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REVIEW

Promoting mobility and healthy aging in men: a narrative review

P. R. Ebeling[1] · F. Cicuttini[2] · D. Scott[3] · G. Jones[4]

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Abstract

Maintaining mobility is an important aspect of health and well-being in older men. This literature review describes several modifiable and nonmodifiable risk factors impacting bone, muscle, and joint health. Exercise and nutritional interventions may help to prevent the progressive deterioration in bones, muscles, and joints impacting mobility in later life. Limitations in mobility are increasingly recognized as a major public health problem due to an aging population and growing number of older individuals affected by disabling comorbidities. Despite increasing numbers and debilitating consequences, there are no guidelines providing recommendations on strategies to maintain mobility for healthy aging among older men. This narrative review aims to fill this literature gap. PubMed, Scopus, and Google Scholar databases were searched using predefined search terms. Primary studies, exploratory analyses, cross-sectional surveys, meta-analyses, evidence-based clinical reviews, and guidelines from nationally recognized societies focusing on mobility in older men and key elements including bone, muscle and joint health, and balance were selected. Several modifiable and nonmodifiable risk factors have been reported in the literature that impact bone, muscle, and joint health and predispose older men to falls and fractures. The most common conditions impacting bones, muscles, and joints are osteoporosis, sarcopenia, and osteoarthritis, respectively. In addition to being key contributors to disability in the elderly, these conditions are all associated with a higher mortality risk. Although more studies are required, current evidence supports the use of various nonpharmacological (mainly exercise and nutrition) and/or pharmacological treatment modalities to help prevent and/or reverse these conditions. Incorporating lifestyle interventions involving exercise and nutrition at a younger age can help prevent the age-related, progressive deterioration in bones, muscles, and joints that can reduce mobility in later life. Established barriers to physical activities (e.g., poor health, social isolation) in men are important to consider for optimizing outcomes.

Keywords Aging · Falls · Male mobility · Osteoporosis · Sarcopenia

Introduction

Mobility, defined as the ability to move about independently and safely in one's environment, is an important component of health and quality of life among older adults [1]. However, 40% of individuals reported mobility limitations in a recent nationally representative survey of insured older adults in the United States (US). The prevalence of mobility limitations assessed as severe or moderate was 21.4 and 18.4%, respectively, among the study sample of 15,989 older adults with Medicare supplemental insurance plans (survey responses were weighted based on demographic, socioeconomic, and clinical variables to adjust for potential bias associated with survey response and stratified sampling to increase generalizability and create a nationally representative study sample) [2]. The authors reported that individuals with mobility limitations were more likely to suffer from depression and less likely to have ambitious goals, resilience, or social support [2].

A previous survey of community-dwelling older adults enrolled in Medicare demonstrated that mobility limitations were common (present in 45% of the population) and strongly associated with development of future functional disability/loss of independence and increased healthcare expenditures and utilization [3]. Furthermore, mobility (defined as self-reported ability to walk one-quarter mile) was shown to be an independent predictor of mortality; across the 12- to 16-

✉ P. R. Ebeling
peter.ebeling@monash.edu

[1] School of Clinical Sciences at Monash Health, Monash Medical Centre, Monash University, Level 5 / Block E, 246 Clayton Road, Clayton, VIC 3168, Australia

[2] School of Public Health and Preventive Medicine, Monash University, Clayton, VIC, Australia

[3] Australian Institute for Musculoskeletal Science, The University of Melbourne, Melbourne, Australia

[4] Menzies Institute for Medical Research, University of Tasmania, Hobart, Australia

month follow-up period, mortality rates were 15% for individuals who were unable to walk one-quarter mile at baseline, 4% for those with mobility difficulty, and 2% for those with no mobility limitations. This association remained significant even after adjustments were made for multiple confounders including demographics, socioeconomic status, chronic conditions, and health behaviors (difficulty walking one-quarter mile, adjusted odds ratio [OR] 1.57; 95% CI 1.10–2.24]; inability to walk one-quarter mile, adjusted OR 2.73; 95% CI 1.79–4.15) [3]. Bergland et al. also reported a significant association (hazard ratio [HR] 1.79; 95% CI 1.33–2.42) between loss of mobility and all-cause mortality in community-dwelling men and women in Norway. This was significant after adjustment for self-reported health, body mass index (BMI), smoking, and education level (HR 1.63; 95% CI 1.20–2.22) for individuals who were fastest on the timed up and go test of mobility compared with those who were slowest) [1].

