<LEAP>
Linking Evidence And Practice

Effectiveness of Exercise for Managing Osteoporosis in Women Postmenopause

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<LEAP> highlights the findings and application of Cochrane reviews and other evidence pertinent to the practice of physical therapy. The Cochrane Library is a respected source of reliable evidence related to health care. Cochrane systematic reviews explore the evidence for and against the effectiveness and appropriateness of interventions—medications, surgery, education, nutrition, exercise—and the evidence for and against the use of diagnostic tests for specific conditions. Cochrane reviews are designed to facilitate the decisions of clinicians, patients, and others in health care by providing a careful review and interpretation of research studies published in the scientific literature.[1] Each article in this PTJ series summarizes a Cochrane review or other scientific evidence resource on a single topic and will present clinical scenarios based on real patients to illustrate how the results of the review can be used to directly inform clinical decisions. This article focuses on exercise for the management of osteoporosis in women postmenopause. Which, if any, approaches to exercise reduce loss of bone mineral density or reduce the chance of fractures in women who are healthy postmenopause?

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A 2003 report from the Surgeon General of the United States estimated that 10 million individuals had osteoporosis and almost 34 million had low bone mass, placing them at increased risk for osteoporosis.[2] Analysis of data from people with 6 to 7 years of Medicare coverage in the United States in 2005 estimated the prevalence of osteoporosis to be approximately 30%.[3] The major outcome of concern in osteoporosis is minimal trauma fracture. This is a type of fracture resulting from injury that would be insufficient to fracture normal bone and are referred to as low-impact fracture, fragility fracture, and osteoporotic fracture.[4] One study estimated that by 2025, osteoporotic fractures will grow to more than 3 million, incurring $25.3 billion in costs.[5]

Primary osteoporosis is the result of aging or menopause, or both.[6] Aging causes a decrease of osteoblastic activity, resulting in decreases in bone formation.[6] Menopause causes an increase of osteoclastic activity, which results in increases in bone reabsorption.[4] The result is a decrease in bone mineral density (BMD), which increases fracture risk. Bone mineral density is measured by dual-energy x-ray absorptiometry (DXA). According to a World Health Organization scientific group report, the risk of fracture at any biologically relevant site increases 1.5-fold per standard deviation decrease in BMD from the average value for young women who are healthy.[7] This measure is termed the gradient of risk. The highest gradient of risk is at the femoral neck; the risk of hip fracture increases by approximately 2.6 for each standard deviation decrease in BMD.

There is a relationship between sarcopenia, which is age-related muscle loss, and osteopenia, or bone tissue loss. The prevalence of sarcopenia increases as BMD decreases.[8] Physical performance is affected by sarcopenia, with deficits in gait and balance noted in people with sarcopenia and osteoporosis.[9] Impaired physical performance increases fall risk, which, in turn, increases the risk of fracture for people with osteoporosis.[9] Severe osteoporosis and sarcopenia are associated with frailty.[10] Decreased physical activity is one risk factor for both osteoporosis[11] and sarcopenia.[12] According to Wolff's law, bone dynamically adapts to the stresses placed upon it.[13] Exercise interventions, theoretically, should improve bone density, both through directly loading bone and through increasing muscle mass, which also places further mechanical stress on the skeleton.

The purpose of a systematic review by Howe et al[14] was to determine the impact of exercise interventions for postmenopausal women in the prevention of bone loss and fractures. The primary outcome examined was vertebral and nonvertebral (hip and wrist) fracture incidence. The secondary outcomes examined were changes in BMD, serious adverse events, and minor adverse events such as falls.

Take-Home Message

The Cochrane review by Howe et al[14] comprised an electronic database search of the literature through December 2010. The review included 43 randomized controlled trials with

Table.

