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A Scoping Review of the Predictive Qualities of Walking Speed in Older Adults

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Abstract

BACKGROUND AND PURPOSE—Walking speed (WS) is an easily assessable and interpretable functional outcome measure with great utility for the physical therapist providing care to older adults. Since WS was proposed as the sixth vital sign, research into its interpretation and use has flourished. The purpose of this scoping review is to identify the current prognostic value of WS for the older adult.

METHODS—A scoping review was conducted using PubMed, CINAHL, and SPORTDiscus to find relevant articles highlighting the predictive capabilities of WS for older adults. Titles and abstracts were reviewed to identify relevant articles. Articles were excluded based on the following criteria: sample included both younger and older adults without separate analyses, sample was focused on a particular disease, if the study was published before 2017, or if the study did not report relevant cut points for interpretation of WS. The search returned 1064 results. Following removal of articles not meeting inclusion criteria and critical appraisal, relevant cut points were extracted from 47 original research publications.

RESULTS AND DISCUSSION—A preliminary review of the included articles showed that WS is a valuable prognostic tool across many health domains, including mental health, mortality, disability, pain, bone and joint health, falls, cognition, physical activity, metabolic health, risk for cardiovascular disease, socialization, and metabolic health. The fastest walking speed of 1.32 meters per second (m/s) served as a cutoff for decreased risk for incident development of type 2 diabetes, while the slowest WS of less than 0.2 m/s was associated with increased duration of hospitalization. Multiple studies reported on the prognostic value of WS slower than 1.0 m/s.

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List of Supplemental Digital Content:

SDC 1 Table 1.doc

SDC 2 Table 2.doc

CONCLUSION—Although the reported range of predictive WS values was broad, multiple studies found WS of approximately 1.0 m/s to be a useful marker for delineating risk or decline across a variety of health domains. Clinicians may find it useful to use a WS slower than 1.0 m/s as a “yellow flag” to guide evaluation and intervention for their older adult clients.

Keywords

Older adults; walking speed; gait speed; risk; prediction

INTRODUCTION

Walking speed (WS) reflects the complex interactions of many body systems, including muscular strength, balance, proprioception, vision, cardiovascular fitness, and more.^{1–5} Each of these systems is impacted by the normal aging process.⁶ A physical therapist working with an older adult client can quickly learn a great deal about past performance, present status, and future prognosis from this functional measure.

Walking speed was proposed as a sixth vital sign more than a decade ago.⁷ Since then, research on walking speed has flourished, growing by approximately 100% in terms of publications per year (388 results for “walking speed” and “older adults” in 2009 versus 773 results returned for that search for the year 2019, [PubMed search]). A subsequent publication included an updated graphic of WS cut points and recommendations for standardization of the clinical measurement of WS.⁸ As evidence continues to accumulate for the prognostic value of WS in the management of older adults, the purpose of this paper is to identify the current prognostic value of WS for the older adult. This work is novel because despite the volume of research on WS in older adults, no current systematically conducted review of the predictive value of WS for older adults was identified during the preparation for this study or in the course of this search.

METHODS

The goal of this scoping review is to provide a concise and clear representation of the current literature on WS as a functional vital sign for older adults. For this review, older adult was defined as a sample of individuals with mean age 65 or older in keeping with the Centers for Disease Control and Prevention (CDC).⁹ With this goal and definition, exclusion criteria were articles not reporting a walking speed cut point for older adults, articles published before the year 2017, and articles not published in/available in the English language. Articles published before 2017 were excluded to focus the current review on the latest findings and research, as various previous works have provided clinicians with a summary of the use of walking speed as a vital sign and outcome measure.^{7,8} An additional exclusion criterion was articles focused on a specific diagnosis (such as multiple sclerosis, chronic obstructive pulmonary disease, stroke, etc.). This was carefully selected as an exclusion criterion, not to exclude all individuals with comorbidities, but to allow clinicians to broadly apply these results to older adults.