Key determinants of male mobility

Several modifiable and nonmodifiable factors have been reported in the literature that impact bone, muscle, and joint health and can lead to progressive loss of mobility and predispose older men to poor balance, falls, and fractures (Fig. 1) [4–7]. Risk factors shown to influence mobility include older age, lower physical activity, obesity, strength or balance impairment, long-term use of certain medications, history of smoking, excessive alcohol use, nutritional deficiencies, chronic diseases such as obesity, diabetes mellitus, or arthritis, and low socioeconomic status [8–12]. Despite the known benefits of physical activity, exercise-related injuries can lead to mobility limitation, either directly [9] or indirectly via osteoarthritis [10]. Additionally, in men, the gradual decline in serum testosterone concentrations with advancing age is associated with limitations in mobility [13]. Given the importance of mobility and the plethora of risk factors among elderly men, the objective of this narrative review is to describe elements that are vital to healthy aging in men and the modifiable risk factors that need to be managed to maintain a long, productive, and independent life without limitations in mobility [4–7]. Because bone, muscle, and joint health are important modifiable factors that can be relatively easily enhanced to improve mobility, these parameters will be the focus of this review.

Maintenance of bone health

Prevalence and implications

A decrease in bone strength (bone mass and bone quality) with a consequent increase in bone fragility and risk of fracture is termed osteoporosis [14], the most common metabolic bone disease in humans [15]. Osteoporosis is associated with an increased risk of minimal trauma fractures of the spine, proximal femur, or distal radius [4]. Osteoporosis-related fractures, particularly hip fractures, can result in significant mobility disability; among a cohort of hip fracture patients in the US, the proportion of patients able to walk across a room independently decreased from 75% prefracture to only 15% 6 months post hip fracture [16]. Although more common in women, the prevalence of osteoporosis in men aged ≥ 50 years is estimated at 4.3% in the US [17], 6.6% in Europe [18], and 5.9% in Australia [19]. Osteoporosis has been categorized as a worldwide epidemic by the International Osteoporosis Foundation (IOF), and prevalence rates are expected to increase dramatically with the aging population in the coming decades, particularly in Asia. Per the IOF estimates, worldwide, one in five men aged over 50 years will experience an osteoporotic fracture [20]. By 2050, the worldwide prevalence of hip fracture is projected to increase by 310% in men compared with rates in 1990, and more than half of all osteoporotic hip fractures are expected to occur in Asia [21]. Approximately 20 to 25% of hip fractures occur in men [21]. In a nationwide cohort study of Danish patients, risk of mortality following a hip fracture was found to be substantially higher among men (37.1%) than women (26.4%) in the first 12 months following a hip fracture (male/female risk ratio 1.4; $p < 0.001$) [22]. Mortality is also higher in men following nonhip minimal trauma fractures [23]. Despite its high prevalence and associated morbidity and increased mortality, osteoporosis in men remains underdiagnosed and undertreated [24].

Risk factors for osteoporosis

The risk factors associated with osteoporosis are listed in Table 1 [4, 25–27]. Among these, lack of weight-bearing exercise, poor calcium intake, vitamin D deficiency, low or high body weight, cigarette smoking, excessive alcohol use, and long-term use of glucocorticoids are common modifiable risk factors [25]. It is now well established that testosterone, adrenal androgens, estrogen, growth hormone, and insulin-like growth factor-1 decline with advancing age, and this decline has been associated with both reduced bone formation and increased bone loss [28]. Among these, testosterone deficiency and glucocorticoid therapy are the most common secondary risk factors for the development of osteoporosis in men [13].

Management of osteoporosis

Management of osteoporosis includes lifestyle measures and pharmacologic as well as hormonal therapy [15]. According to the National Osteoporosis Foundation, the universal

