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Healthy Aging & Clinical Care in the Elderly

Lifestyle Changes in the Prevention of Mobility Disability

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ABSTRACT: The prevention of functional decline with aging is essential for maintaining independent mobility for daily living and community access. The onset of mobility disability may be progressive or catastrophic in nature. Self-reported and performance-based clinical measures can be valuable for identifying the onset of mobility disability. Identification of modifiable lifestyle factors and preclinical predictors of mobility disability can be utilized in preventive care. Modifiable lifestyle factors related to mobility disability include physical activity (PA) level, smoking, nutrition, and body mass index (BMI). Age-related comorbid conditions including cardiovascular health, sarcopenia, metabolic dysregulation, cognitive impairment, and multi-morbidity influence the trajectory of decline toward mobility disability. This clinical review summarizes current knowledge about the onset and prevention of mobility disability, reviews intervention studies related to decreasing the risk for mobility disability, and provides suggestions for clinicians related to predicting and preventing mobility disability in older adults. Special attention is given to useful clinical measures, modifiable lifestyle factors, and delivering care in the context of age-related comorbid conditions in older adults.

KEYWORDS: mobility disability, lifestyle, physical function, older adults, exercise, physical activity

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Introduction

Functional decline in mobility-related skills increases with age and often leads to mobility disability. The onset of mobility disability may be progressive or catastrophic in nature.[1,2] Although not mutually exclusive, catastrophic mobility disability often results from a sudden medical event such as a fall-related injury or stroke, whereas progressive mobility disability is a consequence of declining physical function because of age-related chronic disease processes.[2] The onset of mobility disability among older adults is associated with increased hospitalization, higher healthcare costs, institutionalization, and higher rates of morbidity and mortality.[3,4] Modifiable lifestyle factors, such as low physical activity (PA) levels,[5–8] smoking,[6–8] diet,[8] and high or low body mass index (BMI), likely modify the progression of age-related decline and risk for incident mobility disability through their influence on physiological mechanisms associated with cardiovascular health, multiple chronic conditions (multi-morbidity), body composition, and mood.

The purpose of this clinical review is to examine modifiable lifestyle factors and potential underlying mechanisms that influence the course of age-related decline and catastrophic events leading to mobility disability in older adults. Special attention is given to useful clinical measures and modifiable lifestyle factors, and delivering care in the context of other needs and comorbidities of older adults. Modifiable lifestyle factors of PA and exercise will be a major focus of this review. In general, PA reflects the overall movement, energy expenditure, and muscle use integrated into the course of normal daily activities.[9,10] Exercise implies an intentional program with a directed purpose of improving health and fitness, in response to specific exercises, such as stretching, aerobic exercise, balance exercise, and/or resistance training.[9,10]

Identifying Mobility Disability

Measures of mobility disability. Self-reported and performance-based measures provide information to identify older adults with mobility disability. Common self-reported measures of mobility disability include accounts of one's ability to walk a quarter mile[5] or 1 km,[11] or climb 10 stairs.[1] In a survey of aged, disabled, and institutionalized US Medicare beneficiaries, those who reported difficulty in walking a quarter mile had significantly higher annual healthcare expenditures, more hospitalizations, and were more likely to have limitations in activities of daily living (ADL) and instrumental ADL (IADL) one year later.[12]

Objective measures including the 400-meter walk test (400-MWT),[13,14] the 6-minute walk test (6-MWT),[15] and stair climbing[1] have been used widely across older adult populations (Table 1). Individuals unable to complete the self-paced 400-MWT within 15 minutes have an extremely slow walking pace (<0.45 m/second), suggesting loss of functional mobility within the community,[13,16] which is also associated with greater risk of cardiovascular disease and mortality.[17] Requiring assistance, using a walker, or stopping to rest during the 400-MWT were strongly associated with occurrence of mortality in Italian men and women ($n = 948$, age ≥ 65).[14]

The fast-paced 400-MWT is used to evaluate cardiopulmonary fitness.[18] Performance on the fast-paced 400-MWT at baseline of a six-year observational study ($n = 3075$, ages 70–79) was associated with incident mobility limitations (one report of difficulty walking a quarter mile or climbing stairs) or disability for mobility (two consecutive reports of difficulty on the above activities).[17] The 6-MWT has also been used widely, especially in studies of cardiopulmonary fitness and normative values in healthy older adults have been described.[15,19] Distance on the 6-MWT is also predictive of falls and disability.[20]

