GAIT SPEED ASSESSMENT

Type of test: Gait speed is considered a measure of overall walking performance.

- ***Time to Administer***:*5-7 minutes for 2 trials at each speed*
- ***Clinical Comments***: *Simple reliable test*

Purpose/population for which tool was developed: Gait speed is measured as distance walked per unit time. It is commonly measured over a relatively short distance and thus does not include endurance as a factor.

When appropriate to use: Gait speed is appropriate for any patient for whom ambulation improvement is a goal. Both comfortable (CGS) and fast gait speed (FGS) should be tested. Comfortable gait speed is also called "habitual gait speed" in some studies. The ability to increase/decrease walking speed above or below a "comfortable" pace characterizes normal healthy walking and indicates the potential to adapt to varying environments (e.g. crowed hallways, crossing streets). Many people with disabilities have only one speed for mobility. Riley (2001)[1] reports that propulsive adaptations to speed changes occur primarily at the hip and secondarily at the ankle. In a study of what predicts gait variability in community-dwelling elderly Brach, (2001) [2] found in those who walked the slowest that step-width variability was the smallest. Individuals who could not increase walking speed had an increase in step-length variability and a decrease in step-width variability. Clients who cannot change their walking speed when requested require ambulation training to regain this normal skill.

Scaling: Record two trials to get a sense of your subject's consistency. Record the time needed to walk the central designated distance in **seconds;** divide the timed-distance (e.g. meters) by the number of seconds recorded. Report results in **meters/second (m/s).**

Equipment needed:

- level surface, 10+ meters
- tape measure
- stopwatch (able to record hundredths of seconds)

Directions:
Set-up: Mark-off a 10 meter walkway; then mark-off 2 meters from the START and 2 meters from the END. Begin timing the subject as she/he crosses the first 2-meter marker; stop timing when she/he crosses the second 2-meter marker. Thus, you've timed the number of seconds needed to walk across the central six meters of your walkway. The 2-meter markers at each end allow the subject to accelerate/ decelerate to/from a normal pace.
***Instructions*:** "Walk at your own comfortable walking speed" (CGS) or "Walk as fast as you can safely walk" (FGS)

Factors that affect gait speed: Outcome measure of reduced walking speed and gait deviation were associated with impaired ankle plantar flexion range of motion, knee flexor strength, and non-reciprocal stair climbing pattern.[3] There were no group differences in preferred gait speed following a fatiguing task, fatigue does not affect gait speed.[4] Small but statistically significant declines in gait speed were observed in a large study (N=2349) on declining global cognitive function and executive functioning.[5]

Reliability:

Reference	***N***	***Sample description***	***Reliability statistic***
Intrarater/ Interrater			
Wade, 1987 [6]	19	Regardless of the measurement method, gait speed measures are considered highly reliable in normal individuals and in different patient populations.	.89 to 1.0
Fransen, 1997 [7]	41		
Holden, 1984[8]	61		
Liston, 1996 [9]	20		

