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Physical Therapist Management of Patients With Suspected or Confirmed Osteoporosis: A Clinical Practice Guideline From the Academy of Geriatric Physical Therapy

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ABSTRACT

A clinical practice guideline on physical therapist management of patients with suspected or confirmed osteoporosis was developed by a volunteer guideline development group (GDG) that was appointed by the Academy of Geriatric Physical Therapy (APTA Geriatrics). The GDG consisted of an exercise physiologist and 6 physical therapists with clinical and methodological expertise. The guideline was based on a systematic review of existing clinical practice guidelines, followed by application of the ADAPTE methodological process described by Guidelines International Network for adapting guidelines for cultural and professional utility. The recommendations contained in this guideline are derived from the 2021 Scottish Intercollegiate Guideline Network (SIGN) document: *Management of Osteoporosis and the Prevention of Fragility Fractures*. These guidelines are intended to assist physical therapists practicing in the United States, and implementation in the context of the US health care system is discussed.

Key Words: bone health, clinical practice guideline, osteoporosis, physical therapy

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SUMMARY OF RECOMMENDATIONS

- *Exercise Recommendations for Postmenopausal Women to Slow Decline of Bone Mineral Density of the Hip and the Femoral Neck:* Physical therapists should design and advise postmenopausal women to participate in long-duration exercise programs consisting of static weight-bearing exercises such as single-leg standing to slow the decline of bone mineral density (BMD) at the hip. Physical therapists should design and advise postmenopausal women to participate in long-duration, adequately dosed progressive-resistance strength training exercises such as weight training either alone or in combination with impact exercise training such as jogging, walking, or aerobics to slow the decline of BMD of the femoral neck. (Grade B, recommendation based on moderate evidence)
- *Exercise Recommendations for Postmenopausal Women to Slow Decline of Bone Mineral Density of the Lumbar Spine:* Physical therapists should consider designing and advising postmenopausal women to participate in long-duration exercise programs consisting of walking, tai chi, progressive-resistance strength training (such as weight training), and different combinations of exercise types to slow the decline of lumbar spine BMD. (Grade B, recommendation based on moderate evidence)
- *Exercise Recommendations for Premenopausal Women to Slow Decline of Bone Mineral Density of the Femoral Neck:* Physical therapists should consider designing and advising premenopausal women to participate in long-duration exercise programs consisting of high-impact exercise (such as jogging) and combining impact exercise (such as stair climbing) with progressive-resistance strength training (such as weight training) to slow the decline of femoral neck BMD. (Grade B, recommendation based on moderate evidence)
- *Exercise Recommendations for Premenopausal Women to Slow Decline of Bone Mineral Density of the Lumbar Spine:* Physical therapists should consider designing and advising premenopausal women to participate in long-duration exercise programs consisting of progressive-resistance strength training (such as weight training) alone or in combination with impact exercises (such as stair climbing or jogging) to slow the decline of lumbar spine BMD. (Grade B, recommendation based on moderate evidence)
- *Exercise Recommendations for Men:* There is insufficient evidence to make a recommendation for exercise for improving BMD in men.

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INTRODUCTION

Aim of the Document

The Academy of Geriatric Physical Therapy has an ongoing effort to create evidence-based practice guidelines for the physical therapy management of older adults. The purpose of this document was to provide evidence-based recommendations on exercise interventions that impact bone mineral density (BMD) in individuals with osteoporosis.

Statement of Intent

These recommendations are not intended to be construed or to serve as a standard of medical care. Standards of care are determined on the basis of all clinical data available for an individual patient and are subject to change as scientific knowledge, technology advances, and patterns of care evolve. These parameters of practice should be considered as guidelines only. Adherence to them will not ensure a successful outcome in every patient, nor should they be construed as including all proper methods of care or excluding other acceptable methods of care aimed at the same results. The ultimate judgment regarding a particular clinical procedure or treatment plan must be made in light of the clinical data presented by the patient; the diagnostic and treatment options available; and the patient's values, expectations, and preferences. However, we suggest that significant departures from accepted recommendations should be documented in the patient's medical records at the time the relevant clinical decision is made.

BACKGROUND

Osteoporosis is a systemic, metabolic bone disease characterized by low bone mass, impaired bone quality, and increased susceptibility of low-trauma fracture. The World Health Organization operationally defines osteoporosis via a dual-energy x-ray absorptiometry BMD T score at the spine or hip of −2.5 or below that of sex- and race-matched young adults.[1-3] This definition has been refined to include those with an elevated fracture risk based on the World Health Organization Fracture Risk Algorithm as another critical criterion.[4] In addition, a clinical diagnosis of osteoporosis can be made when a low-trauma hip fracture occurs in the presence of normal BMD (eg, during a fall from a standing height) or when a low-trauma vertebral, proximal humeral, or pelvic fracture (and in some cases, a distal forearm fracture) occurs in an individual with osteopenia.[4] The prevalence of osteoporosis based on data from Centers for Disease Control and Prevention National Health and Nutrition Examination Survey estimates that more than 10 million adults older than 50 years had osteoporosis in 2010, with a higher prevalence in women (~30%) than in men (~16%).[5,6] The risk for osteoporosis increases with advancing age, with women having a higher risk of fracture than men.[5,7] The lifetime risk of osteoporotic fracture for women and men is approximately 50% and 20%, respectively.[8-10]

Fragility fractures that occur from low-trauma forces, such as those experienced during a fall from standing height, result in increased morbidity, mortality, hospitalizations and clinical burden, and reduced quality of life (QOL). Worldwide, osteoporosis causes more than 8.9

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All individuals whose names appear as authors of or contributors to this CPG filed a disclosure statement as part of the grant submission process. In addition, prior to and during the development of this CPG, development group members routinely disclosed conflicts of interest in writing to APTA Geriatrics using the International Committee of Medical Journal Editors (ICMJE) Form for Disclosure of Potential Conflicts of Interest. Each of the guideline development group (GDG) members was asked to disclose any existing or potential conflicts of interest—including financial relationships with pharmaceutical, medical device, or biotechnology companies—prior to being included in the group and routinely thereafter. All guideline development group members report grants from APTA Geriatrics and APTA during the conduct of the work. Dr Hartley served as a member of the board of directors of APTA Geriatrics from during the conduct of this work. He received no compensation for this position; however, the Academy funded travel to annual meeting(s). Dr Betz served as chair of the Bone Health Special Interest Group of APTA Geriatrics from 2009 to 2020. She received no compensation for this position; however, the Academy funded some expenses related to travel to an annual meeting.

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million fractures annually, with an osteoporotic fracture occurring every 3 seconds.[11] More than 2 million osteoporosis-related fractures were reported in the United States in 2005 with hip, spine, and distal radius fractures making up two-thirds of osteoporosis-associated fractures.[12] Patients who suffer from a hip or vertebral fracture have decreased life expectancy compared with population-based controls, are more likely to be women, and carry a higher mortality rate in those with hip fractures and those who suffered subsequent fractures.[13-15]

Physical inactivity is a modifiable risk factor that contributes to the development of low bone mass, osteoporosis, and increased fall risk. As the incidence of osteoporosis and fractures in individuals older than 65 years continues to increase, the development of appropriate physical activity guidelines for bone health requires clear clinical standards implemented across different clinical settings.[16] Guidelines are necessary to promote optimal care across a wide range of clinical settings, such as acute and post–acute care, outpatient, and community-based wellness programs. Since BMD is an important predictor of fracture risk, we based the recommendations in this document on changes in BMD. When prescribing physical activity interventions to promote bone health, it is important to understand the characteristics of physical activity and exercise that are sufficient to effect BMD without causing adverse outcomes such as fractures.[17-20]

Scope, Purpose, and Target Users

This document presents the evidence-based exercise recommendations adapted from the Scottish Intercollegiate Guideline Network (SIGN): *Management of Osteoporosis and the Prevention of Fragility Fractures*.[21] Although the SIGN clinical practice guideline (CPG) addressed multiple aspects of the management of osteoporosis in premenopausal and postmenopausal women, and men, this adapted document includes only the sections dealing with exercise interventions. Furthermore, it should be noted that while the SIGN CPG did not address osteoporosis in transgender individuals, a recent review concluded that treatment of osteoporosis in transgender persons follows the same guidelines as cisgender persons.[22] Optimizing bone health may also reduce fracture risk. However, this adapted document did not directly assess any recommendations or outcomes related to fracture or fall rate/risk. The recommendations included in these adapted guidelines are intended to facilitate decision making by physical therapists treating individuals with known or suspected osteoporosis. In addition, these recommendations may inform consumers of physical therapy as well as other health care providers about recommended exercise interventions for adults with or at risk for osteoporosis.