This review was guided by the use of the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Review (PRISMA-ScR) checklist.¹⁰ The

search terms and strategy were developed in consultation with a health-sciences research librarian. The search was conducted using the following databases: PubMed, CINAHL, and SPORTDiscus. A title and abstract search was conducted using Boolean operators with three concepts: older adults, walking speed, and prediction. The most recent search was conducted March 28, 2022. Exact formatting and text entry of the query varied by database, but for reference the search conducted in PubMed read as follows:

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((((((age[Title/Abstract]) OR (old[Title/Abstract])) OR (aging[Title/Abstract]))
OR (ageing[Title/Abstract])) OR (elder*[Title/Abstract])) OR (senior[Title/
Abstract])) OR (geriatric[Title/Abstract])) AND (predict*[Title/Abstract])) AND
(((walking speed[Title/Abstract]) OR (gait speed[Title/Abstract])) OR (walking
pace[Title/Abstract])) OR (gait velocity[Title/Abstract]))
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A single reviewer (GH) reviewed titles and abstracts for relevance of returned publications, as well as extracted cut points and health outcomes from included articles. Original research trials and secondary analyses of data were considered for inclusion in this manuscript. Full-text articles were reviewed if inclusion criteria were met, and relevant cut points and associated health outcomes were extracted. For articles where statistical results indicated that the authors had calculated a cut point, but not included it in the manuscript (i.e., publication of a receiver-operator characteristic curve about WS in older adults), corresponding authors were contacted via email. Following extraction of cut points from all returned results, findings were grouped into various domains of health (i.e., cognition, falls, metabolic health) established by discussion among the authors of this manuscript.

Critical appraisal of included articles was conducted independently by two of the authors (GH and RDH). The critical appraisal process was guided by the use of the Joanna Briggs Institute checklists relevant to each study type (cross sectional analytical, cohort, and randomized control trial).¹¹ Scores were assigned with one-point for “yes” to a criteria, zero-points for a “no”, and one-half-point for an “unclear.” Because the checklists for each study type contained differing numbers of items, scoring was normalized on a scale from 0 to 1.0, based on total score divided by possible score. Articles rated as greater than or equal to 0.75 were classified as “good” quality, with those articles scoring equal to or greater than 0.5 and less than 0.75 as “fair” quality, while a score of less than 0.5 was considered “poor” quality. This method for appraisal and scoring is consistent with previously published work.¹² Following individual appraisal of each article, the authors met to reach scoring consensus before assigning grades to the included articles. A third author (SF) was consulted when consensus could not be reached regarding scoring on a particular article.

Findings reporting on the prognostic and predictive value of WS are primarily referring to clinically assessed WS and not to free-living WS, as these are distinct constructs.^{13,14} Environmental and consumer technologies for measurement of walking parameters are also being explored.^{15,16} Findings reported here are strictly related to WS at self-selected pace collected in a controlled environment by a clinician. While the use of assistive devices (ADs), fear of falling, and footwear are all important factors associated with WS and health in older adults, this review presents pooled results with reporting of the methods employed in each included study.^{17–19}

RESULTS

Following removal of duplicates, 1064 articles were screened by title and abstract with relevant cut points extracted from 47 full text articles (Figure 1). Quality scores, study design, health domains, and WS cut points for included articles are presented in Table 1 (see SDC_1_Table_1.doc, Supplemental Digital Content 1). Table 2 presents additional details about the articles, including demographic details of the sample and details on WS testing procedures and data analysis (see SDC_2_Table_2.doc, Supplemental Digital Content 2). Extracted WS cut points were grouped into 12 domains reflecting various aspects of health, function, and daily life (Figure 2). Figure 3 presents mean WS for older adults stratified by decade of life and sex; these data reflect usual WS with or without the use of an AD and wearing usual footwear.⁶⁶

Quality appraisal of included studies

Of the appraised articles, 25 utilized a cohort design, while cross-sectional associational studies numbered 20. Two randomized-controlled trials were among the reviewed articles. Forty-one articles (87%) were scored as good quality following critical appraisal. Six articles (13%) were rated as fair. No articles reviewed for this study received a rating of poor.

Testing Procedures

Of the included articles, 14 generally reported that an AD was permitted during WS testing, while 2 studies specifically excluded individuals requiring the use of an AD. The remaining 31 studies did not address the use of an AD by their participants. Results in each study were pooled and were not differentiated by the use/non-use of an AD during gait.

Of the 47 included articles, only 4 mentioned instructions regarding footwear to their participants. Fear of falling was only treated as a variable in 3 of the included studies, while it was at least discussed in the discussion or introduction sections of 4 others. These details are reported in Table 2.