***Test-retest reliability*: same rater over time**							
Author	***N***	***Days Between***	***Population***	***Collection Method***	***Mean & SD***	***Test-Retest Reliability***	***MDC$_{95}$***
Kadaba, 1989 [10]	40	At least 7	Normal Adults	6 Meter, VICON	CGS 1.31 (.17)	Kadaba reported low coefficients of variation for gait speed within a given day. CV%= 2.9 (3.3) and between days CV%=6.1 (7.1)	
VanLoo, 2004 [11]	13	7 days	Patients with a TBI, assessed 2 days in the same week	10 Meter, stopwatch	CGS 1.03 (.43) FGS 1.27 (.50)	CGS: ICC (2,1)=.95 FGS: ICC (2,1)= .96	CGS .06 FGS .06
Fransen, 1997[7]	41	7 days	Osteoporosis	8M Foot switch system	CGS 0.96 (.21)FGS 1.2 (.23)	CGS: ICC (2,1)= .88 FGS:ICC(2,1) = .91	CGS .20 FGS .30
Liston, 1996 [9]	20	3 measures, 7 days apart	CVA	10 meters Stopwatch	CGS 0.62	ICC(2,1)= .96	----------
Jette,1999[12]	105	14 days	Community dwelling elderly	8 foot walk	CGS .7 (.2)	ICC(2,1)= .79	CGS .25
Schaubert, 2005[13]	10	3 measures 6 weeks apart	Community Dwelling elderly	2.44 M Stopwatch	CGS	CGS ICC = .97	
Boonstra, 1993[14]	15	2 measures, 2-7 days apart	Normal adults (mean age=30yrs)	7M infrared beam start and stop	Without AD: CGS 1.45(.18) FGS 2.1 (.25)	Without AD: CGS ICC(2,1)=.83 FGS ICC(2,1)= .87	FGS .25 CGS .29
					With AD: CGS 1.36 (.19) FGS 1.90 (.28)	With AD CGS ICC(2,1)= .89 FGS ICC(2,1) = .91	FGS .25 CGS .25
Flansbjer, 2005 [15]	50	7 Days	CVA	10 M Stopwatch	CGS 0.89(0.3)	CGS ICC (2,1)= .94	.20
					FGS 1.3(0.5)	FGS ICC(2,1)= .97	.24
Kennedy, 2005[17]	21	178 days	OA in Knee	40 M Stop watch		R = .91	---------
Green, 2002 [18]	22	7 days	CVA	10 M Stopwatch	.36(.49)	ICC =.97	.24
Rolland, 2004 [20]	41	7 days	Community dwelling Elderly	4 M Stopwatch	.87 (.18)	R=.94	---------

Author	N	Days Between	Population	Collection Method	Mean & SD	Test-Retest Reliability	MDC95
Lusardi, 2003[16]	76 6 19 34 17	14 days	Community dwelling Elderly	Gait-rite system 3.66 M	CGS 60-69: 1.24 (.10) 70-79: 1.25 (.20) 80-89: .82 (.21) 90-100: .71 (.22)	CGS ICC .95	 0.06 0.12 0.14 0.14
	 6 19 34 17				FGS 60-69: .84(.17) 70-79: 1.86 (.27) 80-89: 1.23(.32) 90-100: 1.08 (.31)	FGS ICC .97	 0.08 0.13 0.15 0.15
Dawes, 2005 [19]	91	Not stated	CVA	Stopwatch	0.7(.32)	Not stated	---------
Sherrington, 2005[21]	30	7 days	Post hip fracture	6 M Stopwatch	CGS: .25(.27) FGS: .34 (.33)	CGS ICC(3,1): .97 FGS : .94	CGS: .12 FGS: .22
Cunha, 2002[22]	20	Not Stated	CVA	5 M Stopwatch	CGS .29 (.27)	ICC= .98	.11
Lim, 2004[23]	26	7 days	Parkinson's	10 M Stopwatch		ICC (2,1)=.81	.19
Steffen, 2008[24]	37	7 days	Community Dwelling Adults with Parkinson's	10 M Stopwatch	CGS: 1.16(.34) FGS: 1.57(.51)	CGS ICC(3,1): .96 FGS: .97	CGS: .18 FGS: .25

Overall MDC_{95} in both CGS and FGS appears to be about .25m/s or less for populations tested to date,

Validity:

Construct / Concurrent Validity: It is difficult to always differentiate between these 2 types of validity. Evaluating this property requires a "gold standard" measure with which to compare the tests results. Such a "gold standard" is often not available.

Population	***N =***	***Support for Validity***
Population unknown		Gait speed is correlated with accuracy of weight shifting tasks on the Balance Master (r=-.49 to -.72),[9] the BBS (r=.81, p<.01), [9] 6MWT (r=-.73) [25] and the TUG (r=-.75, p<.001).[26]
Healthy Elderly	64	Gait speed measured over a 10 meter distance correlated highly (r=.92) with speeds measured over a longer distance (20m).[27]
Healthy Elderly	737	Lower gait speed is correlated with poor executive function. [28]
Healthy young adults	30	Gait speed had significant influence on perceived exertion, muscle activity, kinematic and kinetic measurements.[29]