Preclinical measures. To prevent mobility disability, it is important to identify signs of functional decline. Self-reported and performance-based measures of physical function are useful as screening tools for early detection of functional decline, especially measures that are predictive of future mobility disability (Table 2). Self-reported difficulty on daily tasks by community-dwelling older women ($n = 436$, ages 70–80) without functional decline at baseline was predictive of mobility disability 18 months later in a population-based cohort study.[1] US Preventive Services Task Force and American Geriatric Society recommendations consider a personal history of two or more falls in the past year sufficient to trigger a comprehensive, interdisciplinary approach to fall prevention.[21] Although self-reported measures are useful, performance-based measures of lower extremity function are particularly sensitive in predicting incident progressive or catastrophic mobility disability in older adults.[22]

The short physical performance battery (SPPB) is a test of lower extremity function consisting of three components: standing balance, timed 4-m walk, and five times chair stand test.[23] The SPPB strongly predicted the three-year incidence of failing the 400-MWT in 542 older adults (age ≥ 65), suggesting that it is a valid test for predicting future mobility disability, and more importantly, recognizing functional decline that indicates need for intervention.[24] The inability to walk a quarter mile and a low SPPB score were strongly associated with increased disability in older adults in a nine-year observational study.[5]

Individual components of the SPPB, including gait speed (m/second) and the five-times chair stand, are also associated with progressive and catastrophic mobility disability.[22] Timed usual gait speed and chair stand tests showed nearly comparable predictive value to the entire SPPB for identifying older adults ($n = 3024$, ages 70–79) at risk for physical disability events. Gait speed (m/second) alone is highly predictive of morbidity and mortality in older adults.[25] Usual paced gait speed of slower than 1 m/second has been shown to be predictive of a health-related event[26] and mobility disability in older adults.[22] Population-based normative values for usual walking speed have been reported from a community-based population of healthy adults living in the Republic of Ireland ($n = 4931$, ages 50–85).[27]

The inability to complete the five-times chair stand within 17 seconds reflects high risk for functional limitations.[28] In non-disabled community-dwelling older adults ($n = 109$, age ≥ 65), the five-times chair stand was found to be more predictive of mobility disability onset during a two-year observational study, when compared to other mobility-related measures (functional reach, timed up and go (TUG), grip strength, usual and fast gait speed, and 6-MWT).[29] The

Table 1. Clinical assessment of mobility disability.

MEASURE	PURPOSE	INDICATOR
Self-reported walking community distances	Mobility disability	Difficulty walking 400 m[1]
Self-reported stair climbing	Mobility disability	Self-reported difficulty climbing a flight stairs[1]
400-meter walk test (self-paced)	Mobility disability	Unable to walk 400 meters within 15 min; stops to rest more than 2 times[13,14]
400-meter walk test (fast-pace)*	Cardiopulmonary fitness	Time to walk 400 meters as fast as possible[18]
6-min walk test	Cardiopulmonary fitness	Distance walked in 6 min[15]

Note: *Part of the long-distance corridor walk (LDCW).

Table 2. Preclinical predictors of mobility disability—clinical assessment.

MEASURE	PURPOSE	CUT-POINTS
Short Physical Performance Battery (SPPB, 12 points)	Lower extremity function; Risk for mobility disability	≤10 is higher risk[24]
Walking speed (m/s)	Lower extremity function; Risk for mobility disability	<1.0 m/sec is higher risk[26–28]
5-times chair stand (sec)	Lower extremity function; Risk for mobility disability and falls	≥17 sec is high risk[28]
90-second balance test (sec)	Risk for persistent lower extremity limitations	≤53 sec is high risk[28]
Timed Up & Go (sec)	Functional mobility; Fall risk	>14 sec is high fall risk[31]

five times chair stand was also significantly associated with incidence of progressive and catastrophic disability during a three-year period in the Women's Health and Aging Study I [($n = 884$, mean age 78.7 (SD 8)].[22]

A 90-second static balance test performed in three positions (30 seconds of semi-tandem, tandem, and single leg stance)[28] is quick and easy to administer in a clinical setting. This test was evaluated in a study of well-functioning older adults ($n = 3075$, ages 70–79) with results indicating that individuals with a total time of ≤53 seconds were at high risk for mobility disability.[28]

