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Improvement of the quality of life and the physical activity status in women with osteoporosis and osteopenia following physical activity intervention program

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Abstract: Background. Osteoporosis is characterized by low bone density, affecting predominantly women, especially after menopause, and it is associated with a decrease in the quality of life. It is a known fact that a low level of physical activity represents a substantial risk for osteoporosis. **Purpose**. The purpose of the survey is to compare the health-related quality of life (HRQoL) of patients with osteoporosis and osteopenia before and after a physical exercise intervention**. Material and method**. A prospective descriptive survey on 70 women with osteoporosis and osteopenia was carried out between April 2021 and February 2023 in the ambulatory of the Clinical Emergency Hospital "Prof. Dr. Agrippa Ionescu", Bucharest, Romania. Data are collected using medical documents (sociodemographic and anthropometric data, comorbidities, bone density level, osteoporosis treatment, etc), the Interna-tional Physical Activity Questionnaire (IPAQ) (physical activity level), and the Romanian version of the SF-36 (health-related quality of life). **Results.** The study included 70 female patients with osteoporosis (41.4%) and osteopenia (58.6%). All of the SF-36 doma-ins and the summary scales (physical and mental component scores) revealed significantly (except Social Functioning, p=0.158) higher mean values postinterventional than the baseline mean scores. The most remarkable improvements were observed in the following domains: Role limitation due to physical problems (18.5; p=0.003), Role limitation due to emotional problems (14.7; p=0.018), and General health (14.0; p<0.001). **Conclusions.** All dimensions of quality of life were significant improved after the exercise intervention program in the patients with osteoporosis and osteopenia.

Keywords: physical activity intervention program, osteoporosis, quality of life

Introduction

Quality of life, defined as a complete state of both mental and physical health, with adequate social and personal functioning, good perception of one's own health, high life satisfaction, and general well-being [1], is influenced by a series of factors, among them an important role plays the existence of chronic physical disease, as osteoporosis. [2]

Osteoporosis is a systemic skeletal disease characterized by low bone density and structural deterioration of bone tissue, leading to an increased risk of fractures. It represents an important public health issue. In Europe, the estimated prevalence of osteoporosis is 22.1% in women and 6.6% in men over 50 years old. [3,4] The disease predominantly affects women, especially after menopause, when a massive loss of bone mass is associated to estrogen-related depletion. [5]

Because most cases have no clinical signs before fracture, a large share of patients are not being diagnosed in time to receive adequate pharmacological and non-pharmacological interventions in early phases to prevent the occurrence of disability and consecutive fractures.

Fractures, especially hip and vertebral fractures, but also lumbar and low back pain, and kyphosis, frequently presenting in the life of patients with (severe) osteoporosis, have an impact on daily activities and normal professional and social activities, significantly and progressively influencing patients' quality of life. [6-8]

In Romania, osteoporosis is a growing public health concern, with a 4.8% estimated prevalence, lower than EU level. In 2019 approximately 1,071,000 individuals were estimated to be affected by this silent disease, the third in the hierarchy of prevalent diseases after hypertension and ischemic disease. [9,10]

But, as the population projections for population over 50 are expected to grow by 6.4% between 2019 and 2034, the magnitude of the affected people and the associated health effects are expected to rise. The average treatment gap in Romania is estimated at 71%. [11]

In response to those facts, a series of comprehensive, updated international guidelines were elaborated and contributed to the developement management strategies for the prevention and treatment of osteoporosis fragility fractures. The European guidelines for the prevention and treatment of osteoporosis, as part of the multimodal intervention for disease management, includes a recommendation for regular physical exercise. [12] At present, the national specific programs were developed and they focus on the early detection and on the integrated intervention both on treatment and lifestyle factors modification, including physiotherapy and physical exercises. Consequently, osteoporosis has become a preventable and treatable disease, and it is no longer considered an inevitable consequence of aging. [13]

According with the recent evidence, the exercises and physical activity improve the bone formation and decrease the bone resorption biomarkers in the osteoporotic patients. [14] Also, studies are confirming weighed-vest aerobic effectiveness for improving balance, resistance training, and weight-bearing exercises usefulness for reducing the fracture risk. On the other hand, aerobic exercises have significant benefits on metabolism and on the cardiovascular system. They can help to achieve beneficial and significant effects on functional mobility and quality of life (including mental health domains). [15] On the opposite side, a low level of physical activity (PA) increase the risk of developing osteoporosis by reducing the mechanical stimulation of osteoblasts.