METHODS

Guideline Development Group

The Academy of Geriatric Physical Therapy (APTA Geriatrics), a component of the American Physical Therapy Association (APTA), appointed a multidisciplinary team of researchers and clinicians with expertise in guideline development or the management of osteoporosis to develop an evidence-based document focused on the management of osteoporosis through physical therapy–directed exercise interventions in adults.

CPG Search

To identify existing guidelines on improving or mitigating the loss of BMD through exercise, we conducted a comprehensive search for osteoporosis-related CPGs in the following repositories: National Guideline Clearinghouse, Trip Database, Scottish Intercollegiate Guidelines Network, National Institute for Health and Clinical Excellence, National Health Service, Physiotherapy Evidence Database, Occupational Therapy Systematic Evaluation of Evidence, and Guidelines International Network. The following broad search terms were included: osteoporosis, osteopenia, low bone density, physical activity, exercise, physical therapy, intervention, and treatment. Inclusion criteria included publication within 5 years of search (since January 1, 2013), English language, female-male inclusive, and relevant to exercise in the physical therapy management of patients with osteoporosis.

Our initial search identified the 55 unique abstracts to review for inclusion criteria. We excluded 20 references that were not CPGs, 7 that were not related to osteoporosis, 5 that were outdated, 4 that addressed only diagnosis or pharmacological management, and 2 that included only 1 sex. We reviewed the full text of the remaining 17 to determine whether they included recommendations on physical activity or exercise. Six of the remaining CPGs addressed exercise or physical activity in the management of osteoporosis.[21,23-27]

Because our initial search identified 6 CPGs addressing the use of exercise in managing patients with osteoporosis, the team explored the possibility of adapting an existing CPG to create recommendations for physical therapists for exercise prescription to mitigate BMD loss in patients with osteoporosis. To guide this process, we used the methodology developed by the ADAPTE Collaboration, an international collaboration of researchers, guideline developers, and guideline implementers. ADAPTE Collaboration developed and validated a generic adaptation process that was endorsed by the Guideline International Network (G-I-N).[28] The ADAPTE method as described in the Guideline Adaptation: A Resource Toolkit was used to determine whether existing CPGs could be adapted to meet our stated aims.[29] The ADAPTE method provided a systematic approach to adapting CPGs originally developed for use in one context for use by a different group in a different culture[29] (see the Figure). The ADAPTE method begins by evaluating existing CPGs based upon their quality, rigor, and relevance to the practice of physical therapy.

The ADAPTE Process

To evaluate existing CPGs on their quality and rigor, we used the Appraisal of Guidelines for Research & Evaluation II (AGREE II) instrument.[30] The AGREE II instrument

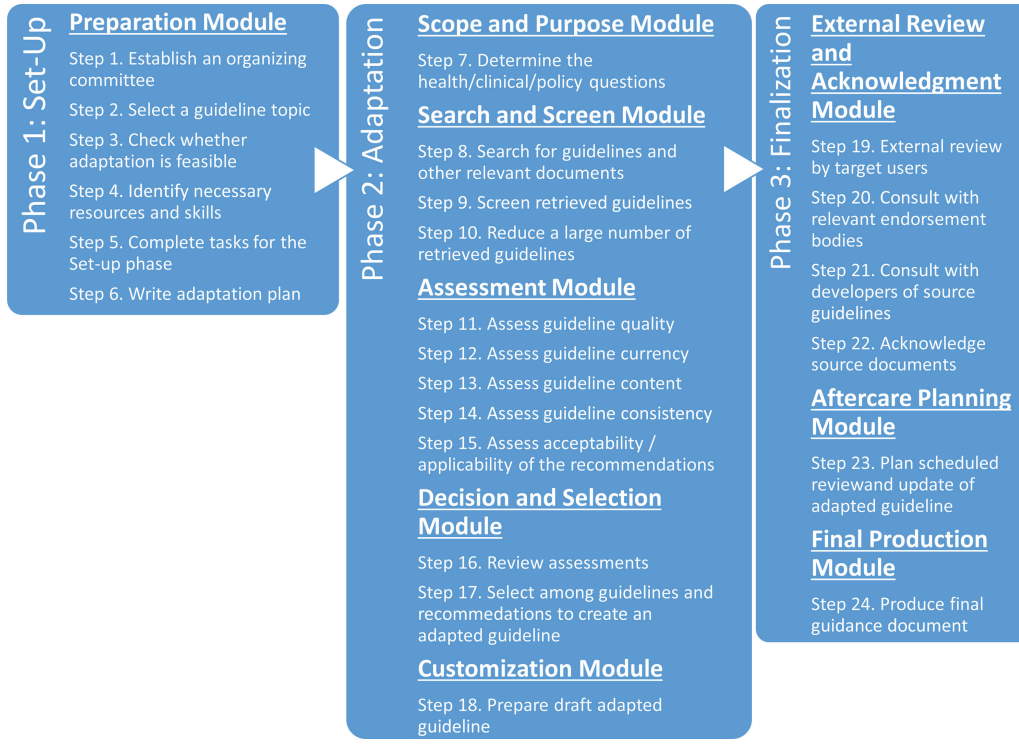

Figure. Phases, modules, and steps in the adaptation process. From the ADAPTE Collaboration, Version 2.0.[29] This figure is available in color online (www jgeript.org).

consists of 23 items scored on a 7-point response scale comprising 6 quality-related domains: scope and purpose, stakeholder involvement, rigor of development, clarity of presentation, applicability, and editorial independence. Before scoring the CPGs, all reviewers completed AGREE II online training.[31] Training was followed by all reviewers scoring 3 CPGs to examine consistency in using the AGREE II instrument. Once consistency was achieved, pairs of reviewers used the AGREE II instrument to independently score the quality and rigor of their assigned CPGs. When incongruent scoring occurred, the study coordinator performed a third appraisal as a mediator with a follow-up discussion if needed. Table 1 presents the AGREE II CPG Rigor and Quality Scores for the 6 scored CPGs. Consistent with previous APTA Geriatrics documents, we included only CPGs with AGREE II scores of 50% for further consideration for adaptation, reducing the total to 3.[32]

The team evaluated these 3 CPGs for relevance to the use of exercise interventions by physical therapists in managing patients with osteoporosis. We reviewed: (1) *SIGN publication no. 142: Management of osteoporosis and the prevention of fragility fractures*[21]; (2) *Too Fit to Fracture: exercise*

Table 1. AGREE II Rigor and Quality Scores for Osteoporosis Clinical Practice Guidelines

Guideline Title	AGREE II Rigor Score	AGREE II Quality Score
Management of osteoporosis and the prevention of fragility fractures. Scottish Intercollegiate Guidelines Network (SIGN). (Scotland, 2015, updated 2020 and 2021)[21]	93%	95%
Too Fit to Fracture: Exercise recommendations for individuals with osteoporosis or osteoporotic vertebral fracture. International Osteoporosis Foundation and National Osteoporosis Foundation. (Canada, 2013)[27]	85%	85%
National Osteoporosis Guideline Group (NOGG) 2017: Clinical guideline for the prevention and treatment of osteoporosis. National Institute for Health and Care Excellence (NICE) accredited. (Britain/United Kingdom, 2017)[26]	71%	65%
2015 Guidelines for Osteoporosis in Saudi Arabia: Recommendations from the Saudi Osteoporosis Society. (Saudi Arabia, 2015)[25]	41%	56%
Clinical guidelines for the prevention and treatment of osteoporosis: Summary statements and recommendations from the Italian Society of Orthopedics and Traumatology. (Italy, 2017)[23]	26%	47%
Taiwanese Guidelines for the Prevention and Treatment of Osteoporosis. (Taiwan, 2014)[24]	21%	38%

Abbreviation: AGREE, Appraisal of Guidelines for Research & Evaluation.

*recommendations for individuals with osteoporosis or osteoporotic vertebral fractur*e[27]; and (3) *National Osteoporosis Guideline Group 2017: Clinical guideline for the prevention and treatment of osteoporosis*.[26] The SIGN CPG had both the highest overall AGREE II score and the most comprehensive scope of exercise recommendations. The team agreed that the other 2 CPGs did not provide additional information beyond that addressed by the SIGN CPG. We therefore decided to adapt the SIGN CPG for use by physical therapists managing patients with osteoporosis in the United States.