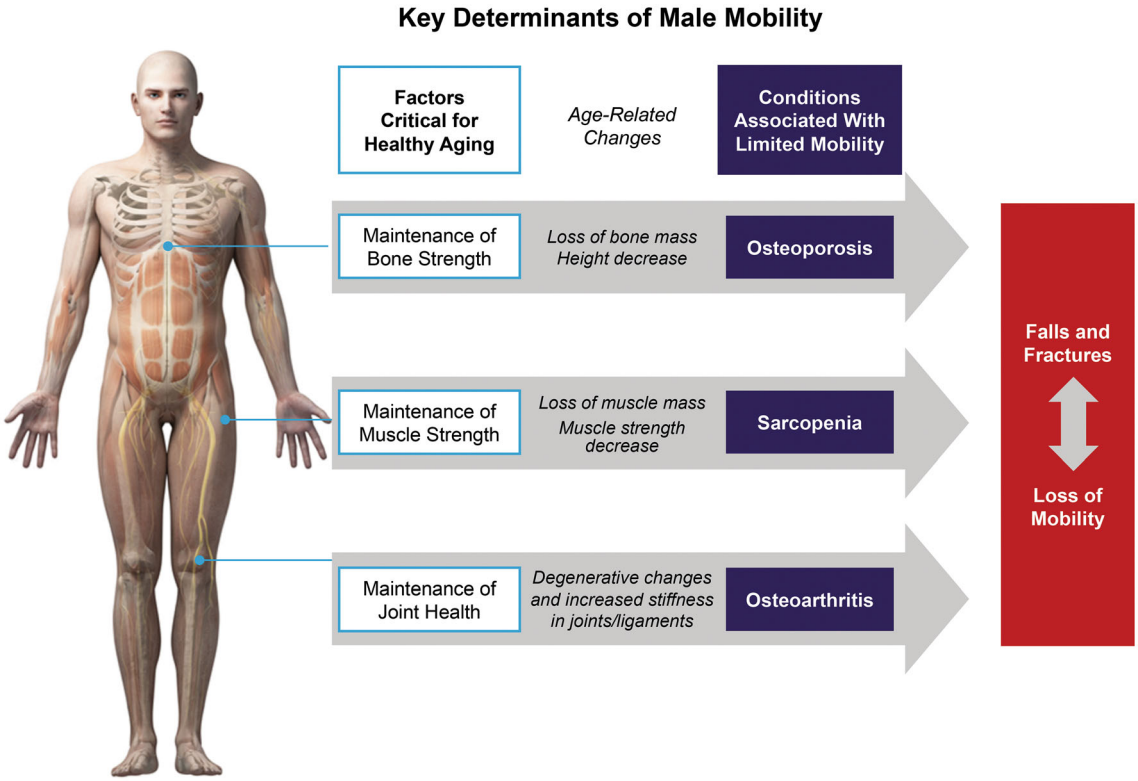

Fig. 1 Key determinants of male mobility [4–7]

recommendations for lifestyle measures include regular weight-bearing and muscle-strengthening exercises, adequate intake of calcium and vitamin D, cessation of tobacco use, avoidance of excessive alcohol consumption, and treatment of risk factors for falling [15]. While the importance of these interventions and the need for supplementation change with age, these lifestyle measures should be maintained throughout life to optimize bone health [25].

Table 1 Risk factors for osteoporosis in men [4, 25–27]

High-risk causes	History of nontraumatic fracture (hip, vertebrae, or wrist)
	Glucocorticoid use of 5 mg or more per day for > 6 months
	Hypogonadism (glucocorticoid induced or following orchiectomy)
	Hyperparathyroidism
	Lack of weight-bearing exercise
	Poor calcium intake
	Vitamin D deficiency
	Low or high BMI
	Excess alcohol consumption
	Tobacco use
Medium-risk or infrequent causes	Anticonvulsant drug use (phenytoin or phenobarbital)
	Rheumatoid or other inflammatory arthritis
	Multiple myeloma or lymphoma
	Hypothyroidism or hyperthyroidism
	Conditions associated with increased risk of falling (nursing home residence, prior fall, gait disorder, dementia, or hemiparesis)
	Family history of osteoporosis
	Cushing's disease
	Chronic liver or kidney disease
	HIV and its treatment
	Pernicious anemia
	Gastric resection
	Mastocytosis

BMI, body mass index; *HIV*, human immunodeficiency virus

A recent systematic review on the effects of exercise on bone mineral density (BMD) [29] found limited positive benefits in controlled clinical trials of exercise training of 6 months or longer in healthy older men (aged ≥ 50 years) who were not being treated with bone-relevant pharmacologic therapy. Of the six studies the authors identified as relevant for analysis, three studies showed significant improvement in proximal femur BMD, and three found no or inconsistent benefits in the exercise groups. Based on the available literature, the authors concluded that it was not possible to recommend specific exercise interventions for older men that would differ from those based on studies in older women. However, promising effects on lumbar spine BMD have been observed from a high-intensity resistance training and impact exercise program in postmenopausal women [30], suggesting higher intensity interventions should be explored in populations at risk of osteoporosis and fracture.

