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Assessing walking speed in clinical research: a systematic review

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Abstract

Objective—To provide a systematic review and describe how assessments of walking speed are reported in the health care literature.

Methods—MEDLINE electronic database and bibliographies of select articles were searched for terms describing walking speed and distances walked. The search was limited to English language journals from 1996 to 2006. The initial title search yielded 793 articles. A review of the abstracts reduced the number to 154 articles. Of these, 108 provided sufficient information for inclusion in the current review.

Results—Of the 108 studies included in the review 61 were descriptive, 39 intervention and 8 randomized controlled trials. Neurological (n = 55) and geriatric (n = 27) were the two most frequent participant groups in the studies reviewed. Instruction to walk at a usual or normal speed was reported in 55 of the studies, while 31 studies did not describe speed instructions. A static (standing) start was slightly more common than a dynamic (rolling) start (30 vs 26 studies); however, half of the studies did not describe the starting protocol. Walking 10, 6 and 4 m was the most common distances used, and reported in 37, 20 and 11 studies respectively. Only four studies included information on whether verbal encouragement was given during the walking task.

Conclusions—Tests of walking speed have been used in a wide range of populations. However, methodologies and descriptions of walking tests vary widely from study to study, which makes comparison difficult. There is a need to find consensus for a standardized walking test methodology.

Keywords

assessment; clinical evaluation; gait; mobility; review; walking

Introduction

Walking is a fundamental part of normal everyday living [1–3]. Its importance is not limited by age, gender, race or medical condition. A decline in walking speed is associated with a

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number of poor health outcomes including hospitalization, falls, nursing home placement, mobility disability and mortality [4–9]. Because walking speed is a quick and easy test to administer, not limited to a specific health care discipline, and is a reliable, valid and sensitive measure [10–14], it is often included in clinical and epidemiological research studies [5–7].

Review aim

The purpose of this article is to provide a systematic review of the research literature and describe how tests of walking speed are used and reported. This summary will highlight the different approaches used in the assessment of walking speed and examine the extent test methodologies vary. This is the first step in determining the feasibility of developing a standardized approach to walking speed assessment in clinical research.

Methods

Literature review

We conducted a comprehensive literature search within MEDLINE for journal articles that included a measure of walking speed. In these articles walking speed could be used as an independent measure or as a primary or secondary outcome. It is important to note that walking speed is not one of the National Library of Medicine's medical subject headings (i.e. MeSH terms) within the OVID databases. Our search terms included various combinations of numerical (e.g. 1–20,25,30,40 and 50) and scale (e.g. m, meter, metre, ft, foot and feet) distances along with the root word 'walk'. We limited the search to English language non-review articles from years 1996 to 2006. This approach yielded 793 articles.

Study selection

Abstracts were reviewed in order to assess the likelihood of success in extracting information on the walk test methodology and results. A total of 154 full text articles were collected and reviewed through electronic records, university library stacks and interlibrary loan. Studies were excluded if they did not provide a sufficient description of walk test methodology or ratio-scale results, for example, some articles included traditional tests of walking speed, but performance ranges were converted to an ordinal scale (summary score) for reporting. Articles were also removed if it was concluded that a single sample of subjects was reported in other studies. A total of 108 articles were retained for review and analysis.

Data extraction

Relevant data were extracted from each article and stored in a customized database (Microsoft Office Access 2003) for easy search and summary reporting. Extracted information included authors, article source, publication year, study type, description and age of participants, sample size, timed-walk distance, test protocol, pace instructions, verbal encouragement provided, mean and standard deviation of performance, and additional outcomes.

Data management

Study types were categorized as descriptive, intervention or randomized controlled trials. Test protocols were classified as static start, where timing begins with a verbal 'go' command; dynamic start, where timing begins as the subject crosses a predefined start line; and turn protocols, where subjects walk a specified distance, turn around and return to the start/end line. Instructions for walking pace were dichotomized as usual/comfortable or fast. Verbal encouragement was also dichotomized (yes vs. no). Distance walked was recorded in metres.

Results

A brief description, including author, year of publication, sample size, study participants and primary outcomes, of all 108 articles is provided in Table 1.