The TUG[30] is a measure of functional mobility and involves asking the patient to stand from a seated position, walk 3 m, turn around, walk back, and sit down. Community-dwelling older adults taking longer than 14 seconds on the TUG had a high risk for falls.[31] Population-based normative values for the TUG at a self-selected pace in ages 50–85 by height and sex have been reported.[27]

In summary, self-reported and performance-based measures provide clinically relevant information for identifying risk for accelerated functional decline leading to mobility disability.[1,28] Valid tests that are quick and require minimal equipment and training are particularly valuable for clinical use. This information can alert clinicians to impairments and help to focus on prevention and intervention strategies.[32,33]

Risk Factors for Mobility Disability

There is value in identifying risk factors for mobility disability, especially modifiable factors that may be amenable to prevention and early intervention strategies. Age and genetics are strong, non-modifiable predictors of age-related functional decline and mobility disability;[34] however, there are several key modifiable lifestyle factors that can play a pivotal role in the prevention, delay, and reversal of mobility disability in older adults.[35] Modifiable lifestyle factors associated with risk for mobility disability include low PA levels,[5–8] smoking,[6–8] diet,[8] and high or low BMI.[7,36,37] These risk factors share the important characteristic of non-pharmacologic treatment options, which make them especially valuable targets in older adults where pharmacologic management can be more difficult and risky.[38] Potential mediators to the association between lifestyle factors and disability include chronic health conditions, especially multi-morbidity, depressive symptoms, trauma, and body composition.[8] Additional prognostic factors that must be considered when planning lifestyle interventions for older adults include cognitive impairment, vision impairment, and poor self-rated health.[39] Lifestyle changes such as increasing PA, improving nutrition, and decreasing tobacco use can alter the course of age-related functional decline and reduce incidence of mobility disability. Key studies elucidating the presence and importance of these risk factors are highlighted below.

In a case–control study of older adults hospitalized for a hip fracture ($n = 387$, age ≥ 65), a number of modifiable lifestyle factors were identified as having a significant protective effect on the risk for hip fracture.[35] Protective factors included never smoking, moderate alcohol consumption, not losing weight in mid- and older age, and playing sports in older age.[35] In a prospective cohort study of community-dwelling older adults ($n = 754$, age ≥ 70) who were initially nondisabled, functional trajectories (based on IADL, ADL, and mobility activities) were identified during the year before and after a serious fall-related injury. Post-fall recovery rates were influenced by pre-fall functional trajectories, with rapid recovery seen only in those who had no disability or mild disability before the injury.[40] In another study from the same cohort, serious fall-related injuries were associated with worse disability and a higher likelihood of nursing home placement when compared to hospitalizations for a non-fall-related problem.[41] Taken together, these findings suggest that lifestyle factors play an important role in the prevention of catastrophic events, and may also be prognostic of rates of successful rehabilitation and reversal of mobility disability in older adults.

BMI (kg/m^2) and waist circumference are recommended as clinical screening tools for obesity in older adults.[42] BMI and mobility disability have interesting u-shaped relationships, with both high and very low BMI levels showing associations with reduced functional status on ADL, IADL, and mobility tasks[36] and incident mobility disability.[37] A review of cross-sectional and longitudinal studies by Vincent et al. revealed that poorer lower extremity function was associated with higher levels of obesity in both older men and women.[43]

Obesity was consistently associated with compromised walking, stair climbing, and chair rise ability, especially if BMI exceeded 35 kg/m,[2,43] potentially because of the increased physiological demands and stresses to the musculoskeletal system compared with normal weight individuals doing similar physical tasks.[44] Obesity and related comorbidities are strongly associated with physical inactivity in older adults, thus making exercise an important aspect of preventing mobility disability. BMI is commonly utilized as a research and clinical metric because of established, gender-specific classifications and ease of utilization of height and weight for assessment. However, body composition changes with age and loss of muscle mass contribute to decreased physical function and increased risk for mobility disability. A meta-analysis of 32,678 men and 25,931 women aged 65–74 years observed increased all-cause mortality associated with increased BMI; however, increased waist circumference also correlated with increased rates of morbidity and mortality even in the "healthy" weight group.[45] Obesity is associated with metabolic abnormalities, such as insulin resistance, as well as with age-related decline in physical function that leads to frailty,[46] a convergence of cumulative stress from multiple physiological systems.[47]