The SIGN CPG provided recommendations for the comprehensive management of osteoporosis and prevention of factures. Because our purpose was limited to recommendations to guide physical therapists in prescribing physical activity or exercise interventions to maintain or improve bone density, we addressed only sections of the SIGN CPG dealing with physical activity and exercise interventions. The SIGN CPG addressed exercise interventions for postmenopausal women, premenopausal women, and men. Exercise recommendations in the SIGN document were based on the findings from 8 systematic reviews. The SIGN CPG was published in 2015 and updated in 2020 and 2021. To evaluate the currency of the SIGN exercise recommendations, we contacted the Scottish Intercollegiate Guidelines Network in April 2020. They indicated that while they were updating the SIGN CPG (*Management of osteoporosis and the prevention of fragility fractures*), the exercise recommendations had not changed and were being republished verbatim in the 2021 update (A. Stein, email communication, April 9, 2020). SIGN recommendations were heavily based on a Cochran Library Systematic Review, which was revised in 2002 and 2011.[33] Emerging research did not trigger changes to SIGN recommendations in 2021. The study team reviewed the SIGN exercise recommendations to determine the extent to which we needed to modify them to make them more relevant to physical therapist practice. We also reviewed the terminology used in the recommendations to assess consistency with the terminology used in the source studies and with terminology commonly used in the United States.

Guideline Adaptation

The SIGN CPG used the definitions of exercise types described in the *Cochrane Library Systematic Review*: "Exercise for Preventing and Treating Osteoporosis in Postmenopausal Women."[33] The Cochrane Review described exercises as static or dynamic, weight-bearing or non–weight-bearing position, and involving high or low force (see Table 2). To provide physical therapists with the type of exercise information they would need to guide practice, we extracted detailed information on exercise mode, frequency and duration, adverse events, and participant characteristics from the systematic reviews on which SIGN based their recommendations. Physical activity encompasses all bodily movements (ie, walking, cycling, active recreation) that are performed at any level of skill and for enjoyment. Exercise falls under the umbrella of physical activity and is planned, structured, and repetitive. These components are the basis of exercise prescription that targets objective improvement or maintenance in physical health and/or fitness.[34] Since this document is focused on improving bone health, we are contextualizing all recommendations under the term "exercise." We described the strength of the adapted recommendations based on criteria from the *APTA Clinical Practice Guideline Process Manual, Revised*[35] (see Table 3).

RESULTS

Sign Exercise Recommendations for Postmenopausal Women

Static weight-bearing exercise

SIGN recommendations: Static weight-bearing (SWB) exercise, for example, single-leg standing should be considered to slow the decline of hip BMD.

SIGN summary: A meta-analysis reported a statistically significant reduction in BMD decline from 1 small study of single-leg standing (mean difference in hip BMD between exercise and control groups: 2.42%; 95% CI, 0.73-4.10). No risk of fracture/falls or QOL outcomes were reported.[33]

Dynamic weight-bearing exercise (low force)

SIGN recommendations: Walking, tai chi, and progressive-resistance strength training (such as closed kinetic chain weight training) should be considered to slow the decline of lumbar spine BMD.

SIGN summary: Dynamic weight-bearing exercise with low force (DWBLF) performed standing (ie, walking, tai chi) showed no effect on fracture outcomes.[33] Dynamic weight-bearing exercise with low force mitigated the decline in spine BMD as demonstrated in a meta-analysis of 7 studies (mean difference in spine BMD between exercise

Table 2. Exercise Interventions Definitions

Exercise	Definition[33]
SWB	Static weight-bearing exercise including single-leg standing.
DWBLF	Dynamic weight-bearing exercise with low force including walking and tai chi.
DWBHF	Dynamic weight-bearing exercise with high force including jogging, jumping, running, dancing, and vibration platform.
NWBLF	Non–weight-bearing exercise with low force, eg, low-load high-repetition strength training.
NWBHF	Non–weight-bearing exercise high force, eg, progressive resisted strength training.
COMB	Combination of exercise types with more than one of the above exercise interventions.

Table 3. Grades/Strength of Recommendation

Letter Grade	Strength of Recommendation	Definition[35]
A	Strong	A high level of certainty of *moderate to substantial* benefit, harm, or cost, or a *moderate* level of certainty for substantial benefit, harm, or cost (based on a preponderance of level 1 or 2 evidence with at least 1 level 1 study).
B	Moderate	A high level of certainty of *slight to moderate* benefit, harm, or cost, or a *moderate* level of certainty for a *moderate* level of benefit, harm, or cost (based on a preponderance of level 2 evidence, or a single high-quality RCT).
C	Weak	A moderate level of certainty of *slight* benefit, harm, or cost, or a weak level of certainty for moderate to substantial benefit, harm, or cost (based on level 2 through 5 evidence).
D	Theoretical/ foundational	A preponderance of evidence from animal or cadaver studies, from conceptual/theoretical models/principles, or from basic science/bench research, or published expert opinion in peer-reviewed journals that supports the recommendation.
P	Best practice	Recommended practice based on current clinical practice norms, exceptional situations in which validating studies have not or cannot be performed; yet, there is a clear benefit, harm, or cost, expert opinion.
R	Research	An absence of research on the topic or disagreement among conclusions from high-quality studies on the topic.

Abbreviation: RCT, randomized clinical trial.

and control groups: 0.84%; 95% CI, 0.26-1.48); however, no effect was observed for hip BMD.[33] Bone mineral density data at the femoral neck were inconsistent in showing a positive effect from walking.[36] However, another systematic review demonstrated reduction in BMD decline associated with walking in 2 studies.[37] No data are available on the effect of DWBLF on the risks of falls or QOL.

Dynamic weight-bearing exercise (high force)

SIGN recommendation: No evidence-based recommendation provided. There was no statistically significant effect of this type of exercise on bone density at the spine or the hip.

SIGN summary: Dynamic weight-bearing exercise with high force (DWBHF) performed in a standing position includes these forms of exercise: jogging, jumping, running, dancing, and use of vibration platforms. There was no effect on change in BMD of the spine reported in a meta-analysis of 4 studies involving DWBHF.[33] Furthermore, high-impact only and odd-impact only protocols were ineffective in increasing BMD at any site.[38] (Odd-impact was defined as aerobic or step classes, bounding exercises, agility exercises, and games in which movements included directional elements that the body is not normally accustomed to.) No data were available on the effects of high-force dynamic weight-bearing exercise on the risks of fracture, falls, or QOL.

Non–weight-bearing exercise (low force)

SIGN recommendation: No evidence-based recommendation provided.

SIGN summary: Non–weight-bearing exercise with low force (NWBLF) includes high-repetition, low-load strength training with open kinetic chain weight exercises in a supported or seated position. No significant differences were observed for any BMD outcomes with low-force non–weight-bearing exercise, for example, seated low-load, high-repetition strength training.[33] No data were available on the effects of non–weight-bearing exercise on the risks of fracture, falls, or QOL.

Non–weight-bearing exercise (high force)

SIGN recommendation: Progressive resistance strength training exercise (such as open kinetic chain weight training) should be considered to slow the decline of femoral neck BMD.

SIGN summary: Non–weight-bearing exercise with high force (NWBHF) includes progressive resistance strength training with open kinetic chain weight exercises in a supported or seated position. The NWBHF exercise slowed the BMD decline at the spine (mean difference in spine BMD between exercise and control groups: 0.86%; 95% CI, 0.58-1.13, 8 studies) and neck of femur (mean difference in femoral neck BMD between exercise and control groups: 1.03%; 95% CI, 0.24-1.82, 8 studies).[33] An increase in spine BMD of 0.006 g/cm^2 (95% CI, 0.002-0.011; P = .006, 14 studies) was demonstrated following NWBHF in a different meta-analysis.[39] No data were available on the effects of non–weight-bearing high force exercise on the risks of fracture, falls, or QOL.

Combination of exercise types

SIGN recommendation: Combinations of closed kinetic chain (low force) (eg, progressive strengthening, balance training, endurance training), paired with open kinetic chain (high force) (eg, flexibility/stretching, progressive strengthening, endurance training) should be considered to optimize bone health.

SIGN summary: Risk of fractures in groups performing combinations of any 2 of the exercise types (SWB, DWBLF, DWBHF, NWBLF, and NWBHF) was significantly lower than that in controls (odds ratio: 0.33; 95% CI, 0.13-0.85, 2 studies).[33] A reduction in BMD decline at the spine was reported (mean difference in spine BMD between exercise and control groups immediately following intervention: 3.22%; 95% CI, 1.80-4.64, 4 studies). Combination of exercise types (COMB) exercise slowed total hip BMD decline when compared with controls (mean difference in total hip BMD between exercise and control groups:

−1.07%; 95% CI, −1.58 to −0.56, 4 studies).[33] Impact protocols that included jogging mixed with walking and stair climbing, and protocols that incorporated impact exercise with high-magnitude force (resistance exercises) were effective at reducing bone density loss at the lumbar spine and femoral neck.[38] Combined aerobics and high-intensity resistance exercises had a positive effect on BMD decline.[37] Intervention with combined exercise programs had better effects on physical function, pain, and vitality domains than controls ($P < .05$).[40] No data were available on the effects of these interventions on the risks of falls.