Ambulatory Elderly Hospitalized on Rehab unit	29	Gait speed is correlated with maximal quadriceps power. (r=.56)[30]
Long Term Care Enrollees	97	Subjects who did not report fear of falling and had higher FES scores had faster gait speeds [31]
Community Dwelling Elderly	379	Gait speed is correlated with incident mobility disability.[32]
Community Dwelling Elderly	2481	Joint effect of cognitive function and habitual gait speed on late-life disability.[33]
Community Dwelling Elderly	523	Reduced gait speed is correlated with smaller left pre-frontal region left cerebellum and Brodmann's area.[34]
s/p CVA	35	Gait Speed correlated with Wisconsin Gait Scale (-.45 to -.54); not correlated with FIM; adapted patient evaluation conference system (.42-.55); or discharge gait speed with discharge Brunnstrom stages.[35]
	20	Gait speed correlated with Sensory Organization Test protocol as part of dynamic posturography (.4) and stair climbing (.5).[36]
	28	Trunk control test on admission correlated with comfortable gait speed (.-64) and fast (.-65) gait speed on discharge. [37]
Healthy elderly persons	36	Curvilinear relationship between gait speed and step width and trunk acceleration.[38]
Population	***N =***	***Support for Validity***
Community-dwelling elderly	3041	Comfortable gait speed correlated with: chair-rise (.36), knee strength (.-24), 400 meter walk (.60) and standing balance (.-25).[39]
Ambulatory Older Adults some with Diabetes	558	Gait speed was correlated with step length, stance time, and double support time. $r > .75$, $P < .0001$[40]
Post CVA severely affected	73	A significant correlation was demonstrated between walking speeds and FAC (Functional Ambulation Categories) for physically independent gait. [41]
Individuals with Parkinson's disease	126	Gait speed was correlated with Tinetti Mobility Test scores. (.53) [42]
Older Japanese Men aged 71-93 with depressive symptoms	283	Gait speed had a significant inverse relation to depression.[43]

***Predictive Validity*:**

Population	***N =***	***Support for Predictive Validity***
s/p CVA	147	Gait speed alone showed some ability to predict the functional ambulation category. Household ambulators: ambulated at a speed of 14-16 m/min or 0.23 – 0.27 m/sec; while community ambulators ambulated at a speed of 24-48 m/min or 0.4 –0.8 m/sec. Ability to predict discharge ambulation category, however, improved greatly when walking speed was combined with the knee extension grade from an "upright motor control" test; the combination of these two measures showed 87% agreement with expert clinicians in differentiating household vs. community ambulators.[44]
	130	Gait speeds of persons after CVA were reported as: for those not walking outside of the house (.52 m/s); walking as far as letter box (.66 m/s); walking in the immediate outside environment (.82 m/s); and walking to shopping venues (1.14 m/s).[45]
Senior living settings	287	(Mean age 81) Slow gait speed (<.9m/s) can predict fear of falling (FES) OR 3.1 along with depression, using a walking-aid, and being an African-American.[46]
Rolland study was community elderly >65	60	Gait speed predicts probability of performing the longer 400-meter walk test. Gait speed of .8m/s or greater had a 90% probability of performing the longer 400-meter walk test. Gait speed < .5 m/sec indicated an 80% probability of an inability to perform the 400-meter walk test.[20]

Community-dwelling elderly	2962	(N=1447 Males) Slower gait speed predicted fallers with an adjusted odds ratio of 1.1. (N=1515 Females) This did not occur in women.[47]
Elderly	97	Brown (2000)[48] found significant differences in fast gait speed (FGS) in different levels of frailty as defined by the PPT; not frail (PPT 32-36) FGS=1.57(.37); mildly frail (PPT25-31) FGS=1.35 SD.31; moderately frail (PPT17-24) FGS=1.01(.30).
	5895	In a large study of elderly women, followed for 33 months, the authors conclude that femoral BMD, calcaneal BUA, gait speed, and age have the ability to discriminate women at high risk for hip fracture. A combination of factors may predict even better. The cutoff levels on gait speed were not given but the mean gait speed of the 170 women (mean age = 83) who fractured was .75 (.22) m/s and for those who did not .87 (.22) m/s.[49]
	54	Gait speed is significantly different between elderly nonfallers (1.2 m/s) and fallers (.47 m/s). [50]