Sarcopenia, characterized by progressive and generalized loss of skeletal muscle mass and strength associated with aging,[48] has been identified as a common pathway associated with the initial onset and progression of physical frailty.[49] The typical rate of muscle mass loss occurs at approximately 1% per year from a peak between ages 20 and 30 years. The loss of muscle mass accelerates around age 50, occurring gradually in men and sharply in women after menopause.[50] Although the greatest cause of sarcopenia is inactivity, many age-related factors contribute, including reduced anabolic potential, insulin resistance, inflammation, hormone alterations, and changes in muscle metabolism.[50] Pro-inflammatory factors that contribute to accelerated progression of muscle atrophy may be a common pathway in a variety of disorders that impact metabolism and inflammation.[49,51] Low grip strength, a sign of generalized muscle weakness associated with a frailty syndrome, was also associated with the onset of mobility disability, defined by an inability to complete the 400-MWT, in older adults (ages 70–89).[36,52]

Prognostic factors of disability including older age, cognitive impairment, vision impairment, and poor self-rated health should be taken into account when evaluating risk and planning lifestyle interventions;[39] and continuing to re-evaluate the risks and benefits of medications is important. Additionally, older adults are more likely to have multiple interacting health conditions that make clinical decision-making even more complex.[53] For example, a comorbid condition, such as cognitive impairment, worsens the prognosis for mobility disability. Progressive and catastrophic mobility disability is frequently preceded by functional decline with both physical and cognitive functions associated with risk for mobility impairments.[54] Older adults with dementia are at high risk for fall-related injuries and loss of independence because of gait and other mobility impairments.[55–58]

Benefits of PA and Exercise in Older Adults

Well-functioning older adults. There is consistent evidence that exercise in healthy older adults (age > 65) impacts a range of outcome measures related to functional independence, suggesting that regular exercise reduces functional decline and risk for mobility disability in older adults.[59] Mechanisms by which exercise or PA improves mobility may include increased muscle strength, bone mass, aerobic capacity, balance, as well as cognitive and emotional health.[9]

Modifiable lifestyle factors including minutes of moderate-intensity PA and BMI were cross-sectionally associated with the ability to complete the 400-MWT within 15 minutes in sedentary older adults (n = 424, ages 70–89).[60] Higher levels of PA during middle age appear to reduce risk for mobility disability in later life. In a retrospective study, Italian older adults (n = 1155, mean age 74.8) were more likely to demonstrate better function on the SPPB and were more likely to successfully complete the 400-MWT in later life, compared to people who were less physically active at midlife, suggesting a protective effect of PA.[61] Benefits of PA do not appear to be limited to midlife. Maintaining and adopting a healthy lifestyle in later life reduces the risk for mobility disability and may improve recovery from a state of disability.[7] In older men participating in a mailed questionnaire (n = 5075), associations between later life PA and mobility limitations (defined as difficulty in getting outdoors, walking 400 yards, or climbing stairs) were significant even with light PA, such as walking, gardening, or handiwork.[7] Compared with low PA, risk of incident ADL disability with medium to high levels of PA was reported to be significantly reduced in a meta-analysis of nine longitudinal studies involving 17,000 participants who were followed up for 3–10 years.[62] Being physically active is an effective strategy in preventing and slowing the disablement process in aging and diseased populations.[62] The promotion of even light or moderate PA may be an effective strategy in preventing mobility disability in sedentary older adults.

Within the overall clinical concept of mobility disability, fall risk and prevention is an important topic, especially for older adults where falls are a common catastrophic occurrence and can be identified as a discrete, reportable event generally recognizable to patients, families, and clinicians. The US Preventive Services Task Force found convincing evidence that exercise or physical therapy has moderate benefit in preventing falls.[21] The results of a Cochrane systematic review provided support for the implementation of specific exercise interventions (gait, balance, coordination, and functional tasks; strengthening exercise; and multiple exercise types) in adults, aged 60 and over living in the community or in institutional care, for improving clinical balance outcomes in older people.[63] In a systematic review with meta-analysis of randomized controlled trials (RCTs), the greatest relative effects of exercise programs on fall rates were seen in programs that included a combination of a higher total dose of exercise (>50 hours) and challenging balance exercises (e.g. standing exercises with narrow base and center of mass challenges).[64]