Based on the evidence, PA should be part of the comprehensive management of osteoporosis. In osteoporotic patients, exercices and physical activity can reduce disability and improve physical function. By increasing the physical capacity, the risk of subsequent falls decreases and the bone structure is improved. As a consequence, the fracture risk decreases. [16,17]

However, the evidence did not establish an optimal exercise training for osteoporotic patients, but there is growing evidence supporting a combined program that includes different types of exercise and different degrees of frequency and intensity of training. [18,19]

In the literature, the evaluation of quality of life in osteoporotic patients represents a topic of interest. Worldwide, there are numerous studies about the effect of exercises and physical activity on the osteoporotic patients. Previous studies investigated the relationship between physical activity and the prevention of osteoporosis, the effects of exercices on the limitation of osteoporosis complications, and the effect of physical activity

on health-related quality of life in osteoporotic and osteopenic patients, and most were not specifically focused on the impact of physical activity on health-related quality of life in osteoporotic and osteopenic patients.

To our knowledge, there is only one study regarding the quality of life assessment in Romanian osteoporotic patients; the researchers evaluated the burden of osteoporosis in Romanian postmenopausal women and they compared the quality of life between osteoporotic women and controls and between the osteoportic women with and without fragility fractures. [20]

The objective of the present study was to evaluate the quality of life of patients with osteoporosis and osteopenia using a general Quality of life Questionnaire, Short form 36 (SF-36), before and after a supervised physical intervention.

2. Materials and Methods

A prospective descriptive study was performed during April 2021 and February 2023 in an ambulatory /outpatient physical exercise setting of the Clinical Emergency Hospital Prof Dr. Agrippa Ionescu from Bucharest. This study presents one centre's experience

At baseline, we collected data about all participants, including sociodemographic and anthropometric data, comorbidities, bone density level, osteoporosis treatment, etc). They completed the International Physical Activity Questionnaire (IPAQ) to assess the physical activity level before and after the diagnosis of osteoporosis or osteopenia.

All patients were diagnosed with osteoporosis and osteopenia by bone densitometry. The procedure used measured the bone density of the bones of the spine, total hip, and femoral neck. The bone mineral density (BMD) was compared for each measurement (spinal, total hip, femoral neck) with healthy young adults, and the T-score was calculated. Osteoporosis was indicated by a T-score lower than -2.5 SD and osteopenia by a T-score between -1 and -2.5 SD. [21]

The bone density was measured using a Lunar Prodigy Advance DXA System analysis version 13.20.

Participants

All patients were women, selected based on medical records and recommendations for physical exercise from the specialty doctors, at one centre of physical rehabilitation.

We selected all the women with osteoporosis or osteopenia who had recommendations for physical exercise and who performed the described intervention in our ambulatory supervised by a physiotherapist. Among the 78 patients initially selected for the study, only 70 followed the two-step exercise program wholly.

Exclusion criteria were: vertebral fractures, severe cardiovascular diseases, secondary causes of bone loss (hyperparathyroidism, untreated long-term hyperthyroidism, anticonvulsant therapy usage, hypogonadism, rheumatoid arthritis, antiestrogenic treatment, prolonged corticosteroid medication use, Cushing syndromes), neoplasms and resting heart rate>100 beats/min.

Intervention

The physical intervention consisted of a set of 10 successive treatment sessions under the supervision of the physiotherapist. Exercises included a systematic cardiovascular and neuromuscular warming up, increasing the movement amplitude, increased strength and muscle endurance, and stretching.

The treatment plan was divided into two parts, with a 6-month interval.

The duration of a treatment session was 45-65 minutes, gradually increasing the time from one session to the next, depending on each patient's endurance.

