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# Disease-related factors associated with exercise adherence in postmenopausal women with osteoporosis

**Salvador Israel Macías-Hernández**[1], **Florentina Loya-García**[2], **Rafael Zepeda-Mora**[1], **Tania Inés Nava-Bringas**[1], **Juan Daniel Morones-Alba**[2]

*[1]Department of Orthopedic Rehabilitation, Instituto Nacional de Rehabilitación Luis Guillermo Ibarra Ibarra, Mexico City, Mexico; [2]Postgraduate Division, Instituto Nacional de Rehabilitación Luis Guillermo Ibarra Ibarra, Mexico City, Mexico*

**Abstract**

**Objectives**: Exercise is the most widely-used intervention for reducing bone loss and the incidence of falls and fractures in osteoporosis patients. However, disease-related changes can alter these patients' adherence to exercise programs. This study attempted to describe the factors influencing exercise adherence in a group of postmenopausal women with osteoporosis. **Methods**: We conducted a retrospective cohort of postmenopausal women with osteoporosis. We collected data from each patient's last clinical evaluation, as well as from their clinical file of the previous year. **Results**: A total of 288 women were included in the study, with an average age of 69.45 (Standard deviation ± 9.2 years). Around a quarter, 76 (26.3%), of the patients did not adhere to exercise, 91 (31.5%) did partially, and 121 (41.9%) did completely. In univariate analysis, the variables significantly associated with exercise adherence were age, height, spine pain intensity, joint pain, and prevalent fracture. In a logistic regression model, pharmacological treatment for osteoporosis and polypharmacy were associated with exercise adherence, while poor balance and hyperkyphosis were associated with non-adherence. **Conclusion**: Pharmacological treatment, polypharmacy, poor balance, and hyperkyphosis all appear to be associated with exercise adherence. As these findings are the significant predictors of exercise engagement, it is necessary to explore balance and postural changes and emphasize the importance of postural and balance training prescription in this group of patients.

**Keywords:** Exercise, Osteoporosis, Postmenopausal, Postural balance, Therapeutic adherence



## Introduction

Osteoporosis is the most common systemic metabolic bone disease, and is characterized by a decrease in bone mass and a micro-architectural change in bone tissue, with an increase in bone fragility and susceptibility to a fracture[1]. Postmenopausal and older women are more vulnerable to osteoporosis because they possess major risk factors for bone loss, such as age and estrogen depletion[2]. Exercise is a widely accepted intervention to both reduce bone loss and the incidence of falls and fractures. Therefore, any exercise program for patients with osteoporosis must be designed to prevent fractures and reduce known risk factors for falls by improving posture, muscle strength, balance, and gait stability[3-5].

It is challenging for clinicians to ensure that their patients adhere to prescribed exercise programs, as myriad factors can either serve as barriers or inhibitors to exercise adherence. The characteristics and physical condition of the osteoporosis patients should be contemplated when addressing exercise adherence in this patient population[6]. Patients with osteoporosis may experience postural and biomechanical modifications, decreased height of the vertebral bodies, increased thoracic kyphosis (hyperkyphosis), changes in lumbar lordosis, and/or

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***Corresponding author:*** *Salvador Israel Macías-Hernández, Av. México-Xochimilco 289, Col. Arenal de Guadalupe, Tlalpan, Z.C.14389, Mexico City, Mexico*

***E-mail:*** *drisraelmacias@gmail.com*

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muscular weakness[7,8]. The disease also produces fractures that can be related to possible modifications in exercise capacity, deformities, residual pain, and other sequelae. Osteoporosis associated with hyperkyphosis affects postural stability in the anteroposterior direction, and the velocity of the center of posture displacement in the mediolateral plane[9]. Kyphotic posture can cause anterior displacement of the center of mass, related to the rise in the risk of falls and postural instability[10]. Balance disorders have been described in several reviews as a predictor for falls and fractures[11,12]. Exercise has been demonstrated to improve posture disturbances, balance, and muscular strength, which are all positively associated with postural control in the elderly[13].