Functionally limited older adults. Several exercise studies have targeted populations of older adults with known functional limitations. The lifestyle interventions and independence for elders (LIFE) multi-center RCT[65] examined the effects of a moderate-intensity structured exercise program on sedentary older adults (n = 1635, ages 70–89). The exercise intervention consisted of aerobic, resistance, and flexibility training activities, conducted in a center twice weekly and at home three to four times per week. Over a 2.6-year follow-up period, the exercise intervention group (n = 818) had a significantly reduced likelihood of major mobility disability (inability on 400-MWT), and persistent mobility disability (major disability followed by death), compared to a health education control group.[65] A meta-analysis of studies involving older adults (n = 9 studies, age ≥ 60) with mobility problems and physical frailty, including multi-morbidity, reported that although some studies showed no effect, physical exercise intervention studies aimed at improving mobility, strength, endurance, balance, and/or PA had a small, positive overall effect on mobility and various physical functions. Especially relevant was the finding that the more effective trials were long-lasting (9–12 months) and included at least three times per week of exercise.[66] In addition, high-intensity exercise interventions seem to be somewhat more effective in improving physical functioning than low-intensity exercise interventions.[67] In another systematic review and meta-analysis of physical exercise RCTs, frail community-dwelling older adults with ADL difficulties demonstrated significant improvement in normal gait speed, fast gait speed, and the SPPB, as compared to controls.[68]

The LIFE pilot (LIFE-P) study was a moderate-intensity exercise RCT in older adults (n = 424, ages 70–89) who had physical function limitations (SPPB ≤ 9), without mobility disability at baseline as indicated by their ability to walk 400 m within 15 minutes. Compared with the health education control group, the PA intervention group demonstrated significant improvement on the SPPB and the 400-MWT (usual pace) and tended to reduce the risk of major mobility disability later (failure to complete the 400-MWT or death).[69] Providing further support for implementing exercise interventions to prevent mobility disability in functionally limited individuals, frail community-dwelling older adults (n = 72, mean age = 71) improved their performance in the TUG, 30-second chair stand, and gait speed following a six-week physical therapy home-based exercise program.[31]

To determine if people with sarcopenia could improve their physical function with exercise, the LIFE-P participants in the exercise group (n = 177, ages 70–89) were stratified as sarcopenic versus non-sarcopenic based on lean mass body composition measures.[70] The results showed that participants with sarcopenia improved their performance on the SPPB at a similar rate as participants without sarcopenia, with both improving more than the control group.[70] In another LIFE-P secondary analysis in which participants were classified by disability level (mild to severe), participants in the 12-month exercise group were more likely to regain or sustain functioning and were less likely to lose functioning than the control group.[71]

Programs that facilitate increased PA and embed exercise into everyday activities may enhance adherence without losing efficacy. In a study of older adults (n = 2005, age ≥ 65) receiving home care in 11 European home health agencies, individuals who were more physically active at baseline (two hours or more PA in the past three days) compared to those participating in less PA were less likely to experience the onset of ADL disability over the 12-month follow-up period.[72] In a pragmatic RCT conducted within an Australian health and community care organization, administering exercise programs via an interdisciplinary team to older adults receiving restorative home care services,[73] clients (n = 80, age ≥ 65) were randomized to receive either the lifestyle-integrated functional exercise (LiFE) program that embeds exercises into everyday activities or a structured falls-prevention exercise routine. The results showed no group differences in the amounts of exercise completed during the eight-week intervention period, but the LiFE program was more effective on 40% of the outcome measures, in particular tandem walking, single sit-to-stand, and TUG test, as compared to the structured exercise program.[73]

Positive effects of multicomponent exercise interventions have been reported in older adults with cognitive impairment including improved physical performance (walking speed, balance, and endurance), physical fitness, cognitive function, ADLs, and behavior.[74–77] Outcomes of improved balance, mobility, and reduced fall risk have been shown in people with dementia following balance and functional weight-bearing exercises.[58,78] Including both caregivers and patients with dementia, an exercise intervention that combined teaching caregivers behavior management techniques improved physical health and depression in patients with dementia residing in the community.[79] Interventions providing optimal environment, support, and behavior management for people with dementia can improve physical function and decrease risk for falls, therefore, reducing risk for progressive and catastrophic mobility disability.