The intensity of the exercises and the number of repetitions was adapted to the health status and comorbidities of each patient.

After completing the first part of the treatment, each patient was instructed to perform the learned program at home for 6 months.

The patients will perform the exercises once a day, 3-4 times a week. The rest of the weekdays, they will walk at a distance and pace that will gradually increase.

Then, the patients will present themselves for the second part of the recovery program.

In the second part of the program, the patients changed the type of exercises and used heavier weights, keeping the same objectives of increasing mobility, correcting posture, increasing muscle strength and endurance, correct breathing exercises, eliminating stress, improving sleep, and increasing well-being.

Outcomes measurements

Outcomes measurements were obtained at baseline and after the physical exercise intervention.

The health–related quality of life was measured using the Short Form-36 questionnaire (SF-36). All patients were asked to complete the validated Romanian version of the SF-36. The SF 36 was selected due to its robustness, complexity, and appropriate internal consistency, as demonstrated by recent studies. [22] The self-administrated SF-36 questionnaire includes 36 standardized items evaluating the generic health status. [23] The SF-36 evaluates 8 health domains: physical functioning (PF); role limitations due to physical problems (RP); bodily pain (BP); general health perception (GH);(PF, RP, BP and GH are domains of the – Physical Component Summary – PCS), vitality (VT); social functioning (SF); role limitation due to emotional problems (RE); mental health (MH) (RE, VT, MH and SF are domains of the Mental Component Summary - MCS. [24]

Each of the eight dimensions of the questionnaire, the items are codified, aggregated and transformed into the scale from zero (worst health status) to 100 (best health status). [25]

Before and after the intervention, all the patients completed the Romanian version of the SF-36 questionnaire.

The physical activity status was assessed using the IPAQ questionnaire. [26]

Statistical analysis.

The quantitative variables were presented as absolute and relative frequencies. The quantitative variables were tested for normality of distribution and were presented as mean and standard deviations. Because the quality of life scores had a normal distribution, the paired t-test was used. The paired T-test was used to compare the means and standard deviations of health-related quality of life scores and to determine if there is a significant difference between before and after intervention scores. When the p-value was lower than 0.05, the corresponding differences were considered significant. Statistical analysis was performed using the software IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY, USA: IBM Corp.

Ethics committee approval

The study was approved by the Ethics Committee of the Clinical Emergency Hospital Prof. Dr. Agrippa Ionescu, Bucharest (approval no. 28892/27.01.2021). All participants were informed about the purpose and characteristics of the survey. An informed consent form was prepared following the Declaration of Helsinki. All of the participants gave signed informed consent before inclusion in the study.

3. Results

The demographic and clinical characteristics of the study population are summarized in Table 1.

The study included 70 female patients with osteoporosis (41.4%) and osteopenia (58.6%) based on bone mineral density. The lowest bone mass density was found at the femoral neck level (0.8±0.1) and the lowest T-score at the spinal level (-2.1±0.7).

The age of the respondents ranged from 45 to 65 years old (58.4±5.1 years) and 17.1% of the patients reported early menopause (<46 years old).

According to the BMI, most of the participants were overweight (38.6%) and 14.3% were obese. 11 participants (15.7%) were smokers. 19 patients (27.1) were in evidence with high blood pressure and 3 (4.3%) with type 2 diabetes.

Regarding the physical activity characteristics, in the past 18.6% of the participants were inactive sedentary, they did not practice any kind of physical activity. At the time of the assessment, 22.9% were sedentary.

Only 49 patients (41.4%) were receiving specific osteoporosis treatment. The most common specific osteoporosis treatments mentioned were bisphosphonates (22 patients, 31.4%) and denosumab (7 patients, 10.0%). Also, vitamin D and calcium supplementation were recommended. Vitamin D was used by 65 patients (92.9%) and calcium by 20 patients (28.6%).