Descriptive studies were the most frequent type of study (61 studies), followed by intervention (39 studies) and randomized controlled trials (eight studies). There were 126 participant groups within the 108 articles. The participant groups categorize studies by common health domains to facilitate the presentation of results. The 'cardiovascular' group includes patients with congestive heart failure (one study), intermittent claudication (one study), and peripheral arterial disease (seven studies). 'Joint' describes groups with hip fracture/joint replacement (two studies), osteoarthritis (eight studies), and rheumatoid arthritis (two studies). The 'neurological' group includes persons with the following conditions: Alzheimer's (one study), brain tumour (one study), developmental problems (one study), multiple sclerosis (eight studies), myelopathy (two studies), neuromuscular conditions (one study), neuropathy (three studies), Parkinson's (five studies), post-polio (three studies), spinal cord injury (three studies), stroke (22 studies), stroke/tumour (two studies), and traumatic brain injury (three studies). The 'miscellaneous' group includes patients with cancer (one study), fasciitis (one study), low back pain (one study), lymphoma (one study), obesity (one study), and renal failure (one study). Two relatively homogenous groups, 'aged' (27 studies) and 'healthy control' (17 studies), were also included.

Many studies assessed walking speed using more than one protocol and/or pace. This, combined with more than one participant group in some studies, yielded 156 total observations from the 108 studies. Table 2 shows the frequency of different study parameters in total and stratified across participant groups. Usual/comfortable walking speed was selected more frequently than fast pace; instructed pace was not described in 29% of the articles. Nearly half of the articles did not describe the testing protocol used to assess walking speed so it is difficult to convey a clear preference. Among those that did describe the timing protocol, a static start was slightly more common than dynamic. A distance of 10 m was the most common distance chosen. Distances stratified across participant groups demonstrate subject-specific patterns. For example, the 4-m walk was the most common in the cardiovascular group, the 6-m walk was used most in the aged group, and the 10-meter walk was the most common in the neurological group. Only four studies reported the use of verbal encouragement (three no, one yes); these data are not included in the summary table.

Discussion

There are two primary findings of this review: (1) walking speed is a commonly used measure in health care research, and (2) there is great variation in the methodology of walking speed measurement and in describing that methodology. Our review revealed a wide range of variability in walk test methodologies including pace, timing protocol and distance covered. This variability makes comparison of walking speed across studies difficult. Our review also found omissions in how tests of walking speed are reported in the research literature. We describe the general implications of the findings and propose recommendations for future research in the discussion below.

Study types

Walking speed spans the spectrum of measurement outcomes: dependent, independent, primary, secondary, and/or predictor variable. A majority of studies (61 of 108) from this review are descriptive in nature. Thus, much of the research utilizing walking speed is aimed at describing differences in walking speed between certain patient populations or describing the relationships between walking speed and other health-related and/or functional outcomes.

Walking speed is also frequently used as an indicator of intervention effectiveness; there are 47 intervention/randomized controlled trials studies in the current review that assessed walking speed.

Patient groups

Both floor [15] and ceiling [16] effects for measures of walking speed have been reported in certain patient groups leading some to suggest that short-walk tests have a narrow range of application; that is, they are only appropriate for patients who are able to perform the test, yet find walking challenging [14]. However, as Table 1 shows and others have reported, there is a broad range of people (patient groups) for whom timed walking is a valid and sensitive outcome measure [17,18]. Our review found a large number of studies involving patients with neurological problems: 55 of the 126 total participant groups were neurological. This is in agreement with previous reports stating that walking speed is an established and recommended clinical outcome measure for patients with neurological conditions [11], particularly in stroke rehabilitation programmes [12]. Walking speed is also commonly used as an indicator of functional ability and/or predictor of disability in ageing studies [5,19,20]; the aged group (27 groups) was the second most common cohort of participants reported in the current review.

Test methodologies

There is considerable variation in testing procedures including pace, protocol and distance among studies in the current review (see Table 2). While each aspect affects the difficulty of the task, virtually all versions of these short, distance-based walk tests have demonstrated high (>0.90) test-retest and inter-rater reliabilities [8,12,21–24]. Thus, the variation in methodologies may be more a reflection of tester preference and convenience than perceived methodology-related influences on performance. Additional studies are needed to determine if differences in testing methods yield predictable and meaningful differences in the distribution of performance scores.