A systematic review and meta-analysis of moderate- to high-quality randomized clinical trials (RCTs), which looked at the effect of falls prevention exercise programs on fracture rates, reported a significant reduction in the rate of falls resulting in fracture, with a pooled estimated rate ratio of 0.39 (0.23-0.66, 6 studies, $I^2 = 0\%$). While mixed populations were included, 77% of participants were postmenopausal women, and no subgroup analysis for men was performed. The studies that decreased falls resulting in fractures included balance training and most were multicomponent, including other exercise types such as strengthening, flexibility, and endurance exercise.[41] Another meta-analysis reported an overall fracture reduction in the exercise group compared with controls (relative risk: 0.49; 95% CI, 0.31-0.76).[42] The findings of this study are limited by methodological flaws of individual studies, and potential for publication bias was noted by the authors.

ADAPTED EXERCISE RECOMMENDATIONS FOR POSTMENOPAUSAL WOMEN

Adapted Exercise Recommendations for Postmenopausal Women to Slow Decline of BMD of the Hip and the Femoral Neck

Physical therapists should design and advise postmenopausal women to participate in long-duration (ie, minimum of 6-48 months) exercise programs consisting of static weight-bearing (SWB—SIGN terminology) exercises such as single-leg standing to slow the decline of BMD at the hip. Physical therapists should design and advise postmenopausal women to participate in long-duration, adequately dosed progressive resistance strength training exercises such as weight training either alone or in combination with impact exercise training such as jogging, walking, or aerobics to slow the decline of BMD of the femoral neck. (Grade B, recommendation based on moderate evidence)

Adapted Exercise Recommendations for Postmenopausal Women to Slow Decline of BMD of the Lumbar Spine

Physical therapists should consider designing and advising postmenopausal women to participate in long-duration exercise programs consisting of walking, tai chi, progressive resistance strength training (such as weight training), and different combinations of exercise types to slow the decline of lumbar spine BMD. (SIGN terminology DWBLF, NWBHF, COMB). (Grade B, recommendation based on moderate evidence)

Postmenopausal Women: Adapted Summary Statement

Based upon evidence from the SIGN CPG systematic reviews, there is a small positive effect on BMD in postmenopausal women that is exercise mode and anatomical site specific. Static weight-bearing exercises such as single-leg stance had a modest impact on the decline in hip BMD.[33] This finding was based solely on 1 RCT in Asian women without a clear diagnosis of osteoporosis; therefore, generalizability to other populations is unclear. However, based upon positive findings and the low risk of adverse events, we agree that single-leg weight-bearing activities should be recommended. The specific dose is unclear, but 1 minute per leg, 3 times per week for 24 weeks had a beneficial effect. The DWBLF exercises slowed BMD loss at the lumbar spine but no effect on BMD at the hip.[33,36,37,41,42] Participants in DWBLF studies ranged from healthy postmenopausal women to women with diagnosed osteopenia, ranging in age from 46 to 92 years. Many of the studies included balance and flexibility exercises in addition to the DWBLF exercises. The reports of injuries and high attrition are of some concern, but injuries did occur in both control and experimental groups. The high attrition rates reported suggest that motivational strategies should be an important aspect of this type of exercise program. The exercise programs in these studies were generally high-intensity and long-duration. The overall dose ranges were 50 to 60 minutes, 3 times per week for 40 to 54 weeks at 60% to 70% of heart rate reserve.

The NWBHF exercise had a positive effect on BMD at both the spine and the femoral neck.[33,39] Participants in these studies ranged from healthy postmenopausal women to women with diagnosed osteoporosis or osteopenia, ranging in age from 41 to 75 years. These studies reported a low incidence of injuries. Because older individuals may be at increased risk for falls, NWBHF exercises such as seated, high-intensity progressive resistive strength training may be inherently safer than DWBHF exercises in this population. The exercise programs in these studies were generally high-intensity and long-duration. The NWBHF exercises doses ranged from 1 to 3 sets, 7 to 14 repetitions, at approximately 70% to 85% 1 repetition maximum (RM), 2 to 3 times per week, for 24 to 104 weeks. Estimation of intensity based on 1RM is beyond the scope of this CPG but has previously been addressed in other publications.[43]

The COMB exercise moderately improved BMD at the spine and slightly improved BMD at the trochanter/femoral neck.[33,37,38,40-42] In each of the 4 COMB studies, references were made to aerobic exercise or low-impact aerobics, but it is not clear how these activities were performed. Therefore, based on the data provided, we recommend

utilizing DWBLF paired with NWBHF. Participants in these studies included postmenopausal women with osteoporosis with ages ranging from 57 to 87 years.

There was insufficient evidence to support the use of NWBLF or DWBHF exercises.[33,38] The NWBLF exercises may be underdosed on the basis of recommendations from the APTA in the American Board of Internal Medicine Foundation's "Choosing Wisely" campaign.[44] However, it is important to note that participants in the studies examining this type of exercise were healthy postmenopausal women. The effect of NWBLF exercises on osteoporotic women is unknown. The DWBHF exercises did not have a positive effect on BMD at the spine or the hip. There is a possibility that the high-frequency, high-magnitude activities, such as plyometrics, jumping, and running, included in DWBHF programs could result in stress reactions or structural failure due to excessive overload in women with osteoporosis.[45] Conversely, the inclusion of vibration as a DWBHF activity is inconsistent with practical application in the United States. This intervention is typically done in a static standing position, with frequencies ranging from 12 to 50 Hz, and with no additional external force added.[46] Thus, overall, DWBHF exercises did not show a positive effect in the SIGN document. Based on the description of DWBHF, it is important to note that minimal injuries were reported across the 4 studies indicating that this type of exercise could be safe, but the conclusions were drawn from a relatively small number of studies utilizing this form of exercise with postmenopausal women (see Table 4).

SIGN EXERCISE RECOMMENDATIONS FOR PREMENOPAUSAL WOMEN

Static Weight-Bearing Exercise

SIGN recommendation: No evidence-based recommendation provided.

SIGN summary: No systematic reviews have provided evidence on SWB forms of exercise intervention in premenopausal women.

Dynamic Weight-Bearing Exercise (Low Force)

SIGN recommendation: No evidence-based recommendation provided.

SIGN summary: No systematic reviews have provided evidence on DWBLF forms of exercise intervention in premenopausal women. One meta-analysis of 10 RCTs on the effect of walking on BMD in postmenopausal and perimenopausal women reported only a single small trial, which included perimenopausal women aged 40 to 60 years (n = 50). This study showed no effect of walking on BMD in this cohort.[47]

Dynamic Weight-Bearing Exercise (High Force)

SIGN recommendation: Progressive-resistance strength training (such as closed kinetic chain weight training) alone, or in combination with impact exercise (such as stair climbing or jogging), should be considered to slow the decline of lumbar spine BMD.

SIGN summary: High-impact only programs were effective in reducing BMD decline only at the femoral neck (weighted mean difference, WMD: 0.024 g/cm^2; 95% CI, 0.002-0.027; $P < .00001$).[48]

Non–Weight-Bearing Exercise (Low Force)

SIGN recommendation: No evidence-based recommendation provided.

SIGN summary: No systematic reviews have provided evidence on NWBLF forms of exercise intervention in premenopausal women.

Non–Weight-Bearing Exercise (High Force)

SIGN recommendation: Progressive-resistance strength training (such as open kinetic chain weight training) should be considered to slow the decline of lumbar spine BMD.

SIGN summary: High-intensity progressive resistance training was shown to be effective in increasing absolute BMD at the lumbar spine (WMD: 0.014 g/cm^2; 95% CI, 0.009-0.019; $P < .00001$) but not the femoral neck (WMD: 0.001 g/cm^2; 95% CI, −0.006 to 0.008, $P = .78$) in premenopausal women.[49]

Combination of Exercise Types

SIGN recommendation: High-impact exercise (such as jogging and stair climbing) and combining impact exercise with progressive-resistance strength training should be considered to slow the decline of femoral neck and lumbar BMD.