Table 1. Patient's demographic and clinical characteristics at baseline

Characteristic	N=70
Age (years, M±SD*)	58.4±5.1
BMI (Body Mass Index) N (%)	
≤24.9 kg/m² (normoponderal)	33 (47.1)
25.0-29.9 kg/m² (overweight)	27 (38.6)
≥30 kg/m² (obese)	10 (14.3)
Premature and early menopause N (%)	12 (17.1)
Diagnostic N (%)	
Osteoporosis	29 (41.4)
Osteopenia	41 (58.6)
Bone density (M±SD*)	
- Spine - T score	-2.1±0.7
- Spine - BMD	0.9±0.1
- Hip - T score	-1.1±0.8
- Hip - BMD	0.9±0.1
- Femoral neck - T score	-1.5±0.6
- Femoral neck - BMD	0.8±0.1
Physical activity status N (%)	
- sedentary in the present	16 (22.9)
- sedentary in the past	13 (18.6)
Osteoporosis treatment N (%)	
Drug treatment	29 (41.4)
Vitamin D	65 (92.9)
Calcium	20 (28.6)
Smoking N (%)	11 (15.7)
Comorbidities N (%)	
High blood pressure	19 (27.1)
Type 2 diabetes	3 (4.3)

*M±SD = mean±standard deviation

Pre- and post-intervention SF- 36 scores are shown in Table 2. The modification of quality of life scores are presented in Graph 1.

Physical functioning (PF). The physical function includes daily living activities, household activities, and general mobility. The baseline PF score (63.1±22.6)was one of the highest before the exercise program. The PF improved to 70.9±21.1 after the intervention, with + 7.8±30. 7, which was statistically significant (p=0.039).

Role limitations due to physical problems (RP). Difficulties with daily regular activities at home or work, as reduced amount of time dedicated, accomplished less or extra effort for some activities, related to physical condition was the most affected component before the intervention, with a score was 43.6±41.2. After the intervention, the score registered the most remarkable improvement (+18.5±57.1) and reached 62.1±39.4, statistically significant higher than the score before the intervention (p=0.008).

Bodily pain (BP). Pain is one of the signs commonly associated with severe osteoporosis, after the occurrence of fractures. The questionnaire addresses explicitly back pain. Patients reported a baseline score of 52.9±17.6 before the exercise intervention. Pain levels reported after the intervention were reduced and the new score is 61.9±18.3, almost 10 points higher (p=0.006), confirming the effect of physical activity.

General health (GH). The perception of one's health in terms of the quality of life and individual resilience to illness (expectation of deterioration, comparison with the health of others) is one of the dimensions most affected, with a baseline score of 54.6±13.8. The post-intervention data showed an important improvement with a score of 68.6±13.4, statistically significant (p<0.001).

Global Physical Component Score (PCS). PCS was improved from 53.5±18.3 at baseline to 65.9±17.2 after the exercise intervention, with a statistically significant difference (p<0.001).

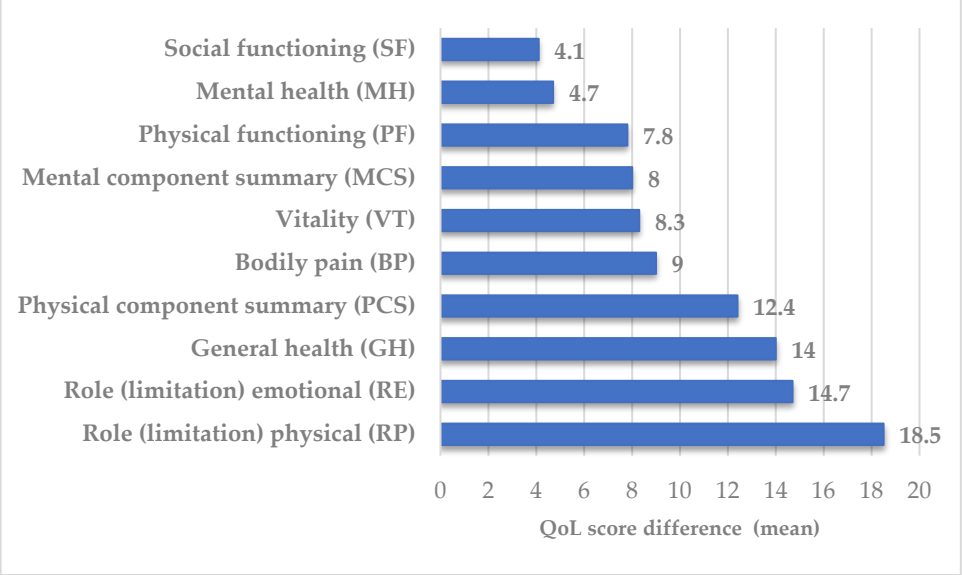
Table 2. SF 36 scores pre and post-intervention