The lack of perceived methodological influence is perhaps best shown by the lack of detailed description of the walk test procedures in many of the studies. This is particularly evident regarding verbal encouragement; only four of the 108 articles addressed the use of verbal motivation. Although encouragement may not influence results when subjects are asked to walk at their usual or normal pace, in studies that tests the individual's ability to walk as fast as they can results are likely to be affected. Guyatt *et al*. [25] showed that verbal encouragement significantly increased distance walked during a 6-minute walking test in patients with chronic heart failure and lung disease. Further research is needed to determine if tester involvement, via verbal encouragement, affects performance on shorter, distance-based walk tests.

It should be noted that the outcome measures and methodologies in peer-reviewed journals may not be representative of daily clinical practice. Turner-Stokes and Turner-Stokes [26] conducted a survey (postal questionnaire) of rehabilitation providers in the UK to determine which outcome measurements are routinely used in clinical practice. Results from 182 centres were summarized: 77% reported that standardized measures were part of routine clinical practice. Of those centres, 46% commonly used one or more mobility tests. In accordance with what we observed in the published literature, the 10-m walk was the most common measure of mobility; 68% of centres collecting mobility data reported using the 10-m distance. The primary reasons cited for not conducting standardized assessments were lack of time and/or knowledge to perform standardized measures. Thus, there is a need to find consensus and promote a standardized walking test methodology.

Our review focused on short, distance-based assessments of walking speed, which reflects lower extremity function. There is a comparable volume of literature, however, involving longer, time-based walks (e.g. the 6-minute walk), which are more measures of fitness [27] than functional performance (see Solway *et al*. [28] for descriptive summaries of endurance-based walk tests). Table 1 demonstrates that both categories of walking test are often used in the same research study. Although the longer endurance walks are considered sub-maximal measures of exercise capacity [29], influenced by factors beyond lower extremity function and muscle strength (e.g. motivation, cardiovascular fitness and respiratory function), strong associations with short measures of walking speed have been described. Eng *et al.* [30], for example, reported that self-selected 6-m walk time was highly correlated ($r = 0.92$) with 6-minute walk distance in stroke patients and van Hedel *et al*. [23] found a similar relationship ($\rho = -0.95$) between 10-m and 6-minute walks in patients with spinal cord injury.

Generalization

While short-distance walking speed is indicative of functional independence within the home [4], one of the primary criticisms of these clinic-/lab-based measures of walking speed is that relative performance may not be representative of independence within the community [2,4, 11]. Not only is basic mobility an essential component for community participation, but in many circumstances there are time constraints imposed upon walking ability [31], for example, the time available to cross a signalled intersection. In the only study (in the current review) comparing clinic-and community-based mobility, Moseley *et al.* [32] evaluated walking speed from common clinical protocols (6 minutes, comfortable 10 m, and fast 10 m) and ‘real-life environments’ (corridor in a rehabilitation unit, parking lot of a shopping centre, and inside a shopping centre) in patients with traumatic brain injury (TBI). The following conclusions were reported: (1) able-bodied pedestrians walk significantly faster than patients with TBI under normal conditions in real-world environments, (2) persons with TBI walk significantly faster during clinical testing compared with normal environment conditions, (3) agreement between clinical tests and natural environments is poor, and (4) the best agreement between clinical and natural settings is observed between the comfortable 10 m and corridor of rehabilitation unit trials. Thus, while there appear to be noteworthy differences between walking speed under clinical and real-world conditions, additional study is needed to determine if this discrepancy is associated with community independence.

Conclusion and recommendations

Walking speed is a commonly used outcome across different types of studies and among numerous health-related disciplines and patient populations. The methodology used to assess walking speed as well as the detail in describing the testing procedures, however, is quite variable. This review examined 108 articles relevant to walking speed as an outcome measure. Based on the frequency of responses reported in the studies examined we propose the following tentative recommendations regarding the development of a standardized protocol to access walking speed:

1. Adopt the 10-m straight line walk.
2. Use a static start with timing commencing at the start.
3. Usual or comfortable pace be used as the standard, and fast paced be used as appropriate for specific research questions.
4. Walking protocol be reported in detail including pace instructions, verbal or other encouragement, and specific timing procedures.