Sensitivity/specificity:

Population	***N =***	***Cutoff Score and Description***	***Results***
Identifying need for referral to physical therapy in residential care facilities	53	Cutoff score of .56 m/s[51]	80% sensitivity 89% specificity
		When combining cut off score of 48 for the BBS **AND** .57 m/s for gait speed[51]	91% sensitivity 70% specificity
Identifying fallers Male veterans mean age 75.5	84	Cutoff score of .56 m/s[52]	72% sensitivity 74% specificity Likelihood ratio 2.78
Identify inability to perform the 400-MWT Community elderly >65yo	60	Cutoff less than .6m/s predicts inability to perform the 400-MWT[20]	90% sensitivity 78% specificity

Responsiveness / sensitivity to change:

Population Descriptor	***N Type of study***	***Reference and Intervention***	***Responsive Yes/No***	***Data Supporting Responsiveness***
s/p CVA	20 RCT	***Duncan, 1998***[53] *Experimental Group (n=10)* 8wk, 3x/wk, home based program *Control Group (n=10)* Usual care as prescribed by physician	YES	Significant changes Mean change experimental: .25 Mean change control:.09
	15 Non-randomized	***Sharp, 1997***[54] 3 days/wk, 40 min/day, 6 weeks Isokinetic training for the hemiparetic knee muscles Measurements at baseline, after intervention, and 4 weeks after training cessation	YES	Increased **5.8**% after training ($p<.05$) and **6.8%** at follow-up ($p<.05$)
	13 Pretest-posttest design	***Teixeira-Salmela, 1999***[55] 10 wks, 3 days/wk, 60-90 min/session Aerobic exercises and LE strengthening	YES	*Experimental:* Baseline: .79 m/s Post tx: 1.03 m/s 31% increase in CGS *Control:* Baseline: .8m/s Post tx: .78m/s

<table>
<tr><td rowspan="8">s/p CVA</td><td>60
RCT</td><td>Nilsson, 2001[56]
30 minutes, 5 days per week
<u>Experimental (N=28):</u>
Treadmill with body weight support
<u>Control (N=32):</u>
Individualized walking training on level surface</td><td>NO</td><td colspan="2"><u>Experimental:</u>
Pre: .4 m/s
Post: .7m/s
<u>Control:</u>
Pre: .4 m/s
Post: .8m/s
There is no significant difference between groups</td></tr>
<tr><td>13
RCT</td><td>da Cunha, 2002[57]
3 hours daily
<u>Experimental: (N=6)</u>
Supported treadmill training substituted for usual gait training
<u>Control</u>: (N=7) PT/OT/Kinesiotherapy</td><td>NO for statistical difference YES for clinical difference</td><td colspan="2">Gait speeds did not reach significant difference, control group changed .15m/s experimental group changed .25m/ Large effect size of 1.16 between the 2 groups at the end.</td></tr>
<tr><td>91stratified RCT by gait speed</td><td>Salbach, 2004[58]
18 sessions, 3x/wk for 6 wks
<u>Experimental (n=44)</u>:
10 walking-related tasks to strengthen LE, increase walking balance, speed and distance
<u>Control (n=47):</u>
UE activities</td><td>YES Significant between –group effects were seen of .21m/s FGS and .11m/s CGS</td><td>CGS
<u>Experimental</u>:
Pre: .64 m/s
Post: .78 m/s
<u>Control</u>:
Pre: .61 m/s
Post: .64 m/s</td><td>FGS
<u>Experimental:</u>
Pre: .79 m/s
Post: .99 m/s
<u>Control:</u>
Pre: .81 m/s
Post: .8 m/s</td></tr>
<tr><td>90 RCT</td><td>Katz-Leurer, 2003[59]
5 days/wk for 2 weeks; then 6 weeks for 3x/week x 30 min
<u>Experimental (N=46):</u>
Leg cycle ergometer (PT supervised) worked at 60% of max HR
<u>Control (N=44)</u></td><td>NO</td><td colspan="2">Experimental end speed: .51 m/s
Control end speed: .45 m/s
NS difference at end</td></tr>
<tr><td>23 RCT</td><td>Schauer, 2003[60]
5 days a week for 20 minutes a day, 15 sessions total
In an inpatient rehab hospital
<u>Experimental:</u>
Musical motor feedback
<u>Control</u>:
Conventional gait therapy</td><td>YES</td><td colspan="2">Test group improved significantly (27%) from baseline with no change in control group</td></tr>
<tr><td>8</td><td>Perell, 2001[61]
12 sessions
Stationary recumbent cycling</td><td>NO</td><td colspan="2">Average change 12-14% not significant</td></tr>
<tr><td>Meta-Analysis 8 studies</td><td>Moreland, 1998[62]
Electromyographic biofeedback over conventional therapy for improving LE function after stroke</td><td>NO</td><td colspan="2">.31 effect size for gait speed</td></tr>
<tr></tr>
<tr><td>CVA with intrathecal baclofen</td><td>7</td><td>Remy-Neris, 2003[67]
ITB by lumbar puncture after a dose-selecting test period</td><td>YES for CGS</td><td colspan="2">After ITB, CGS increased significantly FGS increased but NS</td></tr>
</table>