SIGN summary: Exercise programs that combine odd- or high-impact activity with high-magnitude resistance training appear effective in increasing BMD in premenopausal women at the femoral neck (WMD: 0.007 g/cm^2; 95% CI, 0.001-0.013; $P = .02$) and the spine (WMD: 0.009 g/cm^2; 95% CI, 0.002-0.015; $P = .01$).[48]

ADAPTED EXERCISE RECOMMENDATIONS FOR PREMENOPAUSAL WOMEN

Exercise Recommendations for Premenopausal Women to Slow Decline of BMD of the Femoral Neck

Physical therapists should consider designing and advising premenopausal women to participate in long-duration exercise programs consisting of high-impact exercise (such as jogging) and combining impact exercises (such as stair climbing) with progressive-resistance strength training (such as weight training) to slow the decline of femoral neck BMD. (Grade B, recommendation based on moderate evidence)

Exercise Recommendations for Premenopausal Women to Slow Decline of BMD of the Lumbar Spine

Physical therapists should consider designing and advising premenopausal women to participate in long-duration exercise programs consisting of progressive-resistance strength training (such as weight training) alone or in combination with impact exercises (such as stair climbing or jogging) to slow the decline of lumbar spine BMD. (Grade B, recommendation based on moderate evidence)

Table 4. Detailed Information on Exercise Interventions for Postmenopausal Women

Exercise Type	Exercise	Exercise Dose	Participants	Adverse Events	Evidence Summary
Static weight bearing[33]	Single-leg standing	1 min per limb 3 times per day 24 wk	94 Japanese women, mean age: 68 y (age range: 61-85 y)	None reported	Evidence **supported** a modest positive impact of static weight-bearing exercises on **hip** BMD
Dynamic weight bearing: Low force[33,36,37]	Walking, tai chi	50-60 min 3 times per week 40-54 wk	Healthy postmenopausal women, women with UE fracture, women with osteopenia Age: 46-92 y North America, Europe, Asia, and Australia	Exercise and control groups reported injuries. One exercise-specific injury reported	Evidence **supported** weight-bearing low-force exercises to slow **spine** BMD loss Evidence **did not support** weight-bearing low-force exercises to increase spine BMD
Dynamic weight bearing: High force[33,38]	Standing weight lifting Walking/jogging or hopping Stair climbing with weighted vests, jumping, running, dancing, vibration platforms	50-55 min per session 2-3 d/wk 52 wk	Healthy postmenopausal women, women with osteopenia or osteoporosis Age: 40-65 y United States	One injury reported in an intervention group	Evidence **did not support** dynamic weight bearing: high force exercises to improve or maintain BMD at the spine or the hip
Non–weight bearing: Low force[33]	Seated low-load, high-repetition strength training	~40% 1RM 1-3 sets of 10-20 repetitions 3-7 times per week 24-104 wk	Healthy postmenopausal women Age: 41-82 y	None reported	Evidence **did not support** non–weight-bearing low-force exercises in nonosteoporotic postmenopausal women
Non–weight bearing: High force[33,39]	Seated progressive resistive, high-load strength training Some programs included both upper and lower extremity exercise	1-3 sets ~70%-85% 1RM 2-3 times per week 24-104 wk	Healthy postmenopausal women Age: 41-75 y North and South America and Australia 2 studies excluded women with osteoporosis	None reported	Evidence **supported** modest positive impact of non–weight-bearing high-force exercises on BMD at both the **spine and the femoral neck**
Combination of exercise types[33,37,38,40-42]	Combinations of any 2 of the exercise types described previously	2-7 d/wk 52 wk Intensity not reported	Postmenopausal women Age: 53-87 y Europe and Asia 2 studies included women with osteoporosis	None reported	Evidence **supported** a modest positive impact of combination exercises on BMD at both the spine and the femoral neck Evidence also **suggested** that combination exercise programs substantially reduced the risk of fractures

Abbreviations: BMD, bone mineral density; RM, repetition maximum; UE, upper extremity.

Premenopausal Women: Adapted Summary Statement

There is insufficient or no evidence on which to make recommendations about the use of SWB, DWBLF, and NWBLF exercises in premenopausal women.[47] Evidence supported the positive impact of DWBHF such as jumping, jogging, and running in reducing BMD decline at the femoral neck.[48] Participants in these studies were healthy, premenopausal women aged 20 to 48 years with program durations ranging from 6 months to 2 years. Evidence also supported NWBHF exercises such as seated progressive resistive and high-load strength training for increasing BMD at the lumbar spine.[49] Participants in these studies were healthy, premenopausal women aged 20 to 50 years with program durations ranging from 5 to 18 months. The COMB exercise programs that included combinations such as circuit strength training and high-impact aerobics or skipping and strength training increased BMD at both the femoral neck and lumbar spine in healthy participants with ages ranging from 24 to 41 years with program durations of 6 to 24 months.[48] These findings suggest that long-duration appropriately dosed high-force exercises are required to improve bone health in healthy premenopausal women. These programs must be viewed as preventative in that none of the participants were diagnosed with osteoporosis (see Table 5).

SIGN EXERCISE RECOMMENDATIONS FOR MEN

SIGN summary: One meta-analysis identified 3 studies that investigated the effects of exercise on BMD in men. These studies included diverse populations, with varied exercise types and used different measures of BMD. Study quality was unclear overall, and 2 studies were unpublished dissertations. The primary outcome measures of change in lumbar spine or femoral neck BMD were calculated as standardized effect sizes (*g*). The *g* statistic for each group from each study was calculated as the change score difference (absolute or relative) in the exercise group minus the change score difference in the control group, divided by the pooled standard deviation of the exercise and control groups. The relative magnitude of *g* may be described as trivial (<0.20), small (≥ 0.20 to <0.50), medium (≥ 0.50 to <0.80), or large (≥ 0.80).

Overall, a moderate and statistically significant benefit of exercise on the femoral neck BMD was observed ($g = 0.583$; 95% CI, 0.031-1.135). No significant effect was seen with exercise on lumbar spine BMD ($g = 0.190$; 95% CI, -0.036 to 0.416).[50]

Another systematic review considered the effect of resistance training (eg, weight training) only or in combination with impact-loading (weight bearing) activities. This small review considered heterogeneous study designs of varying and limited quality that used different sites to measure BMD. The authors concluded that exercise may be a safe and effective means to reduce BMD loss in middle- and older-aged men.[51] Exercise protocols included a range of DWBLF, DWBHF, NWBLF, and NWBHF activities.

SIGN recommendation: There is currently limited evidence on the role of exercise in mitigating BMD loss in men. Further well-designed research studies in men are needed before any recommendations can be made.

ADAPTED EXERCISE RECOMMENDATIONS FOR MEN

Men: Adapted Summary Statement

There is insufficient evidence to support exercise as a factor in improving BMD in men. However, exercise is a safe and effective means of maintaining and improving health, function, and QOL supported by national physical activity guidelines.[52]

Because of a lack of research evidence on the role of exercise in improving BMD in men, we were unable to provide any adapted exercise recommendations for men.

DISCUSSION

SIGN Summary of Knowledge Gaps and Future Research

Overall, there was a small, positive effect of exercise on BMD in postmenopausal women that is exercise-type and site-specific. High-force exercise can reduce BMD decline at the femoral neck, progressive-resistance exercise can reduce BMD decline at the lumbar spine, and impact protocols combined with resistance can reduce BMD decline at both the femoral neck and the lumbar spine. When comparing premenopausal with postmenopausal recommendations, there is a change in loading recommendations. Premenopausal women should perform high-force exercises in both weight-bearing and non–weight bearing positions to improve hip and spine BMD. This exercise prescription is aligned with current recommendations to improve bone size and strength, which may translate to a reduction in fractures. When transitioning to postmenopausal women, high forces are recommended only for non–weight-bearing (ie, seated, supported) positions, while low forces should be used with static (unilateral stance) or dynamic (walking, dancing) exercises. Although there was no specific recommendation for men, the lack of adverse effects supported our recommendation of encouraging and implementing lifelong fitness and bone health strategies such as those recommended for women of corresponding ages. Research studies commonly focus on the hip, spine, and radius because these sites make up the large majority of fracture sites. While we cannot speak to BMD improvements at additional sites, we cannot exclude the possibility that these recommendations can have universal skeletal effects. Conclusions must be interpreted with some caution as the original studies suffered from diverse methodological and reporting discrepancies that resulted in low study quality.[21]

Osteoporosis is difficult to capture in a silo of simply BMD. While BMD is important, fracture risk and falling