It is hoped that these recommendations will stimulate additional study and debate concerning the appropriate use and optimal design of walking speed assessments. In follow-up research we plan to assess if the observed variations in walk-test methodology yield clinically meaningful differences in overall performance (mean velocity) and/or the distribution of performance scores. The results of this analysis will help refine and extend the recommendations presented above.

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Table 1

Summary of reviewed studies using timed walk tests

Authors	*n*	Subjects	Outcomes
Arnadottir and Mercer (2000) [10]	35	Aged	10-m walk, functional reach, up and go
Arokoski *et al.* (2004) [33]	30	OA	25-m walk, WOMAC, ROM, balance, marching, long-jump, stairs, leg raises
	27	Healthy	
Askim *et al.* (2006) [34]	62	Stroke	5-m walk, balance, movement
Baer and Smith (2001) [4]	185	Stroke	10-m walk
Bateman *et al.* (2001) [35]	142	TBI	10-m walk, exercise capacity, spasticity, balance, mobility, FIM, ADL, fatigue, anxiety and depression
Bessou *et al.* (1988) [36]	50	Healthy	6-m walk, kinetics/kinematics of gait
Bischoff-Ferrari *et al.* (2004) [37]	4100	Aged	8-ft walk, chair rise, vitamin D, physical activity, BMI
Bonaroti *et al.* (1999) [38]	5	SCI	6-m walk, FIM, mobility skills
Brach *et al.* (2004) [39]	3075	Aged	6-m and 400-m walk, physical activity, strength, chair rise, balance
Bressel and McNair (2002) [40]	10	Stroke	10-m walk, joint stiffness
Brill *et al.* (1998) [41]	25	Aged	6-m walk, chair rise, stairs, grip, balance, physical activity
Cesari *et al.* (2005) [5]	3047	Aged	6-m walk, mobility, death, hospitalization
Chang *et al.* (2004) [42]	62	Aged	4-m and 400-m walk, physical and cognitive function, strength
Deley *et al.* (2005) [43]	24	CHF	200-m and 6-minute walk, VO2 max, strength
Dobkin (2006) [11]	24	Stroke	50-ft and 6-minute walk
Dolan *et al.* (2002) [44]	313	PAD	4-m and 6-minute walk, ABI, neuropathy score, mobility, physical function
	147	Diabetes (PAD)	
Dolin *et al.* (1998) [45]	46	LBP	50-m walk, chair rise, ROM, anxiety, insomnia, depression
Duncan *et al.* (1998) [46]	20	Stroke	10-m and 6-minute walk, motor and hand function, ADL, IADL, QOL, balance
Duncan *et al.* (2003) [47]	100	Stroke	10-m and 6-minute walk strength, motor function, balance, reach, VO2
Einarsson *et al.* (2006) [48]	166	MS	10-m walk cognitive and motor function, memory, 9-HPT,
Elkayam *et al.* (1991) [49]	41	RA	15-m walk, disease severity, grip, stiffness, lab measures, pain