In terms of calcium and vitamin D intake (diet + supplementation), the recommended intakes are 1000–1200 mg of calcium per day and 600–800 IU/day of vitamin D for older men [31, 32]. Calcium is required for the mineralization of bone, and the presence of vitamin D is required for the absorption of dietary calcium in the gut [33]. A meta-analysis based on 8 clinical trials involving 195 hip fracture events and 2231 total fracture events among 30,970 community-dwelling and institutionalized middle-aged to older adults showed a statistically significant 14% reduction (95% CI 0.75–0.98) in risk of total fractures and a 39% reduction (95% CI 0.46–0.82) in risk of hip fractures with calcium + vitamin D supplementation [33]. A larger reduction in risk was observed in the studies that included institutionalized participants compared with those that involved community-dwelling subjects. Another meta-analysis of studies restricted to community-dwelling adults failed to find a benefit for supplementation with calcium, vitamin D, or the combination [34]. In general, the benefits of calcium and vitamin D supplementation are most consistently evident among older individuals who are institutionalized and other individuals who are vitamin D deficient (serum 25-hydroxyvitamin D < 50 nmol/L or < 20 ng/mL) [35]. Other analyses have shown that evidence of a benefit is limited to those with baseline 25-hydroxyvitamin D < 30 nmol/L [36].

For men with clinically recognized osteoporosis (based on fracture history and/or high fracture risk), pharmacologic treatment with bisphosphonates is recommended to reduce the risk of vertebral fracture [37]. Randomized, controlled trials of bisphosphonates in men have mainly been limited to smaller trials examining their effects on BMD as primary study endpoints [38]. However, one trial with intravenous zoledronic acid showed a 67% reduction in vertebral fractures across a 2-year period as a primary study end point [39]. This class of drugs is approved by the US Food and Drug Administration as a first-line treatment for osteoporosis in men [38]. However, although rare, long-term bisphosphonate use (> 5 years) can be associated with osteonecrosis of the jaw, atypical subtrochanteric and diaphyseal femur fractures, atrial fibrillation, and esophageal cancer [40]. Treatment with teriparatide (i.e., recombinant human parathyroid hormone [1–34]), is an option for men with severe osteoporosis at high risk of fracture due to primary or hypogonadal osteoporosis or osteoporosis associated with sustained systemic glucocorticoid use [15]. Although teriparatide was associated with a treatment-dependent increase in the incidence of osteosarcoma in preclinical studies, this has not been observed in humans in postmarketing registries [41]. Nevertheless, the lifetime use of teriparatide is restricted to 18 or 24 months, depending on the country of drug registration [42–44]. Snyder et al. have confirmed a significant positive impact of testosterone therapy on bone density and strength in men with low baseline levels, but larger and longer-duration studies are needed to determine the role of testosterone in fracture prevention [45].

Maintenance of muscle strength

Definition and prevalence of sarcopenia

Sarcopenia is broadly defined as the "age-associated loss of skeletal muscle mass and function" [5]. In defining sarcopenia, the Foundation for National Institutes of Health (FNIH) recommended using mobility impairment as the clinically relevant functional state to determine meaningful weakness, and they established an FNIH Sarcopenia Project team to develop a robust and validated clinical definition of sarcopenia [46]. However, there is no clear consensus on the definition of sarcopenia, and several definitions are used, including the recently updated European Working Group on Sarcopenia in Older People (EWGSOP) definition [47], which primarily characterizes sarcopenia as low muscle strength; if low muscle quantity or quality and low physical performance are also present, it is categorized as severe. Sarcopenia has also been defined as "a loss of function, defined by walking speed or distance coupled with a loss of muscle mass" [48]. In 2016, sarcopenia received an ICD-10 code, which represents a major step in recognizing this condition as a disease [49]. In a nationally representative sample of older adults (age ≥ 60 years) in the US, the prevalence of sarcopenia among men was 16% but increased to 28% when adjusted for BMI [50]. Muscle loss in combination with high levels of adiposity is referred to as sarcopenic obesity [51].

Risks and causes of sarcopenia

Sarcopenia is associated with increased risk of osteoporosis, falls, fractures, physical disability, functional decline, metabolic syndrome, and hospitalizations [52–54]. An analysis of