Health Domains

Mental Health: Walking speed is related to mental health. When in combination with cognitive slowing, WS less than 0.8 m/s places an older individual at 67% greater risk for the development of depression or anxiety.²² Walking speed below 1.0 m/s is associated with a greater burden of depressive symptoms.²⁴ This is particularly important in the older adult population, as rates of depression are significantly higher in individuals with chronic disease processes.⁹ Physical therapists should consider this knowledge in weighing referral or consultation with relevant healthcare providers.

Mortality: Reduced WS is a powerful indicator of mortality. Older adults who walk slower than 0.6 m/s had an odds ratio of 3.03 greater risk of death within 4 years compared to their faster walking peers.²⁵ Results were similar at greater speeds. Individuals with WS below 0.8 m/s were 71% more likely to die during 9-year follow up than their peers with faster WS (hazard ratio of 2.47), and they also had elevated risks at 3 and 5 years.^{27,28,30} For each 0.1 m/s decrease in WS, risk of all-cause mortality increases by about 20%.⁶⁷

From an intervention and prevention perspective, an improvement in WS of 0.1 m/s has been previously shown to be associated with reduced risk of death for older adults.⁶⁸

Hospitalization: Walking speed can indicate an individual's risk for hospitalization, as well as the course of hospitalization, and discharge outcome. Individuals who walk below 0.2 m/s are at risk for longer length of hospitalization, as well as being more likely to have a poor discharge outcome (defined by discharge to a higher level of care).²⁹ Increased risk for hospitalization within a year and longer duration of inpatient stays was also predicted by WS below 0.8 m/s.^{23,26,30} Conversely, WS greater than 0.84 m/s predicted an ambulatory discharge to prior living situation following a rehabilitation stay.³¹ Walking speed below 1.0 m/s is also a useful tool in predicting the correct discharge destination from an acute care hospitalization.³⁶ Lower walking speeds (below 0.92 m/s) may indicate a need for continued rehabilitation in a short-term rehabilitation facility or the need to transition to a higher level of care (assisted-living, long-term care facility, etc.).³⁷

Disability, Independence, and Activities of Daily Living: For the older adult, there are many concerns related to maintaining independence, fear of the loss of independence, and the potential need for a change in living situation.¹⁷ Walking speed is associated with an individual's ability to independently and safely perform activities of daily living (ADLs). A WS less than 1.0 m/s is associated with 10-year functional decline in independence in instrumental ADLs.³⁵ In addition, WS less than 1.0 m/s is predictive of future mobility disability.²⁴ It has also been shown that WS below 0.8 m/s is associated with increased likelihood to acquire mobility disability within three years.³² While not predictive, an association has also been found between an individual's report of depressive symptoms and disability with slow WS, 0.63 m/s.²¹ For individuals with reduced WS, the physical therapist should consider referral to additional resources if limitations in self-care or safety are suspected.

Pain: Recent research reports that WS is associated with pain. WS under 0.88 m/s is associated with increased risk for foot pain.⁴³ More generally, it has been found that WS under 1.0 m/s is associated with increased likelihood for the individual to have experienced pain in the last month.⁴² A WS lower than 0.65 m/s indicates an individual at increased risk for persistent musculoskeletal pain.⁴¹ Older adults with chronic pain walk more slowly than their peers.⁶⁹

Bone and Joint Health: A simple patient self-report of having "fast" WS in comparison to older adult peers is predictive of increased bone density, as assessed by higher calcaneal stiffness index.⁴⁶ Conversely, decline in usual walking speed is associated with a reduction in bone mineral density.⁷⁰ In a related vein, slower self-selected WS is associated with increased risk of fractures.⁴⁴ Even more concerning, WS below 0.8 m/s is associated with increased risk for a major osteoporotic fracture within 2 years.⁴⁴ Walking speed is also associated with joint health, with older adults who walk at a pace less than 1.09 m/s being more likely to report knee osteoarthritis within 4 years.⁴⁵