Eng *et al.* (2002) [30]	25	Stroke	8-m, 6-minute and 12-minute walk, strength, balance, spasticity, HR, RPE
English *et al.* (2006) [15]	78	Stroke	5-m walk, balance, motor function
Gajdosik *et al.* (2005) [50]	19	Aged	10-m walk, agility, functional reach, ROM
Galvao and Taaffe (2005) [51]	28	Aged	6 m, 6 m backwards, and 400-m walk, strength and endurance, chair rise, floor stand, stairs, body fat
Galvao *et al.* (2006) [52]	10	Cancer	6-m, 6-m backward, and 400-m walk, strength, endurance, chair rise, stairs, balance, body fat, blood labs
Gardner *et al.* (2004) [53]	43	Claudication	4-m and 6-minute walk, physical activity, mobility, balance, chair rise, ABI
Gold *et al.* (2003) [54]	187	MS	8-m walk, hand function, QOL, anxiety and depression, EDSS, 9-HPT
Goldie *et al.* (1996) [55]	42	Stroke	10-m walk, disability,
	42	Healthy	
Grant *et al.* (1994) [56]	50	Brain tumour	10-m walk, 9-HPT, memory, language, anxiety and depression, ADL
Grant *et al.* (2004) [57]	26	Obese	20-m walk, BMI, skinfold, BP, cholesterol, chair rise, up and go, strength, stairs, sit and reach, life satisfaction
Green *et al.* (2002) [12]	22	Stroke	10-m walk
Gross *et al.* (2002) [58]	15	Fasciitis	100-m walk, pain
Gur and Cakin (2003) [59]	18	OA	15-m walk, chair rise, stairs, pain, strength, muscle CSA
Hadden *et al.* (1999) [60]	10	Neuropathy	10-m walk, mobility, 9-HPT, FIM, motor function, disability, QOL, NCV
Henwood and Taaffe (2005) [61]	25	Aged	6-m and 6-m backwards walk, strength and power, chair rise, floor rise, lift and reach
Herman *et al.* (2005) [19]	37	Aged	4-m walk, strength and power, stairs, physical performance
Hruda *et al.* (2003) [62]	25	Aged	6-m walk, strength and power, chair rise, up and go
Kadanka *et al.* (2000) [63]	48	Myelopathy	10-m walk, OA severity, ADL, X-rays
Kadanka *et al.* (2002) [64]	68	Myelopathy	10-m walk, OA severity, MRI
Kaufman *et al.* (2001) [1]	139	OA	12-m walk, stairs, kinematic and kinetic measures
	20	Healthy	
Kilidireas *et al.* (2006) [65]	4	Neuropathy	10-m walk, strength, 9-HPT, grip, vibration, sensory score, EMG
Kollen *et al.* (2006) [66]	81	Stroke	10-m walk, mobility, balance
Kressig *et al.* (2001) [7]	287	Aged	10-m walk, fear of falling, depression, timed turn, functional reach, balance, chair rise
Kuo *et al.* (2006) [20]	1753	Aged	20-ft walk, disability, strength and power
Leary *et al.* (2003) [67]	50	MS	10-m walk, EDSS, 9-HPT, MRI
Lee *et al.* (2003) [68]	51	Lymphoma	50-ft and 6-minute walk, chair rise, functional reach, belt tie, sock test, coin test, fatigue
	51	Healthy	