a large prospective cohort of 681 community-dwelling middle-aged and older men and women was performed to determine associations between sarcopenia and risk of falls over 5 years [55]. Results from the analysis indicated variations in the association between sarcopenia and functional decline according to sex; men with low muscle mass had poorer muscle function compared with women [55]. Low muscle mass in older adults with sarcopenia has also been identified as a risk factor for metabolic syndrome and type 2 diabetes. A proposed mechanism is that significantly lower skeletal muscle mass results in greater insulin resistance and consequent type 2 diabetes in older patients with sarcopenia [56]. Sarcopenic men who are obese have even poorer outcomes. In a longitudinal study involving elderly subjects, those with sarcopenic obesity, who were predominantly men, were most likely to experience functional declines, disability, and comorbidities compared with lean sarcopenic or nonsarcopenic obese subjects and those with normal body composition [57]. Similarly, recent data from the Concord Health and Ageing in Men Project (CHAMP) study, a large epidemiologic study of aging in older men (≥ 70 years of age), showed an association between sarcopenic obesity and an increased risk of falls and fractures [58]. Compared with men without sarcopenia or obesity, men with sarcopenic obesity at baseline (defined using the EWGSOP criteria) had significantly higher 2-year fall rates (incidence rate ratio [IRR] 1.66; 95% CI 1.16–2.37), as did individuals with nonsarcopenic obesity (IRR 1.30; 95% CI 1.04–1.62) and in those with sarcopenia without obesity (IRR 1.58; 95% CI 1.14–2.17). Although no significant association was found between FNIH-defined sarcopenic obesity and fall rates, there was a significantly increased 6-year fracture rate observed in the FNIH-defined sarcopenic obesity group relative to nonsarcopenic obese men (HR for nonsarcopenic obesity vs sarcopenic obesity 0.44; 95% CI 0.23–0.86).

In addition to sarcopenia being a key contributor to disability in the elderly, individuals with sarcopenia have a 4 times higher risk of mortality [52]. A meta-analysis of 17 prospective studies observed a 4 times higher risk of mortality in individuals with sarcopenia compared with those without sarcopenia [52]. Older men with sarcopenic obesity have been confirmed to have a higher risk of all-cause mortality compared with well-matched controls in a prospective cohort study [51].

The causes of sarcopenia in elderly men are multifactorial and include declines in testosterone concentrations with age, decreased growth hormone, mitochondrial abnormalities, long-term glucocorticoid treatment, elevated pro-inflammatory cytokines, inactivity, and nutritional deficiencies [59]. It should also be noted that decreases in muscle strength/function are 2–5 times greater than decreases in muscle mass (Fig. 2) [60, 61], and loss of muscle function significantly outpaces loss of muscle mass during aging [62], demonstrating that neuromuscular changes beyond muscle atrophy contribute to functional decline. Indeed, increased fat infiltration of muscle is included in the revised EWGSOP definition as an important component of sarcopenia [47] and a subject we recently reported as being associated with an increased risk for both osteoporosis and falls [63].

Management of sarcopenia

Exercise, particularly progressive resistance training (PRT), is a well-recognized therapeutic strategy to prevent and reverse sarcopenia. High-velocity PRT is particularly effective at improving lower limb muscle power, a key contributor to mobility [64]. In addition, vitamin D/calcium and essential amino acid protein supplementation have been shown to have beneficial effects [65, 66], although the effects for the latter have been variable across studies [66]. A recent trial suggests that leucine content, rather than total protein content, of supplements may be the primary determinant of myofibrillar protein synthesis [67]. Studies have suggested some additional benefits of combining dietary supplementation with exercise training [52], particularly for protein in conjunction with regular, prolonged PRT (≥ 2 weekly sessions for ≥ 6 weeks) [68]. Omega-3 fatty acid supplementation has been shown to enhance the effects of PRT for improving strength in older women [69], although this effect has not been demonstrated in older men [70]. Creatinine supplementation combined with resistance training increased lean mass in an elderly cohort in a greater magnitude compared with isolated resistance training in a 12-week, double-blind, randomized, parallel-group, placebo-controlled trial; however, the long-term benefits of this intervention need to be determined [71].

With respect to pharmacological therapy, there are no approved treatments for sarcopenia to date. Testosterone and selective androgen receptor molecules are being used to treat sarcopenia; however, their safety is a concern [59]. Monoclonal antibodies targeting either activin or myostatin, a growth hormone involved in regulating muscle mass and strength, are

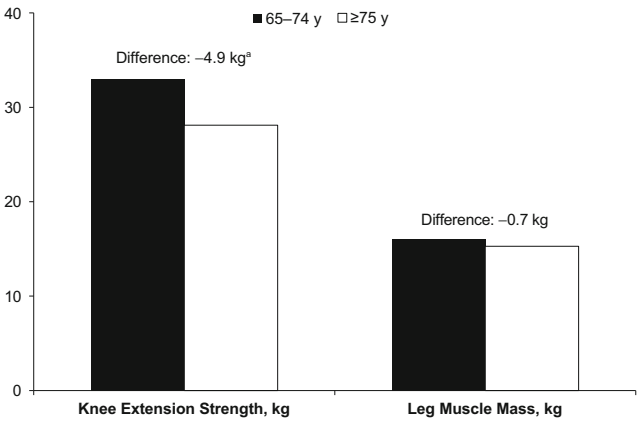

Fig. 2 Comparison of knee extension strength and leg muscle mass in men 65–74 versus ≥ 75 years of age [60]. [a]$p < 0.01$ between age groups