QoL dimensions	Pre (M±SD)	Post (M±SD)	p-value
Physical functioning (PF)	63.1±22.6	70.9±21.1	0.039
Role (limitation) physical (RP)	43.6±41.2	62.1±39.4	0.008
Bodily pain (BP)	52.9±17.6	61.9±18.3	0.006
General health (GH)	54.6±13.8	68.6±13.4	<0.001
Physical component summary (PCS)	53.5±18.3	65.9±17.2	<0.001
Role (limitation) emotional (RE)	62.4±39.3	77.1±31.4	0.018
Vitality (VT)	57.4±17.6	65.7±15.3	0.001
Mental health (MH)	69.4±14.2	74.1±13.3	0.037
Social functioning (SF)	75.4±17.3	79.5±18.4	0.158
Mental component summary (MCS)	66.1±18.4	74.1±15.3	0.005

Role limitations due to physical problems (RE). The emotional state of health, including positive feelings as happiness, calmness, or negative feelings such as nervousness or bad mood was reported at the beginning of the study to be less affected, with a score of 62.4±39.3. Still, after the intervention, it increased significantly (p=0.018) to 77.1±31.4, confirming the influence of exercise on mental health.

Energy/fatigue/vitality (VT). Four items are dedicated to the vitality dimension, assessing both the fullness of energy and the tiredness and exhaustion dimensions. The patients reported a relatively low score of 57.4±17.6 at baseline. It improved significantly (p=0.001) to a higher value of 65.7±15 after the intervention.

Graph 1. Differences in SF 36 scores pre and post-intervention



Mental health (MH). Focusing on the moods and emotional states of patients, the mental function was less affected with one of the highest baseline scores, of 69.4±14.2. After the intervention, a slight improvement (+4.7±18.5), but statistically significant (p=0.037) improvement to 74.1±13.3 was reported.

Social functioning (SF). The social activities items that require interaction with others, such as visiting friends, family, etc. were reported as less affected by intervention program, with a score of 75.4±17.3. A marginal improvement (p=0.158) was also registered in this domain after the intervention, whith a score of 79.5±18.4.

Global Mental Component Score (MCS). MCS was improved from 66.1±18.4 at baseline to 74.1±15.3 after the physical activity intervention, with a statistical significant difference (p=0.005).

4. Discussions

In this study, we aimed to assess the efficacy of physical exercise on the quality of life of patients in an ambulatory setting during a mean follow-up of three years. We used the SF-36 questionnaire to evaluate the outcomes of the physical intervention.

The diagnosis of osteopenia and osteoporosis represents a milestone in the postmenopausal life of women. It is usually accompanied by pain, physical limitations, and compromised vitality but also with fear and anxiety affecting the mental health status. The low baseline scores are confirmed the physical and mental limitations determinated by osteoporosis, especially for physical function, but also for the mental health components.

The diagnosis of osteoporosis are based on the results of the Dual X ray absorptiometry for bone density. 70 women with osteoporosis and osteopenia are included in the study.