Authors	***n***	**Subjects**	**Outcomes**
McCarthy and Oldham (2004) [21]	214	OA	8-m walk, WOMAC, SF-36, stairs, chair transfer, mobility
McConvey and Bennett (2005) [69]	10	MS	6-m walk, gait index
McDermott *et al.* (2005) [70]	397	PAD	4-m and 6-minute walk, ABI, BMI
McDermott *et al.* (2006) [71]	417	PAD	4-m and 6-minute walk, walking log
McDermott *et al.* (2006) [72]	296	PAD	4-m walk, ABI, comorbidities, chair rise, balance
	191	Healthy	
McDermott *et al.* (1998) [73]	145	PAD	4-m and 6-minute walk, ABI, mobility
	65	Healthy	
McDermott *et al.* (1998) [74]	158	PAD	4-m and 6-minute walk, ABI, leg symptoms, comorbidities
	70	Healthy	
Meeuwsen *et al.* (2002) [75]	85	Aged	3.5-m walk, physical activity, leg power, up and go, fitness
Menz and Lord (2001) [76]	135	Aged	6-m walk, postural sway, stability, stairs, vision, sensation, strength, reaction time
Miyai *et al.* (2000) [77]	10	Parkinson’s	10-m walk, disease severity
Miyai *et al.* (2002) [78]	24	Parkinson’s	10-m walk, disease severity
Morey and Zhu (2003) [79]	114	Aged	10-m walk, bed mobility, disability, symptoms
Moseley *et al.* (2004) [32]	10	TBI	10-m and 6-minute walk, real-world walking speed
Nelson *et al.* (2004) [80]	72	Aged	2-m and 6-minute walk, physical performance, strength, balance
Nieuwenhuis *et al.* (2006) [81]	151	MS	25-ft walk, agility, 9-HPT
	64	Healthy	
Ostchega *et al.* (2004) [82]	1499	Aged	6-m walk, strength
Partridge *et al.* (2000) [83]	114	Stroke	5-m walk, body movement, reach, chair rise, anxiety and depression, perceived control
Pellecchia *et al.* (2004) [84]	20	Parkinson’s	10-m walk, disease severity, depression
Perlman *et al.* (2006) [85]	68	OA	50-ft walk, WOMAC, pain, ROM, disease severity
Perron *et al.* (2003) [86]	18	Hip replace	10-m walk, stairs
	15	Healthy	
Petrella and Bartha (2000) [87]	179	OA	40-m walk, WOMAC, stiffness, ROM, pain, physical activity
Peurala *et al.* (2005) [88]	45	Stroke	10-m and 6-minute walk, spasticity, strength, postural sway, motor function, FIM
Peurala *et al.* (2005) [89]	37	Stroke	10-m walk, FIM, MMAS, gait kinematics
Pirpiris *et al.* (2003) [2]	109	Neuromuscular	10-m and 10-minute walk
Protas *et al.* (2005) [90]	18	Parkinson’s	3-m walk, gait, step test, falls
Rantanen *et al.* (1998) [91]	1002	Aged	4-m walk, strength
Riley *et al.* (2001) [92]	14	Aged	10-m walk, kinematic and kinetic measures
	16	Young	
Rolland *et al.* (2004) [8]	60	Aged	4-m and 400-m walk
Romberg *et al.* (2004) [93]	95	MS	25-ft and 500-m walk, EDSS, strength and endurance, Box and Block, GXT, balance
Rudd *et al.* (1997) [94]	331	Stroke	5-m walk, ADL, motor and cognitive function, aphasia, ADL, anxiety and depression, health profile, caregiver index, satisfaction
Salbach *et al.* (2001) [13]	50	Stroke	5-m and 10-m walk, STREAM, balance, ADL, up and go, neurological scale, Albert’s Test
Salbach *et al.* (2004) [95]	91	Stroke	5-m and 6-minute walk, balance, up and go
Schenkman *et al.* (2000) [96]	195	Aged	10-m walk, flexibility, functional reach, floor rise, balance
	56	Parkinson’s	
Scherer *et al.* (2006) [97]	25	PAD	6-m and 6-minute walk, QOL, physical activity, strength, gait
	26	Healthy	
Sherrington and Lord (2005) [22]	30	Hip fracture	6-m walk, strength, balance, floor rise, chair rise
Simonsick *et al.* (2006) [98]	102	Aged	400-m and 2-minute walk, GXT, physical activity level
Storer *et al.* (2005) [99]	12	Renal failure	10-m walk, GXT, strength and power, stair climb, up and go
Stratford and Kennedy (2004) [100]	104	OA	40-m walk, WOMAC, stairs, up and go
Sukenik *et al.* (1990) [101]	30	RA	15-m walk, stiffness, grip, ADLs, disease severity, lab measures
Symons *et al.* (2005) [102]	30	Aged	80-m walk, strength, step test
Taaffe *et al.* (2005) [103]	840	Aged	6-m and narrow walk speed, chair rise, balance, physical activity, muscle CSA, strength
Thompson *et al.* (1996) [104]	7	Neuropathy	10-m walk, 9-HPT, mobility, myometry
	10	Healthy	
Tiedemann *et al.* (2005) [105]	684	Aged	6-m walk, sensory, strength, reaction time, balance, psychological profile
Tyson and DeSouza (2004) [14]	27	Stroke	5-m walk, balance, reach, tap test, step-up test
van den Berg *et al.* (2006) [106]	19	MS	10-m and 2-minute walk, mobility, fatigue
van Hedel *et al.* (2006) [17]	22	SCI	6-minute and 10-m walk, mobility, motor function
van Hedel *et al.* (2005) [23]	75	SCI	10-m and 6-minute walk. up and go
van Herk *et al.* (1998) [107]	43	Stroke	10-m walk
van Loo *et al.* (2004) [24]	13	TBI	10-m and 6-minute walk
Vos Vromans *et al.* (2005) [18]	19	Stroke and brain tumour	10-m walk, motor function, balance
Wang *et al.* (2002) [3]	28	OA	25-m and 6-minute walk
Wang *et al.* (2005) [108]	103	Stroke	10-m walk, balance
Webster *et al.* (2006) [109]	10	Alzheimer	8-m walk, gait
	10	Healthy	