Summary of Key Results of Review by Howe et al[14,a]

Overview		
• 43 RCTs involving a total of 4,320 participants and published up to December 2010		
• Studies carried out in North America (19), Europe (12), Australia (4), Japan (4), China (2), and Brazil (2)		
• Duration of intervention: 10: <12 months, 26: 12 months, 7: >12 months		
• Frequency of intervention: 33: 2–3 times/week, 3: daily, 7: 4–6 times/week		
• BMD measured at lumbar spine in 30 studies and at hip in 30 studies		
Any Exercise vs Control		
Main Outcome	**Grade of Evidence**	**Results**
Fracture risk	High	• 4 studies with 539 participants • OR=0.61 (95% CI=0.23 to 1.64)
% BMD change in spine[b]	High	• 24 studies with 1,441 participants • MD=0.85 (95% CI=0.62 to 1.07)
% BMD change in femoral neck[c]	Low	• 19 studies with 1,338 participants • MD=−0.08 (95% CI=−1.08 to 0.92)
% BMD change in hip[d]	High	• 13 studies with 863 participants • MD=0.41 (95% CI=−0.64 to 1.45)
% BMD change in trochanter	High	• 10 studies with 815 participants • MD=1.03 (95% CI=0.56 to 1.49)
Specific Exercise Interventions vs Control		
Exercise Type	**No. of Studies With Low Risk of Bias**	**Significant Results**
Static weight-bearing exercise (eg, single-leg standing)	0	• 1 study with 31 participants • % change in hip BMD[d]: MD=2.42 (95% CI=0.73 to 4.10)
Dynamic, low-force, weight-bearing exercise (eg, walking, tai chi)	4	• 7 studies with 519 participants • % change in spine BMD[b]: MD=0.87 (95% CI=0.26 to 1.48)
Dynamic, high-force, weight-bearing exercise (eg, jogging, jumping, running, dancing)	2	• 4 studies with 179 participants • % change in hip BMD[d]: MD=1.55 (95% CI=1.41 to 1.69)
Low-force, non–weight-bearing exercise (eg, low-load, high-repetition strength training)	0	• 5 studies with 231 participants • No significant differences in any outcome measures
High-force, non–weight-bearing exercise (eg, progressive resistance strength training)	1	• 8 studies with 246 participants • % change in spine BMD[b]: MD=0.86 (95% CI=0.58 to 1.13)
	1	• 8 studies with 247 participants • % change in femoral neck BMD[c]: MD=1.03 (95% CI=0.24 to 1.82)
Combination exercise (types listed above)	2	• 2 studies with 236 participants • Risk of fractures: OR=0.33 (95% CI=0.13 to 0.85)
	1	• 4 studies with 258 participants • % change in spine BMD[b]: MD=3.22 (95% CI=1.80 to 4.64)
	1	• 2 studies with 200 participants • % change in trochanter BMD[e]: MD=1.31 (95% CI=0.69 to 1.92)
	1	• 3 studies with 325 participants • % change in femoral neck BMD[c]: MD=0.45 (95% CI=0.08 to 0.82)
	1	• 4 studies with 468 participants • % change in hip BMD[d]: MD=−1.07 (95% CI=−1.58 to −0.56)

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Table.
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Adverse Events		
Event Type	**No. of Studies With Low Risk of Bias**	**Results**
Total falls	2	• 3 studies with 378 participants • Exercise groups=75, control groups=55
Others (eg, muscle soreness, joint pain, headache, itching)	5	• 11 studies with 972 participants • Exercise groups=60, control groups=5

[a] RCT=randomized controlled trial, BMD=bone mineral density, OR=odds ratio, 95% CI=95% confidence interval, MD=mean difference.
[b] Least significant change in postmenopausal women=5.43%.[17]
[c] Least significant change in postmenopausal women=6.36%.[17]
[d] Least significant change in postmenopausal women=4.50%.[17]
[e] Least significant change unknown.

a total of 4,320 postmenopausal women who were healthy and aged 45 to 70 years (Table). Studies were included in which the intervention group engaged in an exercise program that could improve aerobic capacity or aerobic capacity and muscle strength and a comparison group engaged in usual activity or a placebo intervention. The duration of the exercise interventions reported in the studies ranged between 6 months and 2 years. Only 8 studies included data obtained after the completion of the intervention. Pooled data showed that the odds of incident fracture in groups engaged in any type of exercise were not different from the odds of fracture in the control groups (odds ratio [OR]=0.61, 95% confidence interval [95% CI]=0.23 to 1.64). There was, however, a small, statistically significant effect for any type of exercise versus a comparison group on mean BMD loss (pooled data from 24 studies), with 0.85% less bone loss in the spine (between-group mean difference [MD]=0.85, 95% CI=0.62 to 1.07) and 1.03% less bone loss in the trochanter (MD=1.03, 95% CI=0.56 to 1.49), based on pooled data from 10 studies.

