were more active had higher QUALEFFO-41 scores. However, they did not specify how they had measured physical activity levels in their study.

Additionally, we examined the relationship between QoL and physiological characteristics including HGS, one-leg standing time and the ability to squat on the floor and found that HGS and one-leg standing time have negative correlations with all scores of the QUALEFFO-41 questionnaire domains. Furthermore, HGS and one-leg standing time were significantly higher in individuals with moderate to

high activity levels compared to those with low activity level. Previous studies have shown that HGS and one-leg standing time were positively correlated with BMD values, but their relationships with the patients' physical activity level and QoL have not been investigated.³⁵⁻⁴⁰

It is well-known that sedentary adults lose bone more quickly. A cause of older people's avoidance of physical activity is osteoporosis.^{2,22,41,42} In individuals with osteoporosis, kinesiophobia may be linked to decreased levels of physical activity and QoL. Gunendi et al.²⁰ found that patients with osteoporosis had greater levels of kinesiophobia than healthy control participants and there was a strong link between the QUALEFFO-41 total score and the kinesiophobia score in patients with osteoporosis. As older adults' mobility and physical activity levels diminish, the risk of falling increases.^{2,22,40,42} Studies have indicated that sedentary older adults experience a higher risk of hip fracture compared to more active ones.² Thus, exercise interventions are crucial for PMO in women.^{2,4,22,40,43-49} Exercise recommendations for older adults with osteoporosis or osteoporotic vertebral fractures incorporate resistance and balance training.⁴³ Multimodal exercise regimens emphasizing postural balance and muscle strength are beneficial in lowering fall and fracture risk factors. Exercise regimens have also been shown to enhance kinesiophobia, mood, and QoL in osteoporosis patients.^{20,48,49} In addition to medication, moderate-to-intense exercise, including weight-bearing and non-weight-bearing activities, may dramatically improve BMD and QoL in older adults with osteoporosis.^{4,20,41,46} Physical activity may include 30-40 minutes of weight-bearing and resistance exercise three to four times weekly.^{2,4,14} The level of evidence is higher for higher-dose exercise regimens involving multiple exercise types seem more beneficial.^{2,14,42} Nevertheless, some reports suggest that patients may benefit from even low-intensity exercise.⁴² In addition to helping to prevent osteoporosis, physical activities may enhance the QoL in osteoporotic patients by reducing pain, increasing mobility, and both.^{2,3,14,22,42,45,46,49}

Limitations

Our study has some limitations. The findings of our study apply only to the women with PMO and do not address osteoporosis from other causes. The study's lack of male participants restricts the generalizability of the results. In our study, the participants' fracture history was not evaluated and a history of anti-osteoporotic medical treatment was not recorded. Lastly, the IPAQ questionnaire's recall bias and subjective scores are problematic when evaluating physical activity levels.

CONCLUSION

In conclusion, our study investigating the relationship between physical activity levels and QoL in women with PMO revealed that PMO patients with low physical activity levels had worse QoL. Higher HGS and one-leg standing time values were also found to be associated with better QoL in these patients. Thus, these findings suggest that interventions to increase muscle strength, balance, and physical activity levels should be incorporated into the treatment to enhance patients' QoL with PMO.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of the Hacettepe University Non-interventional Clinical Researches Ethics Committee (Date: 31.05.2016, Decision No: GO 16/209-02).

Informed Consent

All patients signed and free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