Authors	***n***	**Subjects**	**Outcomes**
White and Petajan (2004) [110]	8	MS	25-ft walk, motor evoked potentials, finger tap, grip, fatigue
Willen *et al.* (1998) [111]	32	Post-polio	30-m walk, pain, strength, creatine kinase, physical activity, health profile
Willen and Crimby (2004) [31]	234	Post-polio	30-m walk, strength
	144	Healthy	
Willen *et al.* (2001) [112]	28	Post-polio	30-m walk, GXT, strength, balance, pain, physical activity, health profile
Winchester *et al.* (2002) [113]	7	Developmental	10-m walk, motor function
Witte and Carlsson (1997) [114]	18	Stroke	30-m walk, mobility, motor function, stiffness
	11	Healthy	
Wolf *et al.* (1999) [115]	28	Stroke	10-m walk, mobility, balance, functional reach
	28	Healthy	
Yanagita *et al.* (2006) [116]	2856	Aged	3-m walk, depression, chair rise, strength, physical activity

OA, osteoarthritis; WOMAC, Western Ontario and McMaster University Osteoarthritis Index; ROM, range of motion; TBI, traumatic brain injury; FIM, functional independence measure; ADL, activity of daily living; BMI, body mass index; SCI, spinal cord injury; CHF, congestive heart failure; PAD, peripheral arterial disease; ABI, ankle brachial index; LBP, low back pain; IADL, instrumental activity of daily living; QOL, quality of life; MS, multiple sclerosis; 9-HPT, 9-hole peg test; RA, rheumatoid arthritis; HR, heart rate; RPE, rate of perceived exertion; EDSS, expanded disability scale score; BP, back pain; CSA, cross-sectional area; NCV, nerve conduction velocity; MRI, magnetic resonance imaging; EMG, electromyogram; MMAS, modified motor assessment scale; GXT, graded exercise test; STREAM, stroke rehabilitation assessment of movement.

Table 2

Frequency of reported test methodologies from studies in Table 1

	Studies	Total outcomes	Control	Aged	Neurological	Cardiovascular	Joint	Miscellaneous
Total	108	156	23	30	67	16	13	7
Pace								
Usual	55	69	12	14	27	9	5	2
Fast	43	51	7	11	19	7	3	4
n/r	31	36	4	5	21	0	5	1
Protocol								
Static	20	28	5	8	8	6	1	0
Static (turn)	10	11	1	2	3	0	2	3
Dynamic	26	40	4	5	23	0	5	3
n/r	53	77	13	15	33	10	5	1
Distance (m)								
2.0	1	1	0	1	0	0	0	0
2.4	1	1	0	1	0	0	0	0
3.0	3	3	0	1	2	0	0	0
3.5	1	1	0	1	0	0	0	0
4.0	11	23	6	4	0	13	0	0
5.0	7	9	0	0	9	0	0	0
6.0	20	32	7	12	6	2	2	3
7.6	3	4	1	0	3	0	0	0
8.0	3	3	0	0	2	0	1	0
10.0	37	47	3	7	36	0	1	0
12.0	1	2	1	0	0	0	1	0
15.0	6	8	1	0	2	0	4	1
20.0	1	1	0	0	0	0	0	1
25.0	2	3	1	0	0	0	2	0
30.0	4	10	3	0	7	0	0	0
40.0	2	2	0	0	0	0	2	0
50.0	1	1	0	0	0	0	0	1
80.0	1	1	0	1	0	0	0	0
100.0	1	1	0	0	0	0	0	1
200.0	1	1	0	0	0	1	0	0
400.0	2	2	0	2	0	0	0	0

Study counts add up to more than 108 as some studies involved multiple methods.

n/r, not reported.