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EVALUATING THE IMPACT OF A COMMUNITY BASED, PEER-LED EXERCISE PROGRAM ON THE PREVENTION OF OSTEOPOROTIC FRACTURES AMONG ELDERLY WOMEN.

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Abstract

Introduction: Osteoporotic fractures pose a significant health risk for elderly women. This study evaluated the impact of a community-based, peer-led exercise program on fracture prevention among this population.

Methods: A randomized controlled trial was conducted at Vyas Medical College and Hospital over six months. 154 women aged 65 and older with osteopenia or osteoporosis were randomly assigned to an intervention group (peer-led exercise program) or a control group (standard care). Outcomes included bone mineral density (BMD), muscle strength, balance, fall incidence, quality of life, and self-efficacy. Data were collected using DXA scans, physical performance tests, questionnaires, and fall diaries.

Results: The intervention group showed significant improvements in BMD at the lumbar spine (0.018 g/cm², $p<0.001$) and femoral neck (0.011 g/cm², $p<0.001$), while the control group showed minimal changes. Significant enhancements were observed in muscle strength and balance measures for the intervention group. Fall incidence was 48% lower in the intervention group (RR=0.52, 95% CI: 0.28-0.97, $p=0.038$). Quality of life and self-efficacy scores improved significantly in the intervention group. High program adherence was achieved, with 62.3% of participants attending ≥75% of sessions.

Conclusion: The community-based, peer-led exercise program demonstrated effectiveness in improving bone health, reducing fall risk, and enhancing quality of life among elderly women at risk of osteoporotic fractures. The high adherence rates and significant improvements across multiple outcomes suggest this approach could be a valuable addition to osteoporosis prevention strategies. Future research should focus on long-term effects and broader implementation of such programs.

Keywords: Osteoporosis, Peer-led exercise, Fracture prevention, Elderly women, Community-based intervention

Introduction:

Osteoporosis is a significant public health concern, particularly among elderly women, due to its association with increased fracture risk and subsequent morbidity and mortality. As the global population continues to age, the prevalence of osteoporosis and related fractures is expected to rise, placing an increasing burden on healthcare systems worldwide (Hernlund et al., 2013). The prevention of osteoporotic fractures has thus become a critical area of focus in geriatric medicine and public health interventions.

Exercise has been widely recognized as a key component in maintaining bone health and reducing fracture risk. Regular physical activity, particularly weight-bearing and resistance exercises, has been shown to improve bone mineral density, enhance muscle strength, and improve balance and coordination, all of which contribute to a reduced risk of falls and fractures (Kemmler et al., 2015). However, despite the known benefits of exercise, adherence to exercise programs among elderly populations remains a challenge.

Community-based, peer-led exercise programs have emerged as a promising approach to address this issue. These programs leverage the power of social support and peer influence to encourage participation and adherence to exercise regimens. By utilizing peers as exercise leaders, these interventions tap into shared experiences and create a more relatable and supportive environment for participants (Burton et al., 2017).

The effectiveness of peer-led interventions has been demonstrated in various health contexts, including diabetes management, smoking cessation, and mental health support (Simoni et al., 2011). In the context of osteoporosis prevention, peer-led programs have shown potential in improving knowledge about the condition and promoting healthy behaviors (Chan et al., 2018). However, the specific impact of these programs on fracture prevention among elderly women remains an area requiring further investigation.

This study aims to evaluate the impact of a community-based, peer-led exercise program on the prevention of osteoporotic fractures among elderly women. By assessing various outcome measures, including bone mineral density, muscle strength, balance, and fall incidence, this research seeks to provide valuable insights into the efficacy of this intervention approach.

The significance of this study lies in its potential to inform public health strategies and clinical practice in osteoporosis prevention. If proven effective, community-based, peer-led exercise programs could offer a cost-effective and scalable solution to reduce the burden of osteoporotic fractures among elderly women. Moreover, the findings could contribute to the growing body of evidence supporting the role of peer support in health promotion and disease prevention.
The study will also explore the mechanisms through which peer-led programs may influence exercise adherence and health outcomes. Factors such as social support, self-efficacy, and health literacy will be examined to better understand the underlying processes that contribute to the program's effectiveness. This knowledge could be valuable in refining future interventions and maximizing their impact on fracture prevention.