Falls: While a history of falls is the greatest predictor of future falls, WS below 1.0 m/s is predictive of future falls and is associated with a history of multiple falls.²⁴ There are

multiple cut points above and below this conferring varying levels of increased risk for falls among older adults. One study found that WS equal to or less than 0.71 m/s was predictive of a hazard ratio of 1.3 for suffering a fall within three years.⁴⁷ A WS of 0.85 m/s or less demonstrated a 13.59 odds-ratio for being at high risk of falls as assessed by the Downtown Fall Risk Index.⁴³ Walking speeds as high as 1.01 m/s were associated with increased risk of falls in comparison to older adults walking at speeds over 1.12 m/s.⁴⁸

Cognition: Self-selected WS can predict many aspects of mental function and cognition. Slower WS has also been shown to predict cognitive decline, with speeds below 0.6 m/s predicting the transition from normal cognition to mild impairment or from mild to severe impairment.⁴⁹ A walking speed of 1.0 m/s is also predictive of cognitive decline.^{51,52} Even faster WS has been shown to be a predictor of cognitive decline. Usual WS less than 1.12 m/s is predictive of 10-year cognitive decline.⁵³ Multiple cut points have been identified for risk of dementia. One study reported that speed above 0.8 m/s was associated with an odds ratio of 0.06 for having dementia, demonstrating a protective effect of greater speed.⁵⁰ However, walking speed as fast as 1.12 m/s was associated with a hazard ratio of 1.49 for the development of dementia over a mean 42.8 month follow-up period.⁵⁴ Change in WS is also a predictor, as a decline in WS by only 0.05 m/s is significantly associated with decreases in brain volume at 4 years.⁷¹

Physical Activity: Walking speed can provide clinicians an insight into the likelihood that their clients are meeting physical activity (PA) recommendations and allow for conversations with the client about a plan to increase PA. For individuals with WS less than 1.0 m/s, they are unlikely to achieve PA guidelines as speeds below this level are associated with less than 9 minutes of accumulated moderate-vigorous physical activity (MVPA) per day.⁵⁵ Usual WS below 1.13 m/s is predictive of a decline in future daily energy expenditure for older adults.⁵⁷

While a daily step recommendation is not a component of the Physical Activity Guidelines for Americans, steps are an approachable and understandable metric of physical activity for older adults. Walking speed is associated with daily step counts, as well. Helping a client to improve their WS by 0.045 m/s is associated with accumulating an additional 5000 steps per day.⁷²

Cardiovascular Disease and Stroke: Multiple cut points have been proposed to indicate increased risk for the development of Cardiovascular Disease (CVD). Both lower, 0.8 m/s, and higher more conservative, 1.0 m/s, cut points were identified.^{23,59} Similarly, for older adults, WS below 1.15 m/s indicates increased risk for the occurrence of stroke within 10 years.⁵⁸ Taken together, these cut points help identify those at risk for the major causes of death and disability among older adults.

Social Health: Slow WS may be predictive of financial and social health, as well. Walking speed below 0.66 m/s is associated with increased odds for financial strain and home disorder.⁶¹ Reduced functional mobility and low WS (defined as less than 1.0 m/s) place an individual at increased risk for the development of “social frailty”.⁶³ The ability to mobilize increases the likelihood that an older adult will remain engaged with peers and

their community, as WS above 1.0 m/s is associated with reduced likelihood to be socially isolated.⁶⁰ For purposes of engagement in the community and community mobility, older adults need to be able to walk at 1.2 m/s to safely cross at a walk light on most streets in the United States.⁶² If a client's goal is to be able to engage in their community, this would provide a measurable outcome.

Metabolic Health: Limited research is available at this point, but preliminary work has found an association between walking speed and future risk for the development of type 2 diabetes mellitus (T2DM). A self-selected WS of less than 1.32 m/s is predictive of incident development of T2DM with a relative risk of 1.35 for development of the disease over 8-years of follow up.⁶⁵ In a related finding, older adults with T2DM walk more slowly than their peers (1.12 m/s versus 1.24 m/s), with lower WS associated with greater risk.⁶⁴ It has also been found that WS greater than 1.1 m/s is associated with lower body mass index (BMI), which may be reflective of the relationship with T2DM risk.¹³

DISCUSSION

This scoping review was conducted to provide clinicians and other interested parties with a systematically conducted summary of recent findings about the use of WS as it pertains to general health and function. With this goal, the search query was built around three concepts: walking speed, older adults, and prediction. After screening over 1000 titles and abstracts, cut points related to WS and prediction of health outcomes in older adults were extracted from 47 unique publications. These findings were grouped into 12 domains related to health, covering everything from hospitalization to metabolic health. Walking speed has been recognized as the sixth vital sign, and the authors hope that this work may provide clinicians and other parties with a concise and thorough resource to the interpretation and use of this measure with older adult patients.