also being investigated as potential agents in the treatment of sarcopenia [72]. One such agent, bimagrumab, an activin type II receptor antagonist, has shown efficacy and safety in increasing skeletal muscle mass and strength in community-dwelling older adults with sarcopenia and mobility limitations and increasing walking speed and mobility in those with lower baseline performance. These data provide strong support for the further evaluation and development of this class of agents [73].

Maintenance of joint health

Definition and prevalence

Osteoarthritis is the most common chronic condition affecting the joint that can impact all joint tissues including the cartilage, bone, ligaments, and muscles [74]. The range of joint motion in patients with osteoarthritis is strongly correlated with the level of disability, including walking, sitting, bending, and reclining [75]. In addition to mobility-related disabilities, patients with osteoarthritis suffer with chronic pain, aching, and stiffness and a poor quality of life [76, 77].

In the US, 33% of men in the age group of 55–64 years have a confirmed diagnosis of arthritis, which increases to almost 50% in men 85 years of age and older (Fig. 3) [78]. Prevalence rates of arthritis and arthritis-attributable activity limitation are projected to progressively increase through the year 2040, with the largest estimated increases occurring in adults over 65 years of age [78]. When comparing differences in prevalence rates based on gender, osteoarthritis has been shown to affect more men than women aged 50 years; however, following menopause, the rate of osteoarthritis is significantly higher among women, which suggests a sex hormone link in the etiology of the disease [6, 79].

Risk factors for osteoarthritis

Osteoarthritis is a multifactorial disease with a number of modifiable and nonmodifiable risk factors. Modifiable risk factors include obesity, muscle strength, physical activity, improper movements, joint injury, and diet, while nonmodifiable risk factors include age, gender, genetics, ethnicity, and joint and/or bone deformities [6]. Individuals with osteoarthritis have a higher risk of falling, which is augmented by increasing age, pain level, and degree of muscle weakness [80].

Management of osteoarthritis

Several pharmacologic and nonpharmacologic modalities have been recommended for the management of osteoarthritis. With respect to the nonpharmacologic modalities, the American College of Rheumatology guidelines recommend that patients with knee and hip osteoarthritis enroll in an exercise program that includes aerobic, aquatic, and/or resistance exercises [81]. Additionally, dietary changes have been recommended to prevent or manage symptoms. These include maintaining dietary amounts of essential nutrients from foods and/or supplementing beyond recommended dietary allowances with vitamins C (ascorbic acid), D (cholecalciferol), E (tocopherols and tocotrienols), B_3 (niacin), B_{12} (cobalamin), and folate (folic acid, a B vitamin), minerals boron and zinc, essential fatty acids, and some nonessential phytonutrients [82]. As obesity is one of the important modifiable risk factors of osteoarthritis, weight loss by combined diet and exercise is likely to be an effective strategy in overweight or obese patients with osteoarthritis [83].

Pharmacologic treatments for hip and knee OA include adequate pain relief with intermittent dosing of acetaminophen, oral and topical nonsteroidal anti-inflammatory drugs (NSAIDs), tramadol, and intra-articular corticosteroid injections. Intra-articular hyaluronate injections, duloxetine, and opioids are options for individuals not responding to initial therapy; for adults 75 years of age or older, topical rather than oral NSAIDs should be considered in view of the adverse cardiovascular effects associated with NSAIDs [81]. However, all these therapies are, at best, moderately effective, and maintaining a healthy weight and regular exercise remain the most strongly recommended intervention [81–84].

Maintenance of balance

Prevalence and risk factors

Loss of balance among older individuals results in falls, which in turn, are associated with fractures, soft tissue injuries, pain, functional impairment, reduced quality of life, hospitalizations, and mortality [7]. According to the US Centers for Disease Control and Prevention, one in four older individuals (> 65 years of age) falls each year, and every 19 min, an elderly person dies from a fall [85]. Consequently, falls should be prevented to avoid debilitating consequences among older adults. To prevent falls, it is important to know the risk factors that make an individual prone to falls, and these include vitamin D deficiency, impaired strength and balance, visual impairment, use of multiple prescription medications, solitary living, and environmental hazards such as poor lighting, slippery floors, and uneven surfaces [86]. Pain, a common symptom among older adults, has been associated with problems with balance or coordination, fear of falls, and a history of falls [87]. Therefore, fall prevention programs should incorporate effective pain management strategies [87].