Table 5. Detailed Information on Exercise Interventions for Premenopausal Women

Exercise Type	Exercise	Exercise Dose	Participants	Adverse Events	Evidence Summary
Static weight bearing	Single-leg standing	No systematic reviews available	Not applicable	Not applicable	There is **insufficient evidence** to make any conclusion about this type of exercise specifically for BMD
Dynamic weight bearing: low force[47]	Walking, tai chi	No systematic reviews available	Not applicable	Not applicable	There is **insufficient evidence** to make any conclusion about this type of exercise specifically for BMD
Dynamic weight bearing: high force[48]	Jumping, jogging, skipping, running, dancing, vibration platforms	*Jumping* 5 sets of 10 repetitions 100 jumps per day 40-min skipping Jumping with weighted vest 2-6 d/wk 6-18 mo *High-impact aerobics* 60 min/session 3 times per week 1-2 y	Healthy, premenopausal women Age: 20-48 y North America, Asia, and Europe	None reported	Evidence **supported** the positive impact of dynamic weight-bearing high-force exercises in reducing BMD decline only at the femoral neck
Non–weight bearing: Low force	Progressive resistive, low-load strength training	No systematic reviews available	Not applicable	Not applicable	There is **insufficient evidence** to make any conclusion about this type of exercise specifically for BMD
Non–weight bearing: High force[49]	Seated progressive resistive, high-load strength training	60% 1RM 5 sets of 20 repetitions 2-3 d/wk 5-18 mo	Healthy, premenopausal women Age: 20-50 y North America Some studies excluded women on oral contraceptives	None reported	Evidence **supported** modest positive impact of non–weight-bearing high-force exercises on BMD at the lumbar spine but not the femoral neck
Combination of exercise types[48]	Circuit strength and high-impact aerobics Skipping and strength training Resistance training and jumping	2-9 sets of 8-12 repetitions 3 d/wk 12 mo	Healthy premenopausal women. Age: 24-41 y North America	None reported	Evidence **supported** that combination exercises were effective in increasing BMD at the femoral neck and the lumbar spine

Abbreviations: BMD, bone mineral density; RM, repetition maximum.

are as equally important to the patient for QOL and mobility. The difficulty lies in how to identify change and utilize palatable evidence-based documents for clinicians and patients. We viewed osteoporotic fractures as a combination of low BMD and fall risk. Given that a falls evidence-based document specific to physical therapy currently exists, our focus for this document was solely on BMD. The challenge specific to BMD is the long duration needed to improve bone health parameters, paired with the clinical need to document BMD changes that we as physical therapists do not measure. The lack of head-to-head comparisons of interventions and outcomes increase the complexity in decision making for clinicians and for patients to realize progress. Regardless of expected outcomes, properly dosed exercise is assumed to be a safe intervention, with appropriate considerations for patients who present to the physical therapist with previous fracture, injuries, or comorbidities in combination with osteoporosis.

Adapted Summary of Knowledge Gaps and Future Research

Evidence concerning the safety of exercise interventions was inferred from reports of very few adverse events in trials of exercise intervention. Older individuals have both real and perceived concerns about participating in long-duration exercise programs. Unfortunately, none of the research studies supporting this CPG specifically examined exercise safety or included participants who would be at high risk for adverse exercise outcomes. The lack of evidence should not infer to the reader that exercise is unsafe for older individuals attempting to improve BMD but rather, further research is warranted particularly in high-risk populations.

Both clinicians and patients want to identify the best exercise program to improve BMD. Unfortunately, none of the studies directly compared 2 potentially effective exercise interventions. Such studies would be very costly and difficult to conduct. One of the challenges of bone research is that in adults, bone does not demonstrate appreciable and measurable short-term (ie, <3 months) adaptations in response to loading, rather bone adapts over the long term (ie, 6-48+ months).[45] Studies comparing 2 exercise interventions for their impact on hip and spine BMD would need to be of long duration. The long duration combined with the large sample size required to compare the effectiveness of 2 interventions would present several challenges including the high cost of such a study, difficulty recruiting participants, and maintaining exercise adherence over a long period. Exercise intervention studies to improve BMD of nonosteoporotic premenopausal women would have the added problem of focusing on preventing rather than treating osteoporosis. In addition, these studies lacked racial diversity and therefore it is difficult to extrapolate findings to the general US population. Given all these obstacles, it is not surprising that we continue to lack evidence to guide physical therapist management of individuals with osteoporosis. Future studies should explore response to exercise interventions targeted to individuals across broader racial groups. Physical therapist management of osteoporosis from examination and evaluation to intervention will be addressed in a companion document that utilized a Delphi process to produce recommendations based on expert opinion.

Although fracture and falls were not a focus of this document, we retained the full spirit of the SIGN recommendation. There was evidence that exercise influences fracture risk when the exercise is multimodal and part of a fall prevention program. No systematic reviews have reported on fracture/falls risk, adverse effects, or QOL outcomes of exercise interventions for premenopausal women with osteoporosis. Fractures are an important outcome measure in individuals with osteoporosis and are closely associated with fall risk. Exercise interventions may decrease the risk of fracture by both increasing BMD and by decreasing risk of falling. It is important for physical therapists to assess the risk of falling in individuals with osteoporosis, which is not addressed in this document. We recommend that clinicians managing patients with osteoporosis consult the Academy of Geriatric Physical Therapy/APTA clinical guidance statement directed at fall risk reduction.[32]

Implementation

The recommendations included in this document are supported by evidence indicating specific types of exercise that may improve or slow the decline in BMD at the hip and the lumbar spine in both pre- and postmenopausal women. However, it is important to recognize that this evidence comes from long-duration exercise programs ranging in length from many months to a year or more. In the United States, the duration of physical therapy episodes of physical therapist care is not commonly sustained for a year or more. However, patients could be managed for much longer episodes of care throughout the life span by participating in long-duration exercise programs and routine/annual physical therapy checkups. For patients with access to Medicare, physical therapists' services are a covered benefit, with no limitations on care (related to time, visits, or cost) if the services provided are medically necessary and skilled.[53,54] This includes maintenance care and care to prevent a decline in function.[54] A new model for physical therapy management of patients with osteoporosis could involve concluding and then resuming multiple short episodes of care over an extended time period. In addition, patients who are able to safely participate in lifelong physical activities to improve bone health, and health in general, should be encouraged to do so.

The ability of individuals to follow physical therapy recommendations requiring them to participate in long-duration exercise programs will be influenced by many of the social determinants of health. *Healthy People 2020* organizes the social determinants of health around 5 key domains: (1) economic stability, (2) education, (3) health and health care, (4) neighborhood and built environment, and (5) social and community context.[55] Physical therapists should evaluate each patient's social determinants of

health when designing long-duration exercise programs to improve bone health in premenopausal women and maintain bone mass in women with osteoporosis. We recommend that clinicians consider the following 5 factors:

Economic stability

Patients in economic distress may be food or housing insecure. Such patients would be unable to join a health club or purchase exercise equipment. Fortunately, many exercises do not require equipment. Static weight-bearing exercises such as single-leg stance may slow the decline of hip BMD if performed at least 1 minute per leg. When individuals cannot join a health club or purchase exercise equipment, NWBHF (seated progressive resistive, high-load strength training) programs can use easily accessible items such as elastic tubing or plastic jugs filled with water to provide resistance. The DWBLF walking programs to slow decline in spine BMD in postmenopausal women with osteoporosis or DWBHF programs to prevent osteoporosis (ie, premenopausal women) such as running, jogging, jumping, or stair climbing do not require equipment or access to a health club.

Education

Patients with marginal literacy may have difficulty understanding written instructions for home exercise programs. Patients with poor literacy may not understand the instructions to progress exercise programs, exercise precautions, or appreciate the benefits of long-duration exercise. This type of patient may require closer supervision, video instruction, or illustrated handouts provided by a physical therapist.

Health and health care

Patients without health insurance may not be able to afford even a small number of physical therapy sessions to develop and progress an exercise program. Patients covered by Medicare advantage plans may have limitations on the number of therapy sessions allowed for an episode of care. Patients with traditional Medicare Part B may have more flexibility in the number and duration of an episode of care for licensed therapists to prescribe and monitor an exercise program to maintain BMD. Patients with poor health literacy may not understand the relationship between exercise and BMD and may require closer supervision by a physical therapist.

Neighborhood and built environment

Exercise programs involving walking or jogging may slow the decline of BMD of the femoral neck and lumbar spine. However, patients who live in dangerous neighborhoods due to crime or in neighborhoods where sidewalks are lacking or in disrepair may have difficulty participating in these types of exercise programs. Physical therapists should consider the patient's physical environment when designing exercise programs and may recommend possible alternative environments such as parks, malls, or school grounds when available.