s/p CVA	64	***Schmid, 2007*** [63] baseline and 3 month assessment Objective was to see if client progressed from the ambulation classifications of <.4 household, .4 to .8 limited community ambulation and >.8 full community ambulation	YES	CGS baseline= .5m/s (.16) CGS at 3months= .68m/s (.24) 3 month gait velocity scores were higher (average .82m/s at the end) among those who transitioned to a higher amb class than those who did not (.56m/s).
	24 RCT	***Pomeroy, 2001*** [64] Experimental Use of weight garments 6 weeks (N=12) Control No weighted garments (N=12)	NO	No significant statistical or clinical change
	25 RCT	***Flansbjer, 2008***[65] *Experimental: (N=15)* progressive resistive training of knee muscles *Control (N=9)*	NO	Both groups improved in fast gait performance, no significant difference between groups after treatment or at follow-up.
	73	***Pyoria, 2007***[66] Activating Physical Therapy (N=36) Traditional Physical Therapy (N=37)	NO	No significant differences found between groups at 12 months
Well elderly from retirement communities	35	***Gras, 2004***[68] Freq and Intensity (both groups):stretching 5 days/wk, and strengthening 3x/wk, x8 wks Rx 1: HEP hip strength/stretch exercises Rx 2: HEP ankle strength/stretch exercises	NO	No statistically significant changes from pre- and post-test
Nursing home residents	30	***MacRae, 1996***[69] 22 week walking program	NO	No significant pre and post intervention changes on max walk endurance speed
	31	***Judge, 1993***[70] 12 weeks 3x/week resistance and balance training	YES NO	CGS increased 8% FGS increased 4% (NS)
Patients with THA	23 non-randomized	***Sashika, 1996***[71] 6 weeks home program Group A ROM ex. of hip flexor and isometric m. strengthening ex of low resistance. Group B: Same ex as group A plus eccentric m. contractile ex of hip abductors in standing position on one leg Control group: No exercise	YES	Improvement in CGS .18m/s difference between control group and group B.
Children with moderate to severe TBI (6-13 yo)		***Kuhtz-Buschbeck, 2003*** [75] Examined 1 (1.2) year post-injury	YES	Significant gait speed differences with matched healthy children
Persons with OA	86 RCT	***Foley, 2003***[74] 3x/week for 6 weeks for 30 minutes Gym based strengthening program N=26 Hydrotherapy strengthening program N=28 *Control group* N=32	YES	Gait speed improved from baseline in both exercise groups, not control group. Gym group change score was significantly better than the control group for gait speed.