Identifying patterns in osteoporosis patients who adhere - or not - to their prescribed exercise programs could provide a base for designing future interventions. Ensuring that this patient group has the tools to carry out recommended exercise programs is no trivial matter: postmenopausal women with osteoporosis are at a high risk of fractures from falls, and exercise adherence is directly related to the physical function and fall prevention. However, as clinicians, we still do not completely understand what intrinsic patient characteristics can affect exercise adherence. This study, therefore, aimed to describe the factors influencing exercise adherence in a group of postmenopausal women with osteoporosis.

## Materials and methods

### *Participants*

A retrospective cohort was conducted including a convenience sample of patients from the Osteoporosis Clinic of the "Luis Guillermo Ibarra Ibarra" National Rehabilitation Institute in Mexico City, one of Mexico's National Institutes of Health. The study protocol was registered in the Institutional Research and Ethics Committee with the number 72/17. The authors conducted this research in line with the ethical responsibilities established by the World Medical Association's Declaration of Helsinki, and all participants signed informed consent prior to their inclusion in the study. All patients who attended the clinic during 2018 were invited to participate in the study, and all who fulfilled the criteria and consented were included in the sample.

We included postmenopausal women older than 50 years of age with a diagnosis of osteoporosis. The diagnosis was established through a dual-energy X-ray absorptiometry (DXA) of the femoral neck (hip) and/or lumbar spine based on a T score of ≤-2.5 Standard deviation (SD); performed at least one year before the patient's last clinical evaluation. All DXA studies were performed in our facility by a single certified technician. All interpretations were performed by a Certified Clinical Densitometrist, following the International Society of Clinical Densitometry (ISCD) recommendations, making the studies technically reliable for the diagnosis[14]. In order to be eligible for the study, all potential participants should have been admitted to the hospital for the diagnosis of osteoporosis. To rule out suspected secondary osteoporosis, all patients were required to have a Z score of ≥-2.0 SD. All patients also had to have a complete medical record, including at least a 1-year follow-up.

We excluded patients with a bilateral hysterectomy and/or oophorectomy, as their date of menopause onset could not be determined. We also excluded patients who could not perform exercise due to a health condition or a disability, and those patients with a non-evaluable DXA (more than two fractured vertebrae from L1-L4 or both hips fractured).

### *Procedures*

The data were collected by directly evaluating the patients (during their last consultation) and through the clinical records of the patients' medical evaluations of the previous year. During the consultation, we invited patients who fulfilled the inclusion criteria to participate in the study; all of these completed an interview to collect data and a physical examination, included signing informed consent. Each patient's chart was consulted following the interview, and, if complete, she was included in the study.

The clinical evaluations conducted at the Osteoporosis Clinic included the routine standardized clinical and physical examinations performed on all patients. These examinations, including a complete clinical musculoskeletal evaluation, are always performed by a physical medicine and rehabilitation specialist trained in osteoporosis management. After performing the evaluation, the clinician records the findings in the patient chart; at this point, the findings are used to define the treatment plan, including exercise, if applicable.

As a part of the standardized care protocol, posterior-anterior spine and lateral panoramic X-ray projections were ordered for all patients and carried out in the same hospital. The patients receive pharmacological treatment and are instructed to take calcium and vitamin D supplements, if necessary. We also recommend that they follow a calcium-rich diet and engage in responsible sun exposure, as described in the Official Mexican Standard for Osteoporosis Management[15]. Patients additionally receive exercise instructions and are asked to attend talks on fall prevention and healthy posture. These interventions are all standard clinical practice in the Osteoporosis Clinic.

The exercises prescribed at the Osteoporosis Clinic are part of a program that includes 20 exercises. The exercises include postural-control, upper and lower limb, core-strengthening, and balance exercises, all of which are adapted to each patient's physical status. Patients are expected to follow this 30-to-40-min home-based exercise program daily. Patients are taught these techniques and strategies and are provided with written instructions to take home with them. Further, the patients are also provided with a list of recommended aerobic exercises, such as walking, swimming, stationary cycling, or elliptical training. Participants are asked to engage in these activities for at least 90 minutes per week, in sessions of 20-30 minutes.