Social and community

Exercise programs to improve or maintain BMD must be of long duration to be effective. The duration can range from 6 to 48 months, while the most commonly employed time frame is 12 months.[56] Social support and encouragement from family or friends are often critical in initiating and sustaining participation. Individuals who live alone or who are socially isolated may benefit from joining health clubs or community exercise groups.

External Review

Expert reviewers

A panel of 17 experts in geriatric physical therapy and/or osteoporosis was invited to review an initial draft of the document. Invited experts included 3 physical therapists with demonstrable research expertise in physical therapist management of patient/clients with osteoporosis, 8 physicians (endocrinology, geriatrics, and/or orthopedics), 3 exercise physiologists with research expertise in exercise and bone health, and 2 lay people who would be impacted by the work. The panelists were provided with a draft of the work and then asked to complete a 22-item survey asking about its methodology and feasibility of implementation. Four of the invited experts commented (2 physical therapists and 2 exercise physiologists). Panelists were given up to 30 days to provide input. Detailed results of the survey are presented in Supplemental Digital Content Table 1, available at: http://links.lww.com/JGPT/A104, which summarizes invited expert and APTA Geriatrics Bone Health Special Interest Group members' levels of agreement. All comments, suggestions, and feedback from the expert reviewers were provided to the authors for consideration and revisions. Revisions to the draft were made in response to relevant comments.

Target user reviewers

Members of APTA Geriatrics were invited to review and comment on the draft via a blast email. Additional targeted emails were sent to members of APTA Geriatrics' Bone Health Special Interest Group. Nine physical therapists initiated the survey and 6 completed it. Users had up to 17 days to complete the survey and comment. The results of the survey responses are presented in Supplemental Digital Content Table 1, available at: http://links.lww.com/JGPT/A104, which summarizes invited expert and APTA Geriatrics Bone Health Special Interest Group members' levels of agreement. There were no additional comments provided by the user group.

Source guideline developer review

The guideline development group sent a copy of the adapted guideline to the source developer (SIGN) for feedback. They had no recommendations for changes aside from clarifying that the original SIGN CPG addressed falls and/or fracture risk/rate, but in this adapted document, those outcomes were not addressed. While SIGN does not

endorse guidelines from other organizations, they did grant full consent to the SIGN guideline being used for the adaptation. (A. Stein, email communication, August 12, 2021.)

Endorsement

This CPG has been reviewed and endorsed by the medical and scientific advisory boards/councils of the following organizations:

- American Bone Health (Raleigh, North Carolina)
- National Osteoporosis Foundation (Arlington, Virginia)

Dissemination Plans

The primary purpose of this CPG is to provide interested readers full documentation of the best available evidence for mitigating the loss of BMD for the management of patients with suspected or known osteoporosis. Publication of this guideline will be announced by press release and published in a high-impact, peer-reviewed journal. Education and awareness about this CPG will be disseminated via online resources, such as webinars and continuing education courses, at professional annual meetings and via social media. Pocket guides will be developed by APTA Geriatrics as implementation tools to aid in the dissemination of the CPG.

Revision and Reaffirmation Plans

This CPG represents a cross-sectional view of current treatment and may become outdated as new evidence becomes available. It will be reviewed in 5 years and will be updated in accordance with new evidence, changing practice, rapidly emerging treatment options, and new technology, reaffirmed, or withdrawn.

REFERENCES

1. Kanis JA, McCloskey EV, Johansson H, Oden A, Melton LJ, Khaltaev N. A reference standard for the description of osteoporosis. *Bone*. 2008;42(3):467-475. doi:10.1016/j.bone.2007.11.001
2. Bunta AD. It is time for everyone to own the bone. *Osteoporos Int*. 2011;22(suppl 3):477-482. doi:10.1007/s00198-011-1704-0
3. Karjalainen JP, Riekkinen O, Töyräs J, Jurvelin JS, Kröger H. New method for point-of-care osteoporosis screening and diagnostics. *Osteoporos Int*. 2016;27(3):971-977. doi:10.1007/s00198-015-3387-4
4. Siris ES, Adler R, Bilezikian J, et al. The clinical diagnosis of osteoporosis: a position statement from the National Bone Health Alliance Working Group. *Osteoporos Int*. 2014;25(5):1439-1443. doi:10.1007/s00198-014-2655-z
5. Wright NC, Looker AC, Saag KG, et al. The recent prevalence of osteoporosis and low bone mass in the United States based on bone mineral density at the femoral neck or lumbar spine. *J Bone Miner Res*. 2014;29(11):2520-2526. doi:10.1002/jbmr.2269
6. Wright NC, Saag KG, Dawson-Hughes B, Khosla S, Siris ES. The impact of the new National Bone Health Alliance (NBHA) diagnostic criteria on the prevalence of osteoporosis in the USA. *Osteoporos Int*. 2017;28(4):1225-1232. doi:10.1007/s00198-016-3865-3
7. Looker AC, Borrud LG, Dawson-Hughes B, Shepherd JA, Wright NC. Osteoporosis or low bone mass at the femur neck or lumbar spine in older adults: United States, 2005-2008. *NCHS Data Brief*. 2012;(93):1-8. Accessed January 18, 2022. https://www.cdc.gov/nchs/data/databriefs/db93.pdf
8. Van Staa TP, Dennison EM, Leufkens HGM, Cooper C. Epidemiology of fractures in England and Wales. *Bone*. 2001;29(6):517-522. doi:10.1016/s8756-3282(01)00614-7
9. Lacombe J, Cairns BJ, Green J, Reeves GK, Beral V, Armstrong ME. The effects of age, adiposity, and physical activity on the risk of seven site-specific fractures in postmenopausal women. *J Bone Miner Res*. 2016;31(8):1559-1568. doi:10.1002/jbmr.2826
10. Malgo F, Appelman-Dijkstra NM, Termaat MF, et al. High prevalence of secondary factors for bone fragility in patients with a recent fracture independently of BMD. *Arch Osteoporos*. 2016;11(1):12. doi:10.1007/s11657-016-0258-3
11. Johnell O, Kanis JA. An estimate of the worldwide prevalence and disability associated with osteoporotic fractures. *Osteoporos Int*. 2006;17(12):1726-1733. doi:10.1007/s00198-006-0172-4
12. Burge R, Dawson-Hughes B, Solomon DH, Wong JB, King A, Tosteson A. Incidence and economic burden of osteoporosis-related fractures in the United States, 2005-2025. *J Bone Miner Res*. 2007;22(3):465-475. doi:10.1359/jbmr.061113
13. Hansen D, Bazell C, Pelizzari P, Pyenson B. Medicare cost of osteoporotic fractures: the clinical and cost burden of an important consequence of osteoporosis; Milliman Research Report. Published August 2019. Accessed January 18, 2022. https://assets.milliman.com/ektron/Medicare_cost_of_osteoporotic_fractures.pdf
14. Cooper C, Atkinson EJ, Jacobsen SJ, O'Fallon WM, Melton LJ. Population-based study of survival after osteoporotic fractures. *Am J Epidemiol*. 1993;137(9):1001-1005. doi:10.1093/oxfordjournals.aje.a116756
15. Kanis JA, Oden A, Johnell O, De Laet C, Jonsson B, Oglesby AK. The components of excess mortality after hip fracture. *Bone*. 2003;32(5):468-473. doi:10.1016/S8756-3282(03)00061-9
16. Liu J, Curtis EM, Cooper C, Harvey NC. State of the art in osteoporosis risk assessment and treatment. *J Endocrinol Invest*. 2019;42(10):1149-1164. doi:10.1007/s40618-019-01041-6
17. Giangregorio LM, McGill S, Wark JD, et al. Too fit to fracture: outcomes of a Delphi consensus process on physical activity and exercise recommendations for adults with osteoporosis with or without vertebral fractures. *Osteoporos Int*. 2015;26(3):891-910. doi:10.1007/s00198-014-2881-4
18. Warden SJ, Hurst JA, Sanders MS, Turner CH, Burr DB, Li J. Bone adaptation to a mechanical loading program significantly increases skeletal fatigue resistance. *J Bone Miner Res*. 2005;20(5):809-816. doi:10.1359/JBMR.041222
19. Warden SJ, Fuchs RK. Exercise and bone health: optimising bone structure during growth is key, but all is not in vain during ageing. *Br J Sports Med*. 2009;43(12):885-887. doi:10.1136/bjsm.2008.054866
20. Cauley JA. Public health impact of osteoporosis. *J Gerontol A Biol Sci Med Sci*. 2013;68(10):1243-1251. doi:10.1093/gerona/glt093
21. Scottish Intercollegiate Guidelines Network (SIGN). *Management of Osteoporosis and the Prevention of Fragility Fractures*. SIGN. (SIGN publication no. 142). Published January 2021. Accessed January 18, 2022. http://www.sign.ac.uk
22. Stevenson MO, Tangpricha V. Osteoporosis and bone health in transgender persons. *Endocrinol Metab Clin North Am*. 2019;48(2):421-427. doi:10.1016/j.ecl.2019.02.006
23. Tarantino U, Iolascon G, Cianferotti L, et al. Clinical guidelines for the prevention and treatment of osteoporosis: summary statements and recommendations from the Italian Society for Orthopaedics and Traumatology. *J Orthop Traumatol*. 2017;18(suppl 1):3-36. doi:10.1007/s10195-017-0474-7
24. Hwang J, Chan D, Chen J, et al. Clinical practice guidelines for the prevention and treatment of osteoporosis in Taiwan: summary. *J Bone Miner Metab*. 2014;32(1):10-16. doi:10.1007/s00774-013-0495-0
25. Al-Saleh Y, Sulimani R, Sabico S, et al. 2015 Guidelines for osteoporosis in Saudi Arabia: recommendations from the Saudi Osteoporosis Society. *Ann Saudi Med*. 2015;35(1):1-12. doi:10.5144/0256-4947.2015.1
26. Compston J, Cooper A, Cooper C, et al. UK clinical guideline for the prevention and treatment of osteoporosis. *Arch Osteoporos*. 2017;12(1):43. doi:10.1007/s11657-017-0324-5
27. Giangregorio LM, Papaioannou A, MacIntyre NJ, et al. Too fit to fracture: exercise recommendations for individuals with osteoporosis or osteoporotic vertebral fracture. *Osteoporos Int*. 2014;25(3):821-835. doi:10.1007/s00198-013-2523-2
28. Guidelines International Network. Welcome to G-I-N. Published 2021. Accessed January 18, 2022. https://g-i-n.net/home
29. ADAPTE Collaboration. *The ADAPTE process: resource toolkit for guideline adaptation*. Version 2.0. Published 2010. Accessed January 18, 2022. https://g-i-n.net/wp-content/uploads/2021/03/ADAPTE-Resource-toolkit-March-2010.pdf
30. Brouwers MC, Kho ME, Browman GP, et al. AGREE II: advancing guideline development, reporting and evaluation in health care. *Can Med Assoc J*. 2010;182(18):E839-E842. doi:10.1503/cmaj.090449
31. AGREE Enterprise Web site. AGREE II training tools. Published 2014. Accessed January 18, 2022. https://www.agreetrust.org/resource-centre/agree-ii/agree-ii-training-tools/
32. Avin KG, Hanke TA, Kirk-Sanchez N, et al. Management of falls in community-dwelling older adults: clinical guidance statement from the Academy of Geriatric Physical Therapy of the American Physical Therapy Association. *Phys Ther*. 2015;95(6):815-834. doi:10.2522/ptj.20140415