- Kanis JA, Cooper C, Rizzoli R, Reginster JY; Scientific Advisory Board of the European Society for Clinical and Economic Aspects of Osteoporosis (ESCEO) and the Committees of Scientific Advisors and National Societies of the International Osteoporosis Foundation (IOF). European guidance for the diagnosis and management of osteoporosis in postmenopausal women. *Osteoporos Int.* 2019;30(1):3-44. doi:10.1007/s00198-018-4704-5
- Cooper C; Ferrari S. IOF Compendium of Osteoporosis 2nd Edition of IOF Compendium of Osteoporosis 2019 International Osteoporosis Foundation. <https://www.osteoporosis.foundation/educational-hub/topic/osteoporosis>
- Stanghelle B, Bentzen H, Giangregorio L, Pripp AH, Bergland A. Associations between health-related quality of life, physical function and pain in older women with osteoporosis and vertebral fracture. *BMC Geriatr.* 2019;19(1):298. doi:10.1186/s12877-019-1268-y
- Anupama DS, Norohna JA, Acharya KK, Ravishankar, George A. Effect of exercise on bone mineral density and quality of life among postmenopausal women with osteoporosis without fracture: a systematic review. *Int J Orthop Trauma Nurs.* 2020;39:100796. doi:10.1016/j.ijotn.2020.100796
- Bączyk G, Samborski W, Jaracz K. Evaluation of the quality of life of postmenopausal osteoporotic and osteopenic women with or without fractures. *Arch Med Sci.* 2016;12(4):819-827. doi:10.5114/aoms.2015.55012
- van Schoor NM, Yu H, Bobula J, Lips P. Cross-geographic region differences in quality of life in women with and without vertebral fracture. *Osteoporos Int.* 2009;20(10):1759-1766. doi:10.1007/s00198-009-0853-x
- Gao S, Zhao Y. Quality of life in postmenopausal women with osteoporosis: a systematic review and meta-analysis. *Qual Life Res.* 2023;32(6):1551-1565. doi:10.1007/s11136-022-03281-1
- Ma L, Li Y, Wang Küçükçakır N, Altan L, Korkmaz N. Effects of Pilates exercises on pain, functional status and quality of life in women with postmenopausal osteoporosis. *J Bodyw Mov Ther.* 2013;17(2):204-211. doi:10.1016/j.jbmt.2012.07.003
- Górczewska B, Jakubowska-Pietkiewicz E. Predictors of quality of life in women with postmenopausal osteoporosis. *Psychiatr Pol.* 2022;25:1-14. doi:10.12740/PP/OnlineFirst/147733
- Ciubean AD, Ungur RA, Irsay L, et al. Health-related quality of life in Romanian postmenopausal women with osteoporosis and fragility fractures. *Clin Interv Aging.* 2018;13:2465-2472. doi:10.2147/CIA.S190440
- Hopman WM, Berger C, Joseph L, et al. CaMos Research Group. Longitudinal assessment of health-related quality of life in osteoporosis: data from the population-based Canadian multicentre osteoporosis study. *Osteoporos Int.* 2019;30(8):1635-1644. doi:10.1007/s00198-019-05000-y
- Wilson S, Sharp CA, Davie MW. Health-related quality of life in patients with osteoporosis in the absence of vertebral fracture: a systematic review. *Osteoporos Int.* 2012;23(12):2749-2768. doi:10.1007/s00198-012-2050-6
- de Oliveira Ferreira N, da Silva RB, Arthuso M, Pinto-Neto AM, Caserta N, Costa-Paiva L. Prevalence of vertebral fractures and quality of life in a sample of postmenopausal Brazilian women with osteoporosis. *Arch Osteoporos.* 2012;7:101-106. doi:10.1007/s11657-012-0086-z
- Pinheiro MB, Oliveira J, Bauman A, Fairhall N, Kwok W, Sherrington C. Evidence on physical activity and osteoporosis prevention for people aged 65+ years: a systematic review to inform the WHO guidelines on physical activity and sedentary behaviour. *Int J Behav Nutr Phys Act.* 2020;17(1):150. doi:10.1186/s12966-020-01040-4