S/p hip fx surgical repair >65 yo Completed PT	90 RCT	***Binder, 2004***[72] 3 sessions/wk for 6 mo. *Experimental (N=46)*: Supervised PT and exercise training Phase 1 (3 mo): group PT focusing on flexibility, balance, coordination, strength Phase 2 (3 mo): progressive resistance training *Control (N=44)*: Home exercise program	YES	FGS Control: Base: 52 m/min or .86m/s 3 mo: 59.6 m/min or .99m/s 6 mo: 59.4 m/min or .99m/s Exp group: Base: 53.9 m/min or .90m/s 3 mo: 69.4 m/min or 1.15m/s 6 mo: 72.9 m/min or 1.21m/s (p=.005) *Group differences approaching significance.* **Exp group increased > control by .18m/s (p=.008)**
Community Dwelling Older Adults	109 Cross-sectional	***Buchner, 1996***[76] *Experimental groups:* 3 FICSIT exercise groups 3x/wk for 6mo 1hr 3 MoveIT exercise groups 3x/wk for 3mo, then HEP *Control Group:* Normal activities	YES	Changes in gait speed (6 months-baseline) .21m/s.
	106 Single-blinded RCT	***Buchner, 1997***[77] Sedentary adults, ages 68-85 3x/week for 3 months *3 Experimental groups*: Stationary cycle, Walking, and Aerobic movement *Control group*: Normal activities	YES	Only walking exercise improved gait speed by 5% (p<.02)
	447	***Aoyagi, 2000***[78] Japanese people over the age of 40 *Experimental group*: Regular physical activity *Control group*: No regular physical activity (results adjusted for age, BMI, and physical activity)	NO	Similar gait speeds between the groups
	171 RCT	***Brach, 2004***[79] 14 year study (1982 to 85, follow-up in 1999) Women *Group* 1: Active**,** walking program (7 miles/week) *Group* 2: Inconsistently Active *Group 3*: Inactive	YES	Group 1 Normal wt/inactive:1.17m/s Group 2 Normal wt/active: 1.22 m/s Group 3Obese/inactive: 1.02 m/s Group 4 Obese/active: 1.13m/s Obese/Inactive significantly slower Significant differences btw groups. Physical activity as measured by a questionnaire in 1995 was a significant independent predictor of gait speed in 1999.
Dx of End Stage Renal Disease	10	***Headley, 2002***[90] Supervised resistance training 12 weeks of 2x/week Began with a 6 week controlled period	YES for FGS	FGS significantly increased compared to baseline; CGS did not change

S/p THA	26 RCT	***Unlu, 2007***[73] 6 weeks *Experimental Group 1 (N=9):* Home exercise program performed 2x/day *Experimental Group 2 (N=8):* In hospital supervised exercise program (same exercises as group 1) 2x/day *Control Group (N=9):* Assigned only walking	YES	Group 1: Gait speed improved from 1.13m/s to 1.24m/s Group 2: Gait speed improved from .81m/s to .95 Control : Gait speed increased from.97 to .99 **SS difference in improvement in groups 1 and 2 relative to group 3. No SS difference between bet. Groups 1 and 2.**
	163 RCT	***Barnett, 2003***[80] 23 sessions over 6 months *Group 1*: Exercise classes *Group 2:* Control	NO	Exercise group showed no significant change in walking speed at 6 month retest
	2349	***Atkinson, 2007***[81] 3 measurements annually over 3 years. Explored relationship between global cognitive function and gait speed. No control group	YES	CGS baseline= 1.15m/s SD .22 CGS at 3 years= 1.10m/s GS declined .05m/s on average over 3 year follow-up. According to authors, this difference was SS
	91	***Kolbe-Alexander, 2006***[82] Measurements at baseline, 10 and 20 weeks Twice weekly low intensity exercise program for site 1 & 2 *Experimental site 1* N=38 *Experimental site 2* N=32 *Control group: relaxation classes* N=21	NO	No difference between groups for CGS. No improvement over time in any group
Community Dwelling Chinese	121	***Wong, 2003***[83] Habitual activities (~2 kcal/min) performed a minimum of 3 min, weekly for previous 6 weeks	NO	Did not show improvement in CGS/FGS
Residents of retirement community	25	***Brill, 1998***[84] 3x/week, 30 minutes for 8 weeks *Experimental Group:* Strength training	YES	Significant differences of 13.3% from pretest to posttest on FGS
Community dwelling adults with 2 or more deficits in physical functioning	22 RCT	***Sayers, 2003***[85]**,** 3x/ week for 16 weeks High velocity resistance training vs. Low velocity resistance training	NO	Neither group showed significant gains in CGS or FGS
Community Dwelling Elderly age 70-79	3075	***De Rekeneire, 2003***[47] Cross-sectional study of fallers and non-fallers.	YES	Significant differences between CGS for fallers .88(.5) and non-fallers .95(.5)
Frail elderly	84	***Brown, 2000***[48] 3 months, subjects grouped according to score on Physical Performance Test (PPT) Mean age 83	YES	Fast gait speed significantly different among the 3 groups. See validity above.
	87	***Chandler, 1998***[86] 10 weeks, 3 times per week *Experimental Group:* Home strengthening exercises *Control Group:* Normal activities	YES	Strength gain was significantly associated with increase in gait velocity.