More than half of the patients are overweight or obese. It is known that a higher BMI correlates with a lower quality of life in osteoporotic patients. The results are similar to other studies, which supports the negative impact of BMI on the quality of life. [27,28]

The most frequent specific osteoporosis treatments mentioned were bisphosphonates (31.4%) and denosumab (10.0%), similar to pharmacological interventions recommended and applied in Europe, in addition to vitamin D and dietary calcium supplementation. [29,30]

The baseline scores distribution fluctuated from 43.6±41.2 for the role limitations due to physical health to 75.4±17.3 for the social functioning dimension. The lowest scores reported before the intervention correspond to the dimensions that are relevant in

osteoporosis: Role limitations due to physical problems (43.6±41.2), Bodily pain (52.9±17.6), General state of health (54.6±13.8), lack of energy (57.4±17.6). The best scores were obtained for Social functioning (75.4±17.3), Mental health (69.4±14.2), and, surprisingly, Physical functioning (63.1±22.6).

This is in line with the conclusions of studies confirming a strong relationship between bone health, general health, and Quality of life. [31]

All the scores were higher after the intervention. The most important reported effect was on the physical domain scores. The Role limitations due to physical health registered the main improvement. It rise from 43.6±41.2 before the intervention to 62.1±39.4 after the intervention. The general health also increases, significantly, from 54.6±13.8 to 68.6±13.4. The body pain was also influenced, and values were better after the intervention. The role limitation due to mental health limitations increased from 62.4±39.3 to 77.1±31.4 and vitality scores (from 57.4±17.6 to 65.7±15.3) rise the most from the mental health domains.

Overall, we found a global improvement in almost all investigated categories, with statistically significant improvement for general health, with a baseline of 54.6±13.8 and follow-up of 68.6±13.4, and vitality with a baseline of 57.4±17.6 and follow-up of 65.7±15.3.

These findings confirm the literature information on the effectiveness of regular physical exercises for osteoporosis, as part of integrated disease management interventions, is associated with reduced pain and a better quality of life for the osteoporotic patients. [32-35]

Recent evidence highlight possible exercise benefits. In osteoporotic patients, the physical activity can improve bone formation and can decrease bone resorption biomarkers. [36] Also, the studies are confirming weighed-vest aerobic effectiveness for improving balance, resistance training, and weight-bearing exercises usefulness for reducing fracture risk. On the other hand, aerobic exercises have significant effects on the metabolism and on the cardiovascular system. The physical activity can improve the functional mobility and health-related quality of life, for both physical and mental health. [37]

There are not evidence regarding an optimal exercise training for osteoporosis. A multimodal approach that includes different types of exercise and training can have greater effect. [38,39]

However, there is still no agreement regarding an optimal program (type of exercise, intensity, frequency, duration, etc.) and its effect on the bone metabolism in osteoporotic patients. [40]

The results presented in this study highlight the importance of involving the patients in daily physical activity and in systematic sessions of exercises as part of the osteoporosis management plan, in line with similar studies in the literature. [41,42]

We acknowledge a few limitations of this survey. The small number of participants represents one of the limitations. The sample size correlates with the statistical power. In this situation, the small number of patients with osteoporosis and osteopenia may decrease the statistical power of the used tests. Another limitation is the type of study. We used a descriptive study and we explored the quality of life of patients with osteoporosis at two points in time: before and after an exercise intervention. Using this type of survey, it was impossible to infer a causal relationship between physical activity and QoL. Another limitation is related to the COVID-19 pandemic. The interference of the COVID-19 pandemic, which reduced the admission to physical exercise settings, represents the main identified limitation of the study.

5. Conclusions

The baseline assessment confirmed a poor quality of life in patients with osteoporosis both in terms of physical function and mental health domains.

Patients who participated in the physical activity program reported significant improvement in their health status and quality of life. These results confirms the fact that systematic programmed exercise improves not only physical characteristics but also

psychological aspects and consequently contributes to a better perception of one's quality of life.

The planned physical activity turned the patient into a healer of his pain and limitations, which encouraged him to change his behaviors and cope with the disease. Therefore, we expect better compliance with the recommended intervention for osteoporosis.

Clinicians should consider these findings to prescribe exercices and physical activity to osteoporotic patients. Policy makers should update the public health decisions based on the literature results.

In conclusion, active participation in a physical exercise program is an endeavor that guarantees visible results both in terms of physical dimensions and mental health scores but also in the ability to cope with the disease.

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Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy.

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