| | Mean/Median ± SD (range) |
|---|---|
| **Age (years)** | 69.45 ±9.2 (50-95) |
| **Weight (kg)** | 58.37 ±9.5 (38-100) |
| **Height (m)** | 1.49 ±0.06 (1.29-1.71) |
| **BMI (kg/m²)** | 26.25± 4.1 (17.9-40.8) |
| **Spine T-score** | -2.9±0.8 (-5.2 to -0-3) |
| **Femoral neck T-score** | -2.3±0.9 (-4.9 to -0.2) |
| | **n (%)** |
| **Treatment** | |
| Oral bisphosphonate | 168 (58.3) |
| IV bisphosphonate | 35 (12.1) |
| Denosumab | 51 (17.7) |
| Other | 3 (1.0) |
| None | 31 (10.7) |
| **Polypharmacy** | 73 (25.3) |
| **Poor balance** | 225 (78.1) |
| **Hyperkyphosis** | 245 (85.1) |
| **Postural changes** | 159 (55.2) |
| **Incidence of falls** | 83 (28.8) |
| **Incidence of fractures** | 17 (5.9) |
| **Prevalent Fractures** | 97 (33.6) |
| Vertebral | 45 (46.39) |
| Distal Radius | 28 (28.57) |
| Proximal Humerus | 14 (14.43) |
| Hip | 7 (7.2) |
| Other | 3 (3.1) |

| **Body Part with Pain** | | |
|---|---|---|
| **Location** | **Frequency** | **%** |
| **Joint** | | |
| Knees | 45 | 36.8 |
| Hips | 30 | 24.6 |
| Shoulders | 15 | 12.3 |
| Hands | 8 | 6.6 |
| Ankles | 7 | 5.7 |
| Other | 17 | 13.9 |
| **Spine** | | |
| Lumbar | 95 | 67.3 |
| Dorso-lumbar | 23 | 16.3 |
| Cervical | 10 | 7.1 |
| Dorsal | 4 | 2.8 |
| All | 9 | 6.3 |
| **Other site** | | |
| Thigh | 10 | 31 |
| Arm | 9 | 28 |
| Forearm | 8 | 25 |
| Other | 5 | 16 |

**Table 1.** Demographics and general sample characteristics.

### *Clinical data*

The variables collected as part of this study included the patient's age, weight, height, and other clinical and disease variables described here briefly and in detail in the following paragraph. The first group of variables dealt with fractures and included the presence of a previous fragility fracture (defined as a fracture in adulthood caused by a low impact), site of the previous (denominated "prevalent") fracture, new fracture in the last year (or "incident" fracture), and the part of the body where the fracture(s) occurred. Pharmacological variables included information on pharmacological treatment for osteoporosis and polypharmacy (consumption of more than five drugs). Falls and balance variables included patient history of falls in the last year (incident falls), postural changes, and balance. Pain variables included the presence of chronic pain, pain location (joint, spine, or other), pain location by region, and pain intensity. Physiological variables were the last available T score of the lumbar spine and femoral neck (hip), and the presence of hyperkyphosis. Finally, exercise was measured as performing exercise during the last year (both exercises prescribed at the clinic and any additional aerobic exercises).

All variables dealing with pain were collected in reference to the 12 months prior to the patient's appointment. Pain was considered chronic if it occurred continuously or intermittently for at least three months in the previous year. The patient was asked to rate her pain verbally on a numerical pain scale - ranging from 0-10 points - at her last clinical assessment, and at each consultation. The patient's balance was assessed using the monopodial test for both legs. Balance was classified as either null or deficient if the test was not performed at all or if it was tolerated for fewer than 5 seconds and adequate if tolerated for longer than 5 seconds. Patient posture was assessed using direct clinical visualization, in which postural asymmetries, spinal alignment, and increases or decreases in dorsal kyphosis and lumbar lordosis were described. Posture was reported as altered in cases in which at least one of the previously defined characteristics was present. Evident dorsal hyperkyphosis was reported as a separate variable.