- Pamuk G, Kutlu R, Civi S. Evaluation of Quality of Life in Postmenopausal Women with and without Osteoporosis using the QUALEFFO-41 Scale. *Turk J Phys Med Rehab.* 2014;60:139-146. doi:10.5152/tftrd.2014.47855
- de Oliveira Ferreira N, Arthuso M, da Silva R, Pedro AO, Pinto Neto AM, Costa-Paiva L. Quality of life in women with postmenopausal osteoporosis: correlation between QUALEFFO 41 and SF-36. *Maturitas.* 2009;62(1):85-90. doi:10.1016/j.maturitas.2008.10.012
- Palacios S, Neyro JL, Fernández de Cabo S, Chaves J, Rejas J. Impact of osteoporosis and bone fracture on health-related quality of life in postmenopausal women. *Climacteric.* 2014;17(1):60-70. doi:10.3109/13697137.2013.808182
- Singh N, Kumar D, Yadav G, et al. Comparison of quality of life and bone mass density among postmenopausal women: a cross-sectional study. *J Midlife Health.* 2020;11(4):224-230. doi:10.4103/jmh.JMH_107_20
- Godala M, Sewerynek E, Gaszyńska E. Dietary behaviors, serum 25(OH) D levels and quality of life in women with osteoporotic disorders. *Int J Environ Res Public Health.* 2022;19(24):17023. doi:10.3390/ijerph192417023
- Gunendi Z, Eker D, Tecer D, Karaoglan B, Ozyemisci-Taskiran O. Is the word "osteoporosis" a reason for kinesiphobia? *Eur J Phys Rehabil Med.* 2018;54(5):671-675. doi:10.23736/S1973-9087.18.04931-6
- Miyakoshi N, Kudo D, Hongo M, Kasukawa Y, Ishikawa Y, Shimada Y. Comparison of spinal alignment, muscular strength, and quality of life between women with postmenopausal osteoporosis and healthy volunteers. *Osteoporos Int.* 2017;28(11):3153-3160. doi:10.1007/s00198-017-4184-z
- Nawrat-Szołtysik A, Miodońska Z, Opara J, Polak A, Matyja B, Małecki A. Effect of physical activity on the quality of life in osteoporotic females living in residential facilities: a randomized controlled trial. *J Geriatr Phys Ther.* 2019;42(2):98-104. doi:10.1519/JPT.0000000000000154
- Wee J, Sng BY, Shen L, Lim CT, Singh G, Das De S. The relationship between body mass index and physical activity levels in relation to bone mineral density in premenopausal and postmenopausal women. *Arch Osteoporos.* 2013;8:162. doi:10.1007/s11657-013-0162-z
- Dallanezi G, Freire BF, Nahás EA, Nahás-Neto J, Corrente JE, Mazeto GM. Physical activity level of post-menopausal women with low bone mineral density. *Rev Bras Ginecol Obstet.* 2016;38(5):225-230. doi:10.1055/s-0036-1583757
- Oniszczuk A, Kaczmarek A, Kaczmarek M, et al. Sclerostin as a biomarker of physical exercise in osteoporosis: a narrative review. *Front Endocrinol (Lausanne).* 2022;13:954895. doi:10.3389/fendo.2022.954895
- Schöfl I, Kemmler W, Kladny B, Vonstengel S, Kalender WA, Engelke K. In healthy elderly postmenopausal women variations in BMD and BMC at various skeletal sites are associated with differences in weight and lean body mass rather than by variations in habitual physical activity, strength or VO2max. *J Musculoskelet Neuronal Interact.* 2008;8(4):363-374.
- Marini S, Barone G, Masini A, et al. The effect of physical activity on bone biomarkers in people with osteoporosis: a systematic review. *Front Endocrinol (Lausanne).* 2020;11:585689. doi:10.3389/fendo.2020.585689
- Rong K, Liu XY, Wu XH, et al. Increasing level of leisure physical activity could reduce the risk of hip fracture in older women: a dose-response meta-analysis of prospective cohort studies. *Medicine (Baltimore).* 2016;95(11):e2984. doi:10.1097/MD.0000000000002984