To account for the variability in the exercise programs reported in the studies, the authors performed additional subgroup analyses for outcomes with sufficient numbers of studies to allow meta-analysis. They found an effect in favor of dynamic, low-force, weight-bearing exercise for percentage change in BMD of the spine (MD=0.87, 95% CI=0.26 to 1.48); an effect in favor of dynamic, high-force, weight-bearing exercise for percentage change in BMD of the hip (MD=1.55, 95% CI=1.41 to 1.69); an effect in favor of high-force, non–weight-bearing exercise for percentage change in BMD of the spine (MD=0.86, 95% CI=0.58 to 1.13) and neck of femur (MD=1.03, 95% CI=0.24 to 1.82); and an effect in favor of combination exercise on odds of total fractures (OR=0.33, 95% CI=0.13 to 0.85) and for percentage change in BMD of the spine (MD=3.22, 95% CI=1.80 to 4.64), trochanter (MD=1.31, 95% CI=0.69 and 1.92), and neck of femur (MD=0.45, 95% CI=0.08 to 0.82).

The adverse events that were documented for the exercise intervention groups included falls, muscle soreness, joint pain, headache, and itching. Although there appeared to be more falls among those in the exercise groups in comparison with the control groups (75 versus 55 falls, respectively, based on 3 studies with 378 participants), a comparative analysis of the risk of falling could not be performed, as studies reported the number of falls rather than the number of people falling. Additionally, most trials reporting adverse events appeared to have paid more attention to adverse events in the exercise intervention groups (known as "performance bias") and did not report whether adverse events were monitored in the same way in the control groups.

The authors noted several factors hindering the interpretation of results of both the main analyses and subgroup analyses. These factors included small sample sizes; heterogeneous ethnicity in samples; losses to follow-up in most studies; the lack of sufficient reporting of type, intensity, frequency, duration, and mode of exercise; and heterogeneity of results across studies. Additionally, conclusions could not be made about the impact of exercise in the initial postmenopausal period versus the later menopausal period.

Case #16: Applying Evidence to a Patient With Osteoporosis

Can exercise training help this patient?

Mrs Baldwin is a 58-year-old Caucasian woman employed as an administrator in a small private high school. She was walking across the school campus when she tripped and fell. She felt immediate pain in her low back and hip. A radiograph revealed no fractures. Although the hip pain quickly resolved, the patient continued to have low back pain for several days and sought the care of her physical therapist.

At her outpatient physical therapist evaluation, Mrs Baldwin reported that she was 4 years postmenopause, was a nonsmoker, had no significant past medical history or predilection to falling, and was taking no medications; she considered herself very healthy. There was no known family history of osteoporosis. Mrs Baldwin reported that she did 30 minutes of walking at a moderate pace most days of the week for exercise and was an avid gardener. She had had a DXA scan approximately 1 year previously indicating the presence of osteopenia in the lumbar spine (T-score=−2.0) and hip (femoral neck T-score=−1.8, total hip T-score=−1.0). At that time, her physician had recommended she take calcium and vitamin D supplements and maintain regular exercise. Although the physical therapist focused on evaluation and management of the patient's acute low back pain, she wondered whether she also should provide specific exercise advice for Mrs Baldwin in view of her known osteopenia and potential future fracture risk.

How did the results of the Cochrane systematic review apply to Mrs Baldwin?

Using the PICO (Patient, Intervention, Comparison, Outcome) format, Mrs Baldwin's physical therapist asked the question: In a postmenopausal woman with osteopenia who is generally healthy, will adding a muscle strengthening component to a daily walking program of exercise reduce the chance of future fractures and slow the loss of bone mineral density? Based on this question, a literature search identified the Cochrane review by Howe et al.[14]

Patient relevance. The systematic review included studies in which the participants were postmenopausal women who were healthy, aged 45 to 70 years, and with or without previous fractures. These criteria matched Mrs Baldwin.