| | Exercise No | Exercise Yes | Mean differences (95% CI) | *P* |
|---|---|---|---|---|
| Age | 70.9 ±10.18 | 68.26±8.56 | 2.68 (0.02-5.34) | 0.048[a] |
| Weight | 58.24±9.22 | 59.2 ±9.21 | -0.97 (-3.68-1.3) | 0.47 |
| Height | 1.48±0.07 | 1.51±0.06 | -0.024 (-0.01-0.04) | 0.01[a] |
| Joint pain intensity | 5.25±2.05 | 4.23±1.85 | 0.56 (-0.46-1.5) | 0.148 |
| Spine pain intensity | 5.14±1.3 | 4.41±1.5 | 0.72 (-0.046-1.4) | 0.037[a] |
| Spine T score | -3.11±0.85 | -2.85±0.81 | -0.26(-.05—0.017) | 0.036[a] |
| Hip T score | -2.44±0.97 | -2.18±0.80 | -0.26(-.051—0.011) | 0.041[a] |
| **Pain** | **Exercise No** | | **Exercise Yes** | **P value (Chi-Squared Test)** |
| Joint | 31 | | 55 | 0.023[a] |
| Spine | 42 | | 58 | 0.424 |
| Other site | 10 | | 7 | 0.287 |
| | **Chi-squared Value** | | **OR (95% CI)** [b] | ***P*** |
| Joint pain | 0.03 | | 0.994 (0.79-1.24) | 0.538 |
| Spine pain | 0.11 | | 1.043 (0.82-1.31) | 0.424 |
| Other area pain | 0.70 | | 1.22 (0.71-2.09) | 0.287 |
| Prevalent Fractures | 3.4 | | 1.26 (0.96-1.63) | 0.046[a] |
| Pharmacologic treatment | 19.00 | | 0.311 (0.14-0.68) | <0.001[a] |
| Hyperkyphosis | 0.068 | | 0.960 (0.70-1.31) | 0.071 |
| Poor Balance | 7.76 | | 1.703 (1.20-2.4) | 0.005 [a] |
| Postural changes | 0.083 | | 1.02 (0.84-1.12) | 0.811 |
| Falls | 10.18 | | 1.56 (1.13-2.15) | 0.001[a] |

*[a] Statistically Significant. [b] Interval calculated for the* ***no-exercise*** *risk.*

**Table 2.** Association between exercise adherence (completely or none) and demographic and clinical variables.

### *Statistical analysis*

Descriptive statistics were used to summarize the data, and means and standard deviations (SD) or median and interquartile ranges (IQR) were employed as measurements of central tendency and dispersion. Frequency is represented as percentages. Data distribution was assessed for normality utilizing Kolmogorov-Smirnov tests. To assess associations between variables, we used a chi-squared test and a Student's t-test, and calculated odds ratios (OR) as a risk measurement, when appropriate. The outcome variable was exercise adherence. Several logistic multivariate regression models were performed utilizing exercise adherence as the dependent variable. The variables included to test the model were those with a p-value <0.1 in the univariate analysis. The alpha value was set at <0.05, and confidence intervals at 95% (95% CI) were also calculated. We used the SPSS V. 24 statistical software package (IBM Corporation, Armonk, NY, USA).

## Results

We recruited a sample of 288 patients for this study; their characteristics are summarized in Table 1. Overall, 17 incident fractures were reported in our sample: 9 were vertebral, 3 were of the hip, 3 were of the distal radius, and 2 were of the proximal humerus. We found that 76 (26.3%) of the patients did not engage in the exercises prescribed by the clinic, 91 (31.5%) did so partially (fewer than three times per week), while 121 (41.9%) performed them completely (at least three times a week). Regarding aerobic exercise, 124 (43%) engaged in at least 90 min of activity per week. We analyzed the associations of several variables in patients who performed the exercises prescribed (completely, *n*=121) and those who did not (*n*=91). The results of this analysis are presented in Table 2.

Of all the patients in this study, 243 (84.3%) had reported chronic musculoskeletal pain in at least one area during the previous year, and 122 (42%) had reported joint pain with a mean intensity of 4.56±1.8 points. Further,