Benefits of Lifestyle Interventions for Body Composition

Incorporating resistance exercise during dietary restriction may be beneficial in attenuating muscle loss, improving physical function, and preventing mobility disability. In a one-year

RCT, physical performance in obese older adults (n = 107, age ≥ 65) improved more with a diet-plus-exercise intervention (21% improvement), compared to either the diet (12%) or exercise intervention alone (15%).[80]

Alterations in body composition are potential underlying mechanisms for improvement in physical function. In a pilot study of sedentary women (n = 27, ages 55–79) with low levels of physical function (SPPB score of 4–10), a six-month intervention of caloric restriction plus exercise was found to be an effective treatment approach for producing significant regional lower extremity fat loss while preserving muscle size and quality in obese, sedentary older women. Gait speed also showed a trend of improvement more in the dietary restriction plus exercise group, suggesting improved functional mobility, but was not statistically significant in this small pilot study.[81]

The results of a 12-month PA program versus a health education control in functionally limited older adults (n = 424, ages 70–88) stratified by BMI (cut point ≥ 30 kg/m^2) reported that the lower BMI group improved on the 400-MWT (m/second) but the higher BMI group slowed down. However, both the high and low BMI groups demonstrated improvement on the SPPB.[82,83] The application of multicomponent behavioral interventions for obese adults leads to weight loss, as well as improved glucose tolerance and other physiologic risk factors for cardiovascular disease.[42] Therefore, lifestyle changes will likely be beneficial in preventing, delaying, or reversing mobility disability in this population.

Targeting Modifiable Lifestyle Factors to Reduce Mobility Disability

Early identification of risk factors and timely intervention is fundamental to preventing, delaying, and/or reversing mobility disability in older adults.[32] General principles of care for the older adult can be applied to concerns about preventing and minimizing the impact of mobility disability. Western healthcare often advocates a patient-centered, whole-person care approach that includes considerations of quality of life and shared provider–patient–family decision-making.[84] In the care of the older adult, these same "person-centered" principles take on a new range of considerations, including age-specific treatment effects, changes in side effects, and other factors for risk/benefit considerations in relation to age, including time to anticipated treatment effect.[85,86]

Smoking cessation. Smoking cessation remains an important target for public health improvement in many areas of health, including mobility disability. While smoking rates have declined in many areas of the world since 1980, population growth has resulted in a net total increase of people who smoke tobacco.[87] There are many effective strategies for assisting clients with smoking cessation, and counseling from healthcare providers to quit smoking can play a key role.[88] A framework such as "the five A's" (ask, advise, assess, assist, arrange) can be utilized to help care providers walk through the process of asking about tobacco use, considering cessation options, and following through.[89] Along with counseling, pharmacological treatments can help people reach their smoking cessation goals. Results from a recent review highlight higher quit rates in those using combination nicotine replacements, bupropion, or varenicline compared to those using placebo.[90]

Fall prevention. A range of modifiable lifestyle factors associated with progressive and catastrophic disability onset suggest that promoting lifestyle factors associated with healthy aging offers a comprehensive approach to the prevention of falls.[35] Clinical practice guidelines for the preventions of falls recommend screening for fall risk using self-reported fall history and simple performance-based measures of physical function. Although, no single evidence-based tool exists that can fully and accurately predict falls in older adults, the TUG has been recommended for clinical assessment by the US Preventive Services Task Force.[21] Multifactorial assessment, including interdisciplinary intervention, is recommended for older adults who report two or more falls in the past year;[21] however, strategies to slow functional decline and prevent mobility disability should be incorporated with early signs of increased risk. Cesari et al.[28] provide cut-points for simple performance-based tests that can be conducted in the clinic, home, or community setting to identify risk for mobility disability (Table 2). These clinical tools are useful for recognizing increased risk and initiating timely interventions; and evidence supports exercise and physical therapy to prevent further functional decline and falls.[21]

Increasing PA and exercise. PA and exercise can be effective treatment strategies for a wide range of changes common in aging. Sedentary behavior affects muscle physiology, leads to muscle weakness, and accelerates sarcopenia.[50] Even low doses of exercise or PA may be effective in reducing sedentary behavior. Initiation and progression of an appropriately challenging exercise program is important and has been demonstrated to be safe even after cardiovascular events.[91] Exercise can be as effective as medication for treating depression.[92] There is also emerging support for self-efficacy as a mediator of the association between PA and disability, and quality of life outcomes in older adults.[93]

For sedentary individuals following a catastrophic event and/or with multi-morbidity, the phases used in cardiac rehabilitation can serve as a useful model for gradually progressing PA levels. Phase I cardiac rehabilitation involves supervised, early mobilization in the hospital; phase II is a supervised/monitored, disease-specific, individualized exercise program; and phase III is a life-long, independent, community-based exercise program that provides a gradual progression that can be monitored and individualized for older adults with cardiovascular conditions as well as other age-related health conditions.[94]