Furthermore, this research addresses the important aspect of community engagement in health promotion. By involving community members as peer leaders, the program has the potential to build capacity within the community and foster a sustainable culture of health and well-being. This approach aligns with the principles of community-based participatory research and empowerment, which are increasingly recognized as crucial elements in addressing complex public health challenges (Israel et al., 2013).

The study will also consider the unique cultural and social context of the participants, recognizing that the effectiveness of peer-led interventions may vary across different populations. By conducting the research in a specific community setting, the findings will provide insights into the feasibility and acceptability of such programs within the local context, while also offering valuable lessons for potential adaptation in other settings.

In addition to evaluating the primary outcome of fracture prevention, this study will assess secondary outcomes such as quality of life, functional independence, and social connectivity among participants. These factors are crucial in understanding the broader impact of the intervention on the overall well-being of elderly women.

The research will also explore potential barriers and facilitators to participation in the peer-led exercise program. Understanding these factors is essential for developing strategies to enhance program uptake and sustainability. By identifying challenges and opportunities, the study aims to provide practical recommendations for implementing similar programs in diverse community settings.

As the global population continues to age, innovative approaches to health promotion and disease prevention among older adults are becoming increasingly important. This study contributes to this critical area of research by examining a novel approach to osteoporosis prevention that combines the benefits of exercise with the power of peer support and community engagement.

The aim of this study is to evaluate the impact of a community-based, peer-led exercise program on the prevention of osteoporotic fractures among elderly women over a six-month period.

Methodology:

Study Design:

A randomized controlled trial (RCT) was conducted to evaluate the impact of the community-based, peer-led exercise program. Participants were randomly assigned to either the intervention group, which received the peer-led exercise program, or the control group, which received standard care and general health education materials.

Study Site:

The study was carried out at Vyas Medical College and Hospital, a tertiary care center.

Study Duration:

The study was conducted over a period of six months, from January 2024 to June 2024.

Sampling and Sample Size:

A convenience sampling method was used to recruit participants from the hospital's geriatric outpatient department and through community outreach programs. The sample size was calculated using G*Power software, considering a medium effect size (Cohen's d = 0.5), an alpha level of 0.05, and a power of 0.80. The calculated sample size was 128 participants (64 per group). To account for potential dropouts, the sample size was increased by 20%, resulting in a final target sample of 154 participants (77 per group).

Inclusion and Exclusion Criteria:

The study included women aged 65 years and older who were able to walk independently or with minimal assistance (e.g., cane or walker). Participants were required to have a diagnosis of osteopenia or osteoporosis based on dual-energy X-ray absorptiometry (DXA) scan results (T-score $\leq$ -1.0). Exclusion criteria included severe cognitive impairment (Mini-Mental State Examination score < 24), unstable medical conditions that would preclude participation in exercise, current participation in a structured exercise program, and history of osteoporotic fracture within the past year.

Data Collection Tools and Techniques:

Several data collection tools and techniques were employed to assess the impact of the intervention:

1. **Bone Mineral Density (BMD):** DXA scans were performed at baseline and at the end of the six-month intervention period to measure BMD at the lumbar spine and femoral neck.
2. **Muscle Strength:** Handgrip strength was assessed using a hand dynamometer, while lower limb strength was measured using the 30-second chair stand test.
3. **Balance and Mobility:** The Timed Up and Go (TUG) test and the Four Square Step Test (FSST) were used to assess balance and mobility.
4. **Fall Incidence:** Participants were provided with fall diaries to record any falls experienced during the study period. Monthly follow-up phone calls were conducted to ensure accurate reporting.
5. **Quality of Life:** The Osteoporosis Quality of Life Questionnaire (OQLQ) was administered at baseline and at the end of the intervention.
6. **Physical Activity Level:** The International Physical Activity Questionnaire (IPAQ) was used to assess participants' overall physical activity levels.
7. **Exercise Adherence:** Attendance records were maintained for the intervention group, and participants were asked to keep exercise logs.
8. **Social Support and Self-Efficacy:** The Multidimensional Scale of Perceived Social Support (MSPSS) and the Osteoporosis Self-Efficacy Scale (OSES) were administered to assess these psychosocial factors.
9. **Anthropometric Measurements:** Height, weight, and waist circumference were measured at baseline and at the end of the intervention.
10. **Dietary Calcium and Vitamin D Intake:** A food frequency questionnaire specific to calcium and vitamin D-rich foods was administered at baseline and at the end of the study.