29. Lips P, Cooper C, Agnusdei D, et al. Quality of life in patients with vertebral fractures: validation of the Quality of Life Questionnaire of the European Foundation for Osteoporosis (QUALEFFO). Working Party for Quality of Life of the European Foundation for Osteoporosis. *Osteoporos Int.* 1999;10(2):150-160. doi:10.1007/s001980050210
30. Choo YW, Mohd Tahir NA, Mohamed Said MS, Makmor Bakry M. Health-related quality of life in osteoporosis: a systematic review of measurement properties of the QUALEFFO-41. *Osteoporos Int.* 2024; 35(5):745-757. doi:10.1007/s00198-023-07005-0
31. Koçyigit H, Gülseren S, Erol A, Hizli N, Memis A. The reliability and validity of the Turkish version of Quality of Life Questionnaire of the European Foundation for Osteoporosis (QUALEFFO). *Clin Rheumatol.* 2003;22(1):18-23. doi:10.1007/s10067-002-0653-6
32. Johansson L, Sundh D, Nilsson M, Mellström D, Lorentzon M. Vertebral fractures and their association with health-related quality of life, back pain and physical function in older women. *Osteoporos Int.* 2018;29(1):89-99. doi:10.1007/s00198-017-4296-5
33. Rizzo M, Tammaro G, Guarino A, Basso M, Cozzolino A, Mariconda M. Quality of life in osteoporotic patients. *Orthop Rev (Pavia).* 2022;14(6): 38562. doi:10.52965/001c.38562
34. Koevska V, Nikolikj-Dimitrova E, Mitrevska B, Gjeracaroska-Savevska C, Gocevska M, Kalcovska B. Effect of exercises on quality of life in patients with postmenopausal osteoporosis-randomized trial. *Open Access Maced J Med Sci.* 2019;7(7):1160-1165. doi:10.3889/oamjms.2019.271
35. Arazi H, Eghbali E, Saeedi T, Moghadam R. The relationship of physical activity and anthropometric and physiological characteristics to bone mineral density in postmenopausal women. *J Clin Densitom.* 2016;19(3): 382-388. doi:10.1016/j.jocd.2016.01.005
36. Lee SH, Gong HS. Measurement and Interpretation of Handgrip Strength for Research on Sarcopenia and Osteoporosis. *J Bone Metab.* 2020;27(2):85-96. doi:10.11005/jbm.2020.27.2.85
37. Wu N, Li X, Mu S, Fu Q, Ba G. Handgrip strength is positively associated with bone mineral density in middle and aged adults: results from NHANES 2013-2014. *Arch Osteoporos.* 2021;16(1):121. doi:10.1007/s11657-021-00938-1
38. Prakash KO, Choudhary R, Singh G. Lean body-mass, body-fat percentage, and handgrip strength as predictors of bone mineral density in postmenopausal women. *J Midlife Health.* 2021;12(4):299-303. doi:10.4103/jmh.jmh_21_21
39. Kim SW, Lee HA, Cho EH. Low handgrip strength is associated with low bone mineral density and fragility fractures in postmenopausal healthy Korean women. *J Korean Med Sci.* 2012;27(7):744-747. doi:10.3346/jkms.2012.27.7.744
40. Kärkkäinen M, Rikkinen T, Kröger H, et al. Physical tests for patient selection for bone mineral density measurements in postmenopausal women. *Bone.* 2009;44(4):660-665. doi:10.1016/j.bone.2008.12.010
41. Caputo EL, Costa MZ. Influence of physical activity on quality of life in postmenopausal women with osteoporosis. *Rev Bras Reumatol.* 2014; 54(6):467-473. doi:10.1016/j.rbre.2014.02.021
42. Küçükçakır N, Altan L, Korkmaz N. Effects of Pilates exercises on pain, functional status and quality of life in women with postmenopausal osteoporosis. *J Bodyw Mov Ther.* 2013;17(2):204-211. doi:10.1016/j.jbmt.2012.07.003
43. Stanghelle B, Bentzen H, Giangregorio L, Pripp AH, Bergland A. Effect of a resistance and balance exercise programme for women with osteoporosis and vertebral fracture: study protocol for a randomized controlled trial. *BMC Musculoskelet Disord.* 2018;19(1):100. doi:10.1186/s12891-018-2021-y
44. Stanghelle B, Bentzen H, Giangregorio L, Pripp AH, Skelton DA, Bergland A. Effects of a resistance and balance exercise programme on physical fitness, health-related quality of life and fear of falling in older women with osteoporosis and vertebral fracture: a randomized controlled trial. *Osteoporos Int.* 2020;31(6):1069-1078. doi:10.1007/s00198-019-05256-4
45. Bergland A, Thorsen H, Kåresen R. Effect of exercise on mobility, balance, and health-related quality of life in osteoporotic women with a history of vertebral fracture: a randomized, controlled trial. *Osteoporos Int.* 2011;22(6):1863-1871. doi:10.1007/s00198-010-1435-7
46. Schröder G, Knauerhase A, Kundt G, Schober HC. Effects of physical therapy on quality of life in osteoporosis patients-a randomized clinical trial. *Health Qual Life Outcomes.* 2012;10:101. doi:10.1186/1477-7525-10-101
47. Angin E, Erden Z. The effect of group exercise on postmenopausal osteoporosis and osteopenia. *Acta Orthop Traumatol Turc.* 2009;43(4): 343-350. doi:10.3944/AOTT.2009.343
48. Oksuz S, Unal E. The effect of the clinical pilates exercises on kinesiphobia and other symptoms related to osteoporosis: randomised controlled trial. *Complement Ther Clin Pract.* 2017;26:68-72. doi:10.1016/j.ctcp.2016.12.001
49. Angin E, Erden Z, Can F. The effects of clinical pilates exercises on bone mineral density, physical performance and quality of life of women with postmenopausal osteoporosis. *J Back Musculoskelet Rehabil.* 2015;28(4): 849-858. doi:10.3233/BMR-150604