Areas for future research and opportunities

Walking speed is a simple measurement that predicts increased risk across multiple health domains in older adults. However, the method of collection of WS is important to its interpretation and use. Despite multiple calls to standardize measurement practices, there is still significant heterogeneity of techniques employed in practice.⁷³ In the course of this review, methods were found ranging from the use of WS derived from the Timed Up and Go test (TUG), trialing a 10-foot walking test, or derivation from a 6-minute walking distance (6MWD).^{8,73–76} In addition, fear of falling, details regarding participant footwear, and the use of ADs were not well reported in the reviewed studies, despite the relationship of these various factors with mobility, risk for falls, and generalizability of test results.^{17–19} Increasing standardization of testing procedures will allow greater generalizability and comparison of results. Prior research has indicated that WS is valid and reliable across measurement methodologies, however.^{77,78}

The future of WS measurement may also include the use of data collected from commercially available wrist worn accelerometers, as well as unobtrusive in-home monitoring systems. Wrist worn accelerometers in the form of smart watches are increasingly ubiquitous and may provide a valuable data source for physical activity and

WS.⁷⁹ These consumer technologies are still being evaluated for clinical relevance and validity.¹⁶ Technologies are also being trialed for the detection and interpretation of in-home vibrations for falls detection, which may have application in future assessment of remote monitoring of WS.^{15,80}

Limitations

Limitations of the current manuscript include review of titles and abstracts by a single individual. However, quality appraisal of included articles was conducted by two of the authors. Although a detailed and extensive search was conducted utilizing a running spreadsheet and citation management software, review by a single person may reduce confidence in the rigor of the search. An additional limitation of the current manuscript is that the search was limited to three major databases, which may have omitted valuable information from other high-quality research. However, the search strategy was developed through study of prior systematic and scoping reviews, as well as the insight of a research librarian. Finally, the exclusion of research focusing on a particular disease process within older adults reduced the breadth of research reviewed for this manuscript. This does allow for clinicians to apply these findings the most broadly to their older adult clients, however.

Associations with social determinants of health and health equity

As WS represents such a detailed snapshot of overall health and function, it is not surprising that recent research has shown social determinants of health are related to WS among older adults.⁸¹ Specifically, individuals of lower socioeconomic status experience a reduction in years of healthy function, demonstrating WS at age 60 equal to WS at age 64 to 66 for individuals of high economic status.⁸¹ In light of these findings, physical therapists must consider the unique experiences and circumstances of the patient when interpreting WS in order to provide the highest level of care for each individual.