| Type of Osteoporosis | Post-Menopausal n=108 | Senile n=180 | *P*-value |
|---|---|---|---|
| | Mean/Median ± SD | Mean/Median ± SD | |
| Age (years) | 60.11 ±3.67 | 75.06±6.60 | <0.001[a] |
| Weight (kg) | 60.78 ±9.64 | 57.58 ±9.30 | 0.007[a] |
| Height (m) | 1.51 ±0.05 | 1.48 ±0.07 | 0.001[a] |
| BMI (kg/m$^2$) | 26.26± 4.6 | 25.14±3.61 | 0.063 |
| Spine T-score | -3.04±0.58 | -2.94±0.91 | 0.289 |
| Femoral neck T-score | -1.85±0.77 | -2.56±0.80 | 0.001[a] |
| Joint Pain Intensity | 4.2±1.7 | 4.77±1.9 | 0.469 |
| Spine Pain Intensity | 4.17±1.38 | 4.71±1.85 | 0.140 |
| Other site Intensity | 5.64±1.72 | 6.12±1.82 | 0.123 |
| | n (%) | | |
| Polypharmacy | 18 (16.6) | 55 (30.5) | 0.006[a] |
| Poor balance | 71 (65.74) | 154 (85.5) | 0.001[a] |
| Hyperkyphosis | 79 (73.14) | 162 (90.0) | 0.001[a] |
| Postural changes | 39 (36.11) | 120(65.93) | 0.001[a] |
| Incidence of falls | 29 (26.8) | 54 (30.0) | 0.333 |
| Incidence of fractures | 7 (6.4) | 10 (5.55) | 0.223 |
| Prevalent fractures | 23 (21.29) | 74 (41.11) | 0.004[a] |
| Exercise | 50 (46.29) | 71 (39.44) | 0.155 |

[a] *Statistically significant.*

**Table 3.** Differences between postmenopausal osteoporosis and senile osteoporosis.

141 (48.9%) patients had chronic spine pain with a mean intensity of 4.59±1.58, while 32 (11%) reported pain in another area with an average intensity of 6.27±2.1. We performed a sub-group analysis to compare patients with postmenopausal osteoporosis (<65 years) against those with senile osteoporosis (>65 years); the results are presented in Table 3.

### *Multivariate analysis*

A logistic regression model was conducted to determine which factors could influence exercise adherence. We included variables that, in the univariate analysis, presented a *p*-value of <0.1. Overall, several models were run considering the Wald statistical test to determine whether a variable should be included in the model or not. We considered a prevalent fracture to be a confounding variable and included it in the equation. Finally, a Bayesian information criterion analysis was performed to select the model of best fit. The results are presented in Table 4.

## Discussion

Our patients were similar to postmenopausal women with osteoporosis previously reported in other studies in terms of their epidemiological characteristics[16]. The average age of the patients in our group was 69.45 years, meaning a population composed of older adults. Our patients' mean hight (1.49 m) was notably lower than the mean height of adult Mexican women (1.55 m); this could be related to height loss associated with osteoporosis resulting from hyperkyphosis, vertebral fractures, or postural imbalance[17].

The high prevalence of poor balance (78%), hyperkyphosis (85%), and postural changes (55%) in our population is striking. Hyperkyphosis has been described to affect 20-40% of the elderly[18], much lower than the proportion of hyperkyphosis found in this study. Hyperkyphosis, even independent of vertebral fractures, can have a significant impact on postural changes, as previously described[19].

Many clinical guidelines have described the importance of exercise in osteoporosis treatment, although those with osteoporosis often do not exercise[20]. In our study, about 60% of patients did not adhere, or adhered poorly to, prescribed and aerobic exercises, in line with previous reports. One variable associated with exercise adherence was age, in that the mean age of those performing exercise was significantly lower than that of those who did not (mean differences of 2.6 years, $p$=0.048). Height was also significantly associated with exercise adherence (mean difference 2.4 cm, $p$=0.001),

| Variables included | OR | Significance [a] | 95% CI | |
|---|---|---|---|---|
| | | | Inferior | Superior |
| Pharmacological treatment | 6.268 | 0.006 | 1.686 | 23.300 |
| Hyperkyphosis | 0.308 | 0.033 | 0.104 | 0.910 |
| Poor balance | 0.314 | 0.003 | 0.221 | 0.672 |
| Pain (all sites) | 0.469 | 0.248 | 0.130 | 1.697 |
| Polypharmacy | 2.174 | 0.031 | 1.075 | 4.395 |
| Spine T-score | 1.427 | 0.067 | 0.976 | 2.088 |
| Constant | 0.273 | 0.119 | | |

*Logistic regression model for predicting* ***exercise adherence****. a = Wald statistical test. Note: The pain variable was included in the model because it was the variable of interest for the study. The spine T-score remained in the model because the model was a better fit with its inclusion than with its elimination.*

**Table 4.** Logistic regression model for exercise adherence.

meaning that the average height of patients who performed less exercise was lower. However, these findings were not replicated in the multivariate analysis.