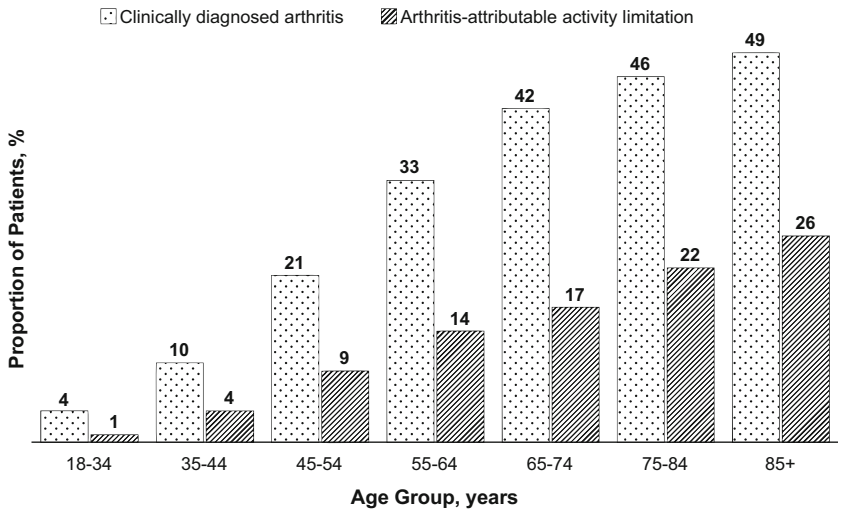

Fig. 3 Prevalence of arthritis and attributable activity limitation [78]

Prevention of falls

Several structured programs have been reported to be effective in preventing falls. One such primary prevention program, Pennsylvania's Healthy Steps for Older Adults (HSOA), comprises balance assessments, education on falls, and referrals for fall assessments [88]. Completion of the HSOA was associated with a 17% reduction in falls after adjustment for fall risk factors [88]. The benefits of another approach called the Lifestyle integrated Functional Exercise program, wherein balance and strength activities are taught over five home visits with two booster visits, were assessed in a three-arm, randomized, parallel trial. This study reported a 31% reduction in the rate of falls compared with a control program [89]. A systematic review and meta-analysis of randomized, controlled trials of exercise as a primary intervention for fall prevention in older adults (mean age ≥ 65 years) has reported that exercise programs of higher doses (> 3 h/week) and those that incorporate challenging balance activities are most effective for preventing falls [90]. A recent meta-analysis of 40 randomized, controlled trials of > 20,000 individuals reported that moderately intensive exercise 2 to 3 times per week significantly decreased the risk of falls and injurious falls but had no effect on fracture risk [91]. Programs that combined balance training and exercise resulted in a 39% reduction in falls (IRR 0.61; 95% CI 0.53–0.72) compared with the 21% risk reduction found for exercise programs of any type among community-dwelling older adults (pooled rate ratio 0.79; 95% CI 0.73–0.85). The authors found limited evidence available supporting the effect of exercise for fall prevention among older adults living in residential care facilities, after stroke, or following discharge from the hospital [90]. A 9-month study involving members from the University of Connecticut arm of the Frailty and Injuries: Cooperative Studies of Intervention Techniques (FICSIT) trials concluded that a maintenance program of balance and strength exercises might be a more effective strategy to improve balance and strength in older individuals rather than interventions such as Tai Chi, which have shown some benefits in reducing falls, probably by knee and hip strengthening [92].

To recommend suitable interventions that are feasible to implement in primary care for community-dwelling adults over 65 years of age, the US Preventive Services Task Force (USPSTF) published an evidence review and recommendation statement on interventions to prevent falls [93], which was recently updated [94]. This evidence-based guideline recommends exercise interventions (including supervised individual or group classes and physical therapy) to help prevent falls in older adults. The National Council on Aging has further recommended a number of evidence-based fall prevention programs, including Otago, A Matter of Balance, Stay Active and Independent for Life, Stepping On, and Fit & Strong [95]. Although earlier recommendations included vitamin D supplementation, the benefits to individuals without osteoporosis or vitamin D deficiencies for fall prevention are unclear [94]. As a result, the USPSTF now recommends against vitamin D supplementation for prevention of falls in all community-dwelling older adults. It should be noted that USPSTF regards vitamin D supplementation in subjects with a deficiency as treatment, and these recommendations do not apply to individuals with a diagnosis of osteoporosis or vitamin D deficiency [94]. However, the Endocrine Society and the National Osteoporosis Foundation recommend consumption of fortified foods and/or vitamin D supplements to ensure that recommended intake levels are reached [96, 97]. In addition, a fall prevention program could consider individualizing interventions to address specific risks for each patient, such as the use of anti-slip shoe devices when walking in slippery conditions, monitoring and adjusting psychotropic medications, vision correction, and pacemaker implantation in patients with cardioinhibitory carotid sinus hypersensitivity