CONCLUSION

Mean self-selected walking speed for older adults varies on average from 1.16 m/s (0.22) for men aged from 60 to 69 years of age down to 0.95 m/s (0.24) among women aged 80–85.⁶⁶ Although the reported range of predictive values for WS was broad, multiple studies found a value of approximately 1.0 m/s to be a useful marker for delineating risk or decline across a variety of health domains. Clinicians may use a WS of less than 1.0 m/s as a “yellow flag” to guide the evaluation, treatment, and goal setting of their older adult clients. This should include providing the patient with additional resources or providing appropriate external referrals.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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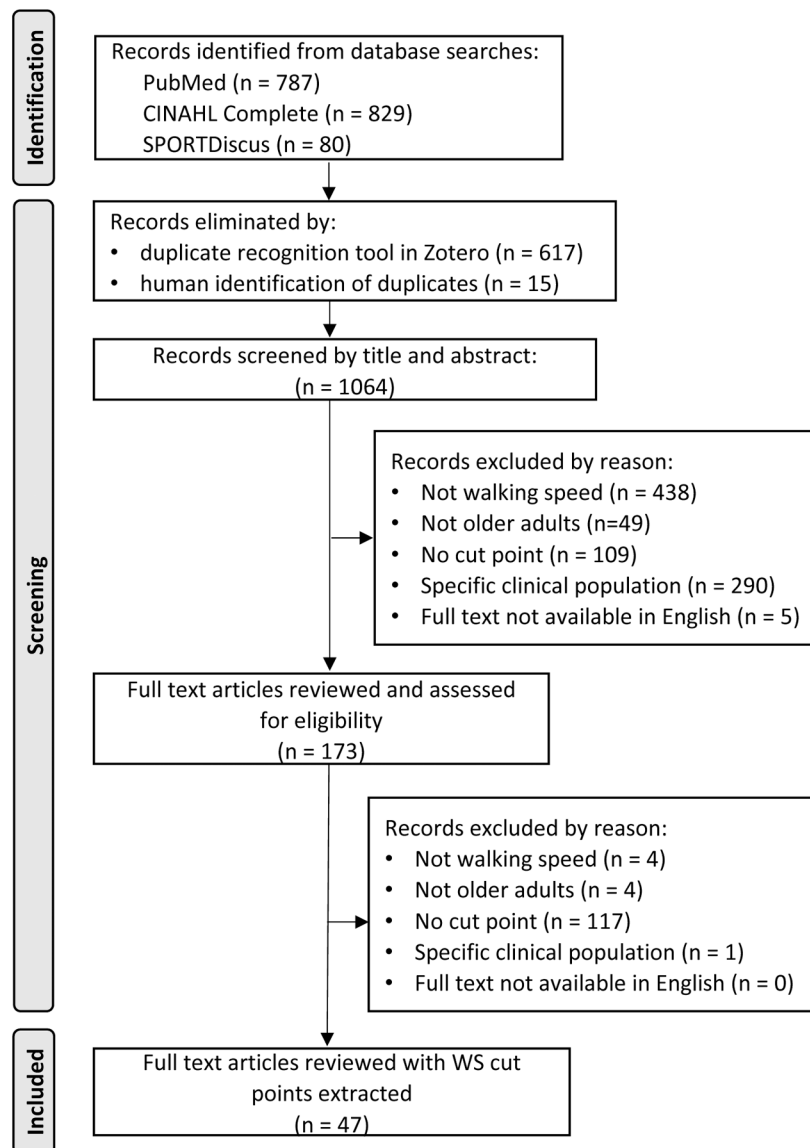


Figure 1.
Flow Diagram for Article Identification, Screening, and Extraction.

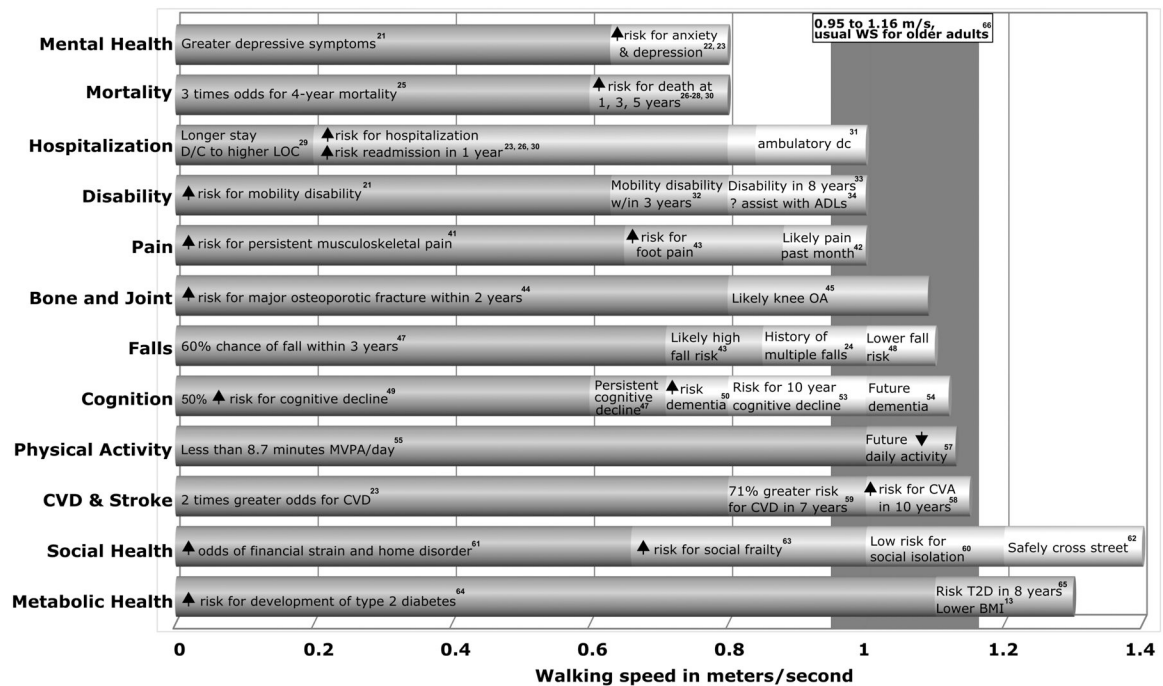


Figure 2.