Data Management and Statistical Analysis:

Data were entered into a secure, password-protected database using REDCap (Research Electronic Data Capture) software. Double data entry was performed to minimize errors. Statistical analysis was conducted using SPSS version 26.0. Descriptive statistics were calculated for all variables, including means and standard deviations for continuous variables and frequencies and percentages for categorical variables. The normality of data distribution was assessed using the Shapiro-Wilk test. For the primary outcome of BMD changes, a repeated measures ANOVA was conducted to compare the intervention and control groups over time. The intention-to-treat principle was applied, and multiple imputation was used to handle missing data. Secondary outcomes were analyzed using appropriate statistical tests based on the nature of the data. Paired t-tests or Wilcoxon signed-rank tests were used for within-group comparisons, while independent t-tests or Mann-Whitney U tests were used for between-group comparisons. Chi-square tests were employed for categorical variables. The significance level was set at $p < 0.05$ for all analyses. Effect sizes were calculated using Cohen's d for continuous variables and odds ratios for categorical variables.

Ethical Considerations:

The study protocol was approved by the Institutional Ethics Committee of Vyas Medical College and Hospital (approval number: VMCH-IEC-2023-156). The research was conducted in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines. Informed consent was obtained from all participants prior to their enrollment in the study.

Table 1: Baseline Characteristics of Study Participants

Characteristic	Intervention Group (n=77)	Control Group (n=77)	p-value
Age (years)	72.3 ± 5.6	71.8 ± 5.9	0.583
BMI (kg/m²)	26.4 ± 4.2	26.7 ± 4.5	0.662
T-score (lumbar spine)	-2.1 ± 0.8	-2.0 ± 0.9	0.456
T-score (femoral neck)	-1.8 ± 0.7	-1.9 ± 0.8	0.391
Handgrip strength (kg)	18.5 ± 4.3	18.2 ± 4.5	0.659
TUG test (seconds)	11.8 ± 2.7	12.1 ± 2.9	0.507

Note: Values are presented as mean ± standard deviation. BMI = Body Mass Index, TUG = Timed Up and Go.

Table 2: Changes in Bone Mineral Density Over 6 Months

Site	Group	Baseline	6 Months	Mean Change	p-value
Lumbar Spine	**Intervention**	0.856 ± 0.112	0.874 ± 0.118	0.018 ± 0.015	<0.001
	Control	0.861 ± 0.109	0.863 ± 0.111	0.002 ± 0.008	0.057
Femoral Neck	**Intervention**	0.692 ± 0.089	0.703 ± 0.092	0.011 ± 0.009	<0.001
	Control	0.688 ± 0.091	0.689 ± 0.092	0.001 ± 0.005	0.124

Note: Values are presented as mean ± standard deviation. BMD values are in g/cm².

Table 3: Changes in Muscle Strength and Balance Measures

Measure	Group	Baseline	6 Months	Mean Change	p-value
Handgrip Strength (kg)	**Intervention**	18.5 ± 4.3	20.7 ± 4.6	2.2 ± 1.8	<0.001
	Control	18.2 ± 4.5	18.5 ± 4.6	0.3 ± 1.2	0.038
30-s Chair Stand (reps)	**Intervention**	10.3 ± 3.1	13.1 ± 3.5	2.8 ± 1.9	<0.001
	Control	10.1 ± 3.2	10.4 ± 3.3	0.3 ± 1.1	0.022
TUG Test (seconds)	**Intervention**	11.8 ± 2.7	10.2 ± 2.4	-1.6 ± 1.2	<0.001
	Control	12.1 ± 2.9	11.9 ± 2.8	-0.2 ± 0.8	0.041

Note: Values are presented as mean ± standard deviation. TUG = Timed Up and Go.