Intervention and comparison relevance. The review included studies with any exercise intervention that could be assumed to improve aerobic or muscle strength, and several of the included studies examined the effects of combination exercise regimens. Included studies compared exercise with usual care or placebo intervention. Because Mrs Baldwin had a regular walking exercise program already, her physical therapist was interested in whether adding a strength training component would provide added benefits. The alternative was to continue with the walking program and not add muscle strength training. The therapist, therefore, was most interested in the results for combination exercise regimens.

Outcomes relevance. The review examined the differences between intervention and comparison groups in risk of fracture and percent change in BMD, 2 important considerations for Mrs Baldwin given her DXA results.

Based on the results of the systematic review and its applicability to Mrs Baldwin, upper-extremity and lower-extremity progressive resistive exercises were gradually implemented as Mrs Baldwin was able to tolerate them. Additionally, a twice-weekly program consisting of multidirectional jumps and jumping on and off boxes of various heights (plyometrics) was initiated. Mrs Baldwin's physical therapist recommended that she join a health club to continue the muscle strength training and plyometrics program 2 to 3 times per week and that she continue to walk 30 minutes most days of the week.

How well do the outcomes of the intervention provided to the patient match those suggested by the systematic review?

After Mrs Baldwin had been engaged in her exercise regimen for 2 years, her physician requested a repeat DXA scan.[15] The results demonstrated no further bone loss at the spine or hip. These DXA results, which might be at least partially attributed to Mrs Baldwin's combination exercise regimen, are consistent with those reported in the systematic review for combination exercise. The systematic review showed that exercise programs combining different types of exercise and lasting between 6 and 24 months resulted in a reduced risk of fracture, as well as a slightly beneficial effect on BMD of the spine, trochanter, and neck of femur.

Can you apply the results of the systematic review to your own patients?

The findings of this study may be applied to postmenopausal women who are healthy, up to the age of 70 years, and who may or may not have experienced previous fractures. The nature of the included studies precluded the review authors from distinguishing the effects of the interventions for women in early phases of menopause compared with later phases. The first 3 to 5 years postmenopause is a period of hormonal variability,[16] making it challenging to apply results across all women postmenopause. The studies were performed in several countries; however, the nature of the included studies did not allow the review authors to distinguish the effects of the interventions for women of different racial or ethnic backgrounds. There was a good deal of variability in the interventions across studies; they included exercises such as walking, plyometrics, progressive resistance strength training, and combinations of exercise types.

Although the majority of studies provided the exercise intervention 2 or 3 times per week, most studies did not provide a complete description of duration, intensity, and frequency. Most of the types of exercises reported in the review could be readily accomplished in many settings; all but one study included only land-based exercises. Some types of exercise, however, are likely to be better performed in a gym or health club setting than in the home setting. With limited follow up after the completion of most study interventions, the long-term benefits of exercise interventions on BMD and fracture rate of women postmenopause could not be determined. Finally, the results of the review are based on studies with variable risk of bias, with only 13 of 43 (30%) classified as having a low risk of bias.

What can be advised based on the results of this systematic review?

Postmenopausal women who are healthy, such as Mrs Baldwin, may benefit from an exercise program at least 2 to 3 times per week over the course of at least 6 months, and physical therapists should consider helping their clients and patients to plan and design appropriate programs. Although engaging in any type of exercise may be effective in slightly reducing loss of BMD in the spine and femoral trochanter, the most effective type of exercise for reducing loss of BMD in the neck of the femur might be high-force, non–weight-bearing exercise such as progressive resistance training of the lower extremity. A combination exercise regimen seems to be the most effective for reducing loss of BMD in the spine and neck of the femur and reducing risk of fracture, at least in the short term. Combining results across studies with all types of exercise, 4 more women out of 100 in the usual care or placebo group sustained a fracture than in the exercise group, although this difference was not statistically significant. The long-term impact of these small differences between women who engage in exercise interventions and those who perform only their normal activities is unknown.

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