Walking Speed Cut Point Values and Associated Risk Prediction for Older Adults. Walking speed (WS) is presented in meters per second (m/s). The vertical gray band from 0.95 m/s to 1.16 m/s represents the normal range for older adults' WS, with 0.95 m/s representing 80–85 year old females and 1.16 m/s representing 60–69 year old males.⁶⁶ Abbreviations and symbols: D/C, discharge; LOC, level of care; w/in, within; MVPA, moderate-vigorous physical activity; CVD, cardiovascular disease; CVA, cerebrovascular accident; T2D, type 2 diabetes; BMI, body mass index; ?, potential need for; ↑, increased; ↓, decreased. Example interpretation of figure: for domain of Metabolic health, a WS lower than 1.12 m/s indicates significantly increased risk for development of T2D compared to faster peers. Individuals walking greater than 1.12 m/s likely have lower BMI. Individuals walking slower than 1.32 m/s have an increased risk for development of T2D over 8-year follow up.

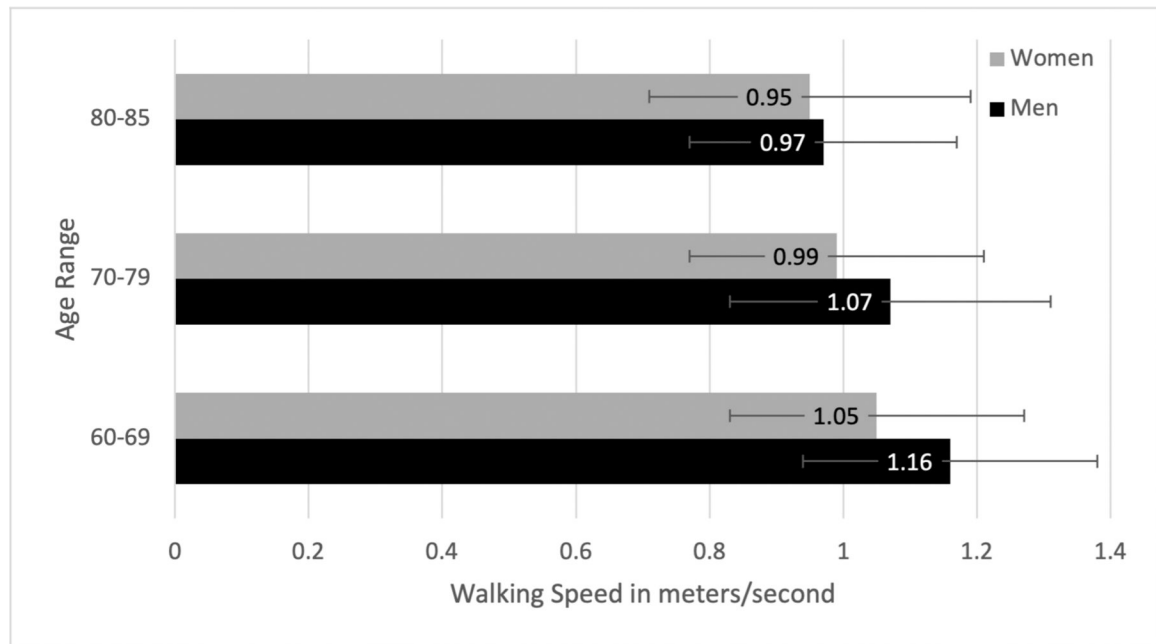


Figure 3.
Mean Walking Speed Values for Older Adults.

Walking speed (WS) is presented in meters per second (m/s) with error bars representing standard deviation. Data extracted from published report of mean WS data from a sample of older adults performing 4-meter WS test. Testing completed with comfortable shoes. Use of an AD was not reported.⁶⁶