Table 4: Fall Incidence and Fracture Rates

Outcome	Intervention Group (n=77)	Control Group (n=77)	Relative Risk (95% CI)	p-value
Falls (n, %)	12 (15.6%)	23 (29.9%)	0.52 (0.28-0.97)	0.038
Fractures (n, %)	1 (1.3%)	4 (5.2%)	0.25 (0.03-2.19)	0.174

Note: CI = Confidence Interval

Table 5: Changes in Quality of Life and Self-Efficacy Scores

Measure	Group	Baseline	6 Months	Mean Change	p-value
OQLQ Total Score	**Intervention**	72.3 ± 14.6	83.5 ± 15.2	11.2 ± 8.7	<0.001
	Control	73.1 ± 15.1	75.2 ± 15.4	2.1 ± 5.3	0.001
OSES Score	**Intervention**	62.5 ± 18.3	78.9 ± 16.7	16.4 ± 12.1	<0.001
	Control	63.2 ± 17.9	65.1 ± 18.2	1.9 ± 6.8	0.018

Note: OQLQ = Osteoporosis Quality of Life Questionnaire, OSES = Osteoporosis Self-Efficacy Scale. Scores are presented as mean ± standard deviation.

Table 6: Exercise Adherence in the Intervention Group

Adherence Level	Number of Participants (%)
High (≥75% of sessions)	48 (62.3%)
Moderate (50-74% of sessions)	19 (24.7%)
Low (<50% of sessions)	10 (13.0%)

Discussion:

The present study evaluated the impact of a community-based, peer-led exercise program on the prevention of osteoporotic fractures among elderly women. The findings reveal significant improvements in various outcome measures for the intervention group compared to the control group, suggesting the potential effectiveness of this approach in osteoporosis management and fracture prevention.

Baseline Characteristics: As shown in Table 1, there were no significant differences in baseline characteristics between the intervention and control groups, indicating successful randomization. This similarity in baseline measures allows for more reliable comparisons of the intervention effects.

Changes in Bone Mineral Density: One of the most notable findings of this study is the significant improvement in bone mineral density (BMD) observed in the intervention group (Table 2). After six months, participants in the peer-led exercise program showed a mean increase of 0.018 g/cm^2 in lumbar spine BMD and 0.011 g/cm^2 in femoral neck BMD, both statistically significant ($p<0.001$). In contrast, the control group showed minimal, non-significant changes.

These results are consistent with previous studies that have demonstrated the positive effects of exercise on BMD in postmenopausal women. For instance, Kemmler et al. (2015) reported significant improvements in BMD at various skeletal sites following a long-term exercise intervention. The magnitude of BMD changes observed in our study is particularly encouraging given the relatively short intervention period of six months.

The differential effects on lumbar spine and femoral neck BMD are also noteworthy. The more pronounced improvement in lumbar spine BMD aligns with findings from other studies, such as that by Zhao et al. (2017), who reported that the lumbar spine tends to be more responsive to exercise interventions compared to the femoral neck. This difference may be attributed to the varying composition of cortical and trabecular bone at these sites and their differential responses to mechanical loading.

Muscle Strength and Balance: The intervention group demonstrated significant improvements in muscle strength and balance measures (Table 3). Handgrip strength, often used as a proxy for overall muscle strength, increased by 2.2 kg in the intervention group compared to only 0.3 kg in the control group. Similarly, the 30-second chair stand test, which assesses lower body strength, showed a mean increase of 2.8 repetitions in the intervention group versus 0.3 in the control group.

These findings are particularly important given the established relationship between muscle strength, balance, and fall risk. A meta-analysis by Sherrington et al. (2019) found that exercise programs that challenge balance and include moderate to high-intensity strength training are most effective in preventing falls in older adults. Our results suggest that the peer-led program successfully incorporated these elements.

The Timed Up and Go (TUG) test results further support the effectiveness of the intervention in improving functional mobility and balance. The intervention group showed a mean decrease of 1.6 seconds in TUG time, which is clinically significant. Bohannon (2006) suggested that a change of 1.4 seconds in the TUG test represents a minimal clinically important difference for community-dwelling older adults.

Fall Incidence and Fracture Rates: Perhaps the most clinically relevant outcome of this study is the reduction in fall incidence observed in the intervention group (Table 4). Participants in the peer-led exercise program had a 48% lower risk of experiencing a fall compared to the control group (RR = 0.52, 95% CI: 0.28-0.97, p = 0.038). This finding is consistent with a systematic review by

Gillespie et al. (2012), which found that exercise programs can reduce the rate of falls in older people living in the community.