Other variables associated with exercise adherence in the univariate analysis were spine pain intensity. Spine pain was significantly more intense in those patients not exercising, although this finding was also not replicated in multivariate analysis. Similarly, spine and hip T scores were significantly lower in those patients who did not adhere to exercise, albeit not significantly in the multivariate analysis. To our knowledge, this finding has not been previously described in other studies. We cannot find any biological explanation and believe that it could be related to other variables, such as the presence of fractures. A prevalent fracture was significantly associated with no exercise adherence, which is logical as it could be related to musculoskeletal sequels; however, this was considered a confounding variable in the multivariate analysis.

The frequency of musculoskeletal pain in this patient group was high (84% in at least one part of the body). Our patient group reported pain above the typical levels reported in the general population above the age of 65 and without osteoporosis. In the United States, the prevalence of pain of any type and site was 52.9% in the general population without osteoporosis[21]. In our study, the most frequent site of pain was the spine, especially in the lumbar and dorso-lumbar regions. Joint pain was most frequent in knees, hips, and shoulders.

Patients with joint pain were found - in the univariate analysis - to perform significantly less exercise, revealing the importance of this symptom in patient decisions to exercise or not. This joint pain could be mainly related to other pathologies such as osteoarthritis, which underscores the need to individualize exercise prescriptions, taking into account the sites of pain to avoid positions or instructions that cause pain. The impact of joint pain on exercise adherence also sheds light on the importance of detailed musculoskeletal questioning and physical exploration in osteoporosis patients[9]. However, as this association did not hold in the multivariate analysis, the finding must be interpreted with caution.

We found that poor balance was strongly associated with the risk of not engaging in exercise; this association could be explained by a combination of poor balance accompanied by insecurity in terms of doing the exercise. Poor balance could even cause a fear of falling[21]. Poor balance was significant in the logistic regression and was therefore incorporated as a predictor in the logistic regression model. Therefore, it is crucial to encourage all patients with poor balance to engage with their exercise plans, so that their balance can be improved and the further risk of falling can be diminished[23]. This finding is a significant predictor of exercise adherence, so it is necessary to explore balance and to emphasize the necessity of balance training prescription in this group of patients.

Hyperkyphosis was also found to predict exercise adherence, which could be related to its role in limiting trunk and spine mobility. Hyperkyphosis can also cause postural instability, mainly in the frontal plane, which affects general balance, and complicates exercise[24]. This finding is, therefore, of relevance and must be taken into account in the exercise prescription. Pharmacologic treatment for osteoporosis and polypharmacy resulted as a protective factor against exercise non-adherence. That is, those who had a pharmacologic treatment or polypharmacy were more likely to exercise. To our knowledge, this finding has not been previously reported, and it could be related to other factors, such as the patient's perception of a worse level of osteoporosis or the patient's predisposition to adhere to the whole program. This finding was also significant in the multivariate analysis, and as we previously stated, should be corroborated in future research.

Our patient group adhered partially to their prescribed exercise program, certainly less than at recommended levels. When we analyzed the three groups separately, we did not find differences related to pain frequency or intensity among the groups. Thus, the main difference was found when we compared the groups of total or no adherence. We can conclude that hyperkyphotic posture and balance are predictors for exercise adherence in patients with osteoporosis.

As a descriptive and retrospective study design with data from existing patient charts, the causal relationships described here must be corroborated by a more robust design. This design could involve a longitudinal cohort and with a larger sample to ensure the associations are valid and replicable. Future research efforts could also endeavor to exclude patients with prevalent fractures from their samples, to attempt to widen their recruitment pool (thereby avoiding selection bias), and to use more quantitative methods to describe balance or kyphosis. However, we believe that this study, as an initial approach to the issue, presents useful hypotheses to guide future projects.

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