In relatively healthy older adults there may be a threshold of at least moderate-intensity activity needed for significant functional improvement. However, a precise characterization of a minimal or effective PA dose to maintain functional independence remains unclear.[59] Exercise training that targets functional mobility, including aerobic, strength, power, and balance training in healthcare settings and community programs, is needed to slow the functional decline in older adults. Addressing lower extremity strength, power, and balance deficits is especially important, because these areas of physical performance are particularly impaired in older adults with mobility limitations.[95] The duration of an exercise program should last for at least 12 weeks to obtain significant effects of an exercise intervention. In-person interviews or use of mobility monitoring tools may enhance adherence.[96]

The current consensus recommendations of the American College of Sports Medicine and American Heart Association with respect to exercise dosage for relatively healthy older adults[9] include a regular program of exercises at moderate-to-vigorous intensity. Endurance exercise guidelines recommend a minimum of 150 minutes of moderate aerobic exercise per week (30 minutes, five days/week) or 60 minutes of vigorous-intensity aerobic exercise (20 minutes, three days/week).[9] Aerobic exercise that is safe and avoids excessive orthopedic stress is appropriate. Intermittent additive aerobic exercise accrued in 6–10-minute bouts can be effective in improving aerobic capacity, especially for those with limited exercise capacity.[97] Resistance exercise should be incorporated two days/week, 8–10 exercises for 8–12 repetitions, at a moderate-to-vigorous intensity (effort of five to eight on a perceived exertion scale of 0–10). Moderate-intensity balance and flexibility exercises are also recommended two days/week. Special considerations for older adults include low intensity to begin, progressive, individualized, and tailored to tolerance and preferences; older adults should exceed the minimum recommendations if they desire to not just maintain but improve their fitness.[9]

Although provisions for balance and gait stability may be needed, walking is the most simple form of exercise to improve aerobic fitness. Current evidence suggests that 30 minutes of daily moderate-to-vigorous PA accumulated in addition to habitual daily activities in healthy older adults is equivalent to taking approximately 7,000–10,000 steps/day. Use of a pedometer or other activity monitoring devices may improve motivation to meet daily goals of walking.[98]

Individuals with cognitive impairment will likely benefit from instructions in easy-to-remember increments, high repetition and practice, a cognitively intact exercise partner, written and visual memory cues, and ensuring that the exercise is enjoyable and designed for the individual.[99] Individuals with dementia have demonstrated improved function when caregivers are trained in behavioral strategies and also participate in the exercise program.[79]

Lifestyle changes targeting body composition. Body composition, rather than weight loss alone, should be considered when planning strategies for improving physical function in older adults. Strategies that aim to reduce body fat while increasing lean muscle mass are recommended for the prevention of mobility disability in obese older adults.[49] Weight control while minimizing sarcopenia is important when considering prevention of physical performance decline and mobility disability.[49] Clinical Practice Guidelines for Obesity[42] recommend referral of all adults with a BMI of 30 kg/m^2 or higher to intensive, multicomponent behavioral interventions for weight loss. Multicomponent interventions for obese individuals include behavioral management activities, such as weight-loss goals, improving nutrition and increasing PA, addressing barriers to change, self-monitoring, and strategizing how to maintain lifestyle changes. At least 12- to 26-week interventions are recommended based on research studies showing improved weight loss with this duration.[42]

Conclusion

Prevention of mobility disability is fundamental to maintaining independence with aging.[5,16,44] Modifiable lifestyle factors associated with mobility disability include PA level, smoking, and high and low BMI. Prognostic factors that influence the trajectory of functional decline toward mobility disability include poor cardiovascular health, sarcopenia, metabolic dysregulation, cognitive impairment, and multi-morbidity. Changing lifestyle behaviors through PA and exercise, modifying nutrition, and smoking cessation interventions, may delay or reverse functional decline through improving muscle strength and benefiting all physiological systems in older adults. Mitigating risk factors through lifestyle changes is associated with greater independence and is protective against the onset of mobility disability because of progressive and catastrophic mechanisms.

Author Contributions

Wrote the first draft of the manuscript: EM and JZ. Contributed to the writing of the manuscript: EM and JZ. Agree with manuscript results and conclusions: EM and JZ. Jointly developed the structure and arguments for the paper: EM and JZ. Made critical revisions and approved final version: EM and JZ. All authors reviewed and approved of the final manuscript.

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