While the study was not powered to detect significant differences in fracture rates due to the relatively short follow-up period, there was a trend towards lower fracture incidence in the intervention group (1.3% vs 5.2% in the control group). This trend is promising and warrants further investigation with larger sample sizes and longer follow-up periods.

Quality of Life and Self-Efficacy: The intervention had a positive impact on participants' quality of life and self-efficacy related to osteoporosis management (Table 5). The significant improvements in Osteoporosis Quality of Life Questionnaire (OQLQ) scores indicate that the peer-led program had benefits beyond physical health outcomes. This aligns with findings from Papaioannou et al. (2006), who reported that exercise interventions can improve quality of life in women with osteoporosis.
The substantial increase in Osteoporosis Self-Efficacy Scale (OSES) scores in the intervention group is particularly noteworthy. Self-efficacy has been identified as a crucial factor in adherence to osteoporosis prevention behaviors, including exercise (Horan et al., 1998). The peer-led nature of the program may have contributed to this improvement by providing relatable role models and social support.

Exercise Adherence: The high level of adherence to the exercise program (Table 6) is a key strength of this study. Over 60% of participants in the intervention group attended 75% or more of the exercise sessions. This high adherence rate is particularly impressive given the challenges often associated with maintaining exercise habits in older populations.
The success in achieving high adherence rates may be attributed to the peer-led nature of the program. This finding supports the work of Burton et al. (2017), who found that peer-led interventions can be effective in motivating older adults to increase their physical activity levels. The social support and accountability provided by peers likely played a crucial role in maintaining participant engagement.

Mechanisms of Action: The positive outcomes observed in this study can be attributed to several potential mechanisms. The improvements in BMD are likely due to the osteogenic effects of weight-bearing and resistance exercises included in the program. These exercises create mechanical stress on bones, stimulating bone formation and reducing bone resorption (Kohrt et al., 2004).

The enhanced muscle strength and balance can be explained by the neuromuscular adaptations that occur in response to regular exercise. These include increased motor unit recruitment, improved inter-muscular coordination, and enhanced proprioception (Cadore et al., 2013).

The reduction in fall risk is likely a combined result of improved muscle strength, balance, and functional mobility. Additionally, the exercise program may have increased participants' confidence in their physical abilities, leading to more active lifestyles and further reducing fall risk.

The peer-led aspect of the program likely contributed to the improvements in quality of life and self-efficacy. Social support from peers can enhance motivation, provide encouragement, and create a sense of community, all of which can positively impact psychological well-being and confidence in managing one's health (Simoni et al., 2011).

Limitations and Future Directions: Despite the positive findings, this study has several limitations that should be acknowledged. The six-month follow-up period, while sufficient to demonstrate short-term benefits, may not capture long-term effects or sustainability of the intervention. Future studies should consider longer follow-up periods to assess the durability of the observed improvements and the long-term impact on fracture rates.

The study was conducted at a single center, which may limit the generalizability of the findings to other settings or populations. Multi-center trials across diverse geographical and cultural contexts would provide more robust evidence for the effectiveness of peer-led exercise programs in osteoporosis management.

While the peer leaders underwent thorough training, the quality and consistency of program delivery across different peer leaders were not systematically assessed. Future research could incorporate fidelity measures to ensure consistent implementation of the intervention.

The study did not include a third arm with a traditional, professionally-led exercise program, which would have allowed for direct comparison between peer-led and professional-led interventions. Such a comparison could provide valuable insights into the relative effectiveness and cost-efficiency of these approaches.

Conclusion:

This study provides compelling evidence for the effectiveness of a community-based, peer-led exercise program in improving bone health, reducing fall risk, and enhancing quality of life among elderly women at risk of osteoporotic fractures. The high adherence rates and significant improvements across multiple outcome measures suggest that this approach could be a valuable addition to osteoporosis prevention strategies. The peer-led nature of the program appears to offer unique benefits, particularly in terms of participant engagement and psychosocial outcomes. These findings have important implications for public health initiatives aimed at reducing the burden of osteoporosis and related fractures in aging populations. Future research should focus on replicating these results in larger, more diverse populations and over longer time periods. Additionally, cost-effectiveness analyses would be valuable in assessing the feasibility of implementing such programs on a broader scale. As the global population continues to age, innovative, community-based approaches like the one evaluated in this study will become increasingly important in promoting healthy aging and reducing the impact of age-related conditions such as osteoporosis.

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