33. Howe TE, Shea B, Dawson LJ, et al. Exercise for preventing and treating osteoporosis in postmenopausal women. *Cochrane Database Syst Rev*. 2011;(7):CD000333. doi:10.1002/14651858.CD000333.pub2
34. Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Heal Rep*. 1985;100(2):126-131. Accessed January 18, 2022. http://europepmc.org/article/med/3920711
35. American Physical Therapy Association. *APTA Clinical Practice Guideline Process Manual, Revised*. American Physical Therapy Association; 2020. Accessed January 18, 2022. https://www.apta.org/patient-care/evidence-based-practice-resources/cpgs/cpg-development/cpg-development-manual
36. Martyn-St James M, Carroll S. Meta-analysis of walking for preservation of bone mineral density in postmenopausal women. *Bone*. 2008;43(3):521-531. doi:10.1016/j.bone.2008.05.012
37. Asikainen TM, Kukkonen-Harjula K, Miilunpalo S. Exercise for health for early postmenopausal women: a systematic review of randomised controlled trials. *Sport Med*. 2004;34(11):753-778. doi:10.2165/00007256-200434110-00004
38. Martyn-St James M, Carroll S. A meta-analysis of impact exercise on postmenopausal bone loss: the case for mixed loading exercise programmes. *Br J Sports Med*. 2009;43(12):898-908. doi:10.1136/bjsm.2008.052704
39. Martyn-St James M, Carroll S. High-intensity resistance training and postmenopausal bone loss: a meta-analysis. *Osteoporos Int*. 2006;17(8):1225-1240. doi:10.1007/s00198-006-0083-4
40. Li WC, Chen YC, Yang RS, Tsauo JY. Effects of exercise programmes on quality of life in osteoporotic and osteopenic postmenopausal women: a systematic review and meta-analysis. *Clin Rehabil*. 2009;23(10):888-896. doi:10.1177/0269215509339002
41. El-Khoury F, Cassou B, Charles MA, Dargent-Molina P. The effect of fall prevention exercise programmes on fall induced injuries in community dwelling older adults: systematic review and meta-analysis of randomised controlled trials. *BMJ*. 2013;347:f6234. doi:10.1136/bmj.f6234
42. Kemmler W, Häberle L, Von Stengel S. Effects of exercise on fracture reduction in older adults: a systematic review and meta-analysis. *Osteoporos Int*. 2013;24(7):1937-1950. doi:10.1007/s00198-012-2248-7
43. Avers D, Brown M. White Paper: strength training for the older adult. *J Geriatr Phys Ther*. 2009;32(4):148-153. doi:10.1519/00139143-200932040-00002
44. Choosing Wisely. American Physical Therapy Association: Five things physical therapist and patients should question. Published 2021. Accessed January 18, 2022. https://www.choosingwisely.org/societies/american-physical-therapy-association/
45. Hart NH, Nimphius S, Rantalainen T, Ireland A, Siafarikas A, Newton RU. Mechanical basis of bone strength: influence of bone material, bone structure and muscle action. *J Musculoskelet Neuronal Interact*. 2017;17(3):114-139. Accessed January 18, 2022. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5601257/
46. Marín-Cascales E, Alcaraz PE, Ramos-Campo DJ, Martinez-Rodriguez A, Chung LH, Rubio-Arias J. Whole-body vibration training and bone health in postmenopausal women: a systematic review and meta-analysis. *Medicine (Baltimore)*. 2018;97(34):e11918. doi:10.1097/MD.0000000000011918
47. Ma D, Wu L, He Z. Effects of walking on the preservation of bone mineral density in perimenopausal and postmenopausal women: a systematic review and meta-analysis. *Menopause*. 2013;20(11):1216-1226. doi:10.1097/gme.0000000000000100
48. Martyn-St James M, Carroll S. Effects of different impact exercise modalities on bone mineral density in premenopausal women: a meta-analysis. *J Bone Miner Metab*. 2010;28(3):251-267. doi:10.1007/s00774-009-0139-6
49. Martyn-St James M, Carroll S. Progressive high-intensity resistance training and bone mineral density changes among premenopausal women evidence of discordant site-specific skeletal effects. *Sport Med*. 2006;36(8):683-704. doi:10.2165/00007256-200636080-00005
50. Kelley GA, Kelley KS, Kohrt WM. Exercise and bone mineral density in men: a meta-analysis of randomized controlled trials. *Bone*. 2013;53(1):103-111. doi:10.1016/j.bone.2012.11.031
51. Bolam KA, Van Uffelen JGZ, Taaffe DR. The effect of physical exercise on bone density in middle-aged and older men: a systematic review. *Osteoporos Int*. 2013;24(11):2749-2762. doi:10.1007/s00198-013-2346-1
52. US Department of Health & Human Services. *Physical Activity Guidelines for Americans, 2nd Edition*. US Department of Health & Human Services; 2018. Accessed January 18, 2022. https://health.gov/sites/default/files/2019-09/Physical_Activity_Guidelines_2nd_edition.pdf
53. Centers for Medicare and Medicaid Services. Your Medicare coverage: physical therapy. Accessed January 18, 2022. https://www.medicare.gov/coverage/physical-therapy
54. Centers for Medicare & Medicaid Services. Jimmo settlement. Updated December 1, 2021. Accessed January 18, 2022. https://www.cms.gov/Center/Special-Topic/Jimmo-Center
55. Healthy People 2020, Office of Disease Prevention and Health Promotion, US Department of Health & Human Services. Social determinants of health. Published 2014. Updated December 28, 2021. Accessed January 18, 2022. https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-health/interventions-resources
56. Gómez-Cabello A, Ara I, González-Agüero A, Casajús JA, Vicente-Rodríguez G. Effects of training on bone mass in older adults: a systematic review. *Sport Med*. 2012;42(4):301-325. doi:10.2165/11597670-000000000-00000