[98]. However, these interventions are supported by limited evidence. The evidence review conducted by the USPSTF found that multifactorial interventions customized to the patient based on an assessment of risk have a small benefit for the prevention of falls, and they recommend that such interventions be selectively offered by clinicians only to those at increased risk for falls [94]. Evidence for medication management and other interventions was too limited or heterogeneous to allow for any definitive conclusions.

Overall clinical recommendations for promoting mobility and healthy aging in men

Despite the availability of greater socioeconomic facilities and resources, men have a shorter life span than women [99]. Premature mortality among men is often attributed to unhealthy lifestyle choices and lower levels of preventive healthcare [99, 100]. This combined with the numeric surge in older people presents a critical challenge for public health and highlights the need to specifically improve the health and well-being of older men [100]. In this review, we have focused on discussing various conditions that commonly cause limitations in mobility among older men, including osteoporosis, sarcopenia, osteoarthritis, and balance.

Bone health can be improved by taking relatively simple preventive actions throughout the life span [25]. Preventive care should focus on regular weight-bearing and muscle-strengthening exercises; adequate intake of protein, calcium, and vitamin D; maintaining a healthy weight; cessation of tobacco use; avoidance of excessive alcohol consumption; and treatment of risk factors for falling [15]. While the importance of these interventions and the need for supplementation change with age, these lifestyle measures should be maintained throughout life to optimize bone health [25].

Men with strong masculinity beliefs are less likely to receive preventive care [99] and often have difficulty talking about their health problems when they occur, which frequently serves as a barrier to help-seeking behavior [101]. Poor health has been shown to be one of the most important barriers to participating in physical activity, in particular for older men (≥ 80 years) [102]. For men in particular, aches and pains, which are frequent consequences of physical activity, are often a barrier to further physical activity for men who start these activities aggressively and subsequently become disincentivized to participate. Additionally, social isolation is common among older men, particularly among those who experience mood or cognitive problems or who live alone [100], which has been shown to be an independent risk factor for not participating in physical activities [102]. Potential motivators for physical activity include task-related factors, such as meaningful, enjoyable, and routine activities to participate in; individual-level factors, including a group of peers as well as younger friends; and environmental factors such as places to rest and family support [101]. A recent study reported that older adults should receive adequate background information about the rationale for performing physical exercise and clarification that an exercise program will be safe and provide benefits to various aspects of their lives, including mobility, independence, and quality of life, and will not do harm [103].

Considering the benefits of engaging in community programs and men's relatively lower rate of involvement, there is a strong need to develop community programs that target older men in particular, such as "Men's Sheds" [100]. This program originated in Australia to create a positive impact on social engagement, adult education, and health and has now expanded to several other countries globally, enabling men to socialize and participate in learning activities. Such programs should be made available to all older men and should include educational programs and lifestyle interventions to support desirable lifestyle behaviors at all stages of life in healthy individuals [104].

Summary

Age-related changes in bones, muscles, and joints, as well as declines in balance, can impact mobility in older men. There needs to be a coordinated approach among healthcare providers, who should work closely with older men and/or their caregivers to provide and re-evaluate evidence-based and effective interventions to optimize bone, muscle, and joint health. This is required to maintain strength, balance, and flexibility, which are essential for independent mobility, a key component of healthy aging. Additionally, interventions involving exercise and nutrition, and specifically supporting participation in men, should be initiated as early as possible to prevent and/or reverse the progressive deterioration in bone, muscle, and joint health with aging and, subsequently, to delay the onset of these common and chronic diseases that limit mobility and prevent healthy aging. Barriers specific to males have been identified, including a tendency to have difficulty discussing health-related concerns, and these should be the focus of interventions to engage men in health-promoting behaviors that are relevant to improving bone, muscle, and joint health.

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Compliance with ethical standards

Conflict of interest PRE has received research funding from Alexion, Amgen, and Eli Lilly and speaker honoraria from Amgen. FC declares that she has no conflict of interest. DS has received a speaker honorarium from Amgen. GJ declares that he has no conflict of interest.

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