S/p reconstructive surgery for lumbar scoliosis	20	***Engsberg, 2003*** [87] Reconstruction surgery All patients were significantly slower than able-bodied persons pre-operatively with gait speed.	NO	8 with primary surgery & 12 with revision surgery not different from preop but statistically different than able-bodied on gait speed at 2 yrs post-op.
Adolescents with idiopathic scoliosis	31	***Engsberg, 2003***[88]Anterior vs. Posterior fusion	NO	No difference in gait speed with different fusions.
Dx of Alzheimer'	28	***Sheridan, 2003*** [89] Adding cognitive task (repeating random digits) to walking	YES	Gait speed is significantly reduced with cognitive task and variability increased with dual task walking
Dx of End Stage Renal Disease	10	***Headley, 2002***[90] Supervised resistance training 12 weeks of 2x/week Began with a 6 week controlled period	YES for FGS	FGS significantly increased compared to baseline; CGS did not change
Individuals with early Parkinson's disease	**30** RCT	***Fisher, 2008***[91] 24 sessions over 8 weeks: *Group I:* High intensity treadmill exercise *Group II:* Low intensity treadmill exercise 6 education classes over 6 weeks: *Group III:* Zero intensity group (no exercise)	YES statistically significant but not clinically significant at MDC of .2m/s	All subjects showed significant improvement in CGS and FGS.. High intensity group showed post exercise increases in gait speed. Group I CGS: pre:1.46(.20) Post: 1.52 (.19) (Change score=.06m/s) FGS pre 1.91(.32) to post 2.00(.34) Change score .09m/s Group II CGS pre 1.40(.18) post 1.42(.17) Change score .02m/s FGS pre 1.92(.23) post 1.94(.19) Change score .02m/s Group III CGS: pre:1.39 (.17) Post: 1.41 (.17) (Change score=.02m/s)FGS pre 1.96(.38) to post 2.04(.4) Change score .08m/s
Individuals with Parkinson's disease	19	***Hackney, 2007***[92] 2 one-hour sessions per week for 13 weeks *Experimental Group:* Learned Tango *Control Group:* Strength/Flexibility group exercise	NO	Tango Group pre .86m/s (.04) post .88m/s (.04) Exercise Group pre .89m/s (.05) post .91m/s (.01)
Ambulators with Multiple Sclerosis	109	***Paltamaa, 2008***[93] 3 testing sessions over 2 year period. Test sessions separated by 1 year.	YES	MDC_{95} CGS &FGS=.26
Subjects with incomplete spinal cord injury (iSCI)	51	***van Hedel, 2007*** [94] iSCI group (N=31) control group (N=31)	YES	iSCI group CGS=.93m/s (.38) FGS=1.28m/s SD.55 Control group CGS= 1.49m/s SD.18 FGS=2.55m/s SD .42

Ceiling & floor effect: This is a continuous scale thus there is no ceiling or floor effect on gait speed as long as the person can walk with no physical assistance of another person. They are able to use an assistive device. Perry

1995[44] suggests that improvements in walking speed in the range less than 22-25 m/min (or 0.37-0.42 m/sec) are of questionable functional significance (see predictive validity above).

Reference data:

Subjects	***N =***	***Resource***	***Comfortable Walking Speed***
Healthy Adults over 60 years	10-85	Oberg 1993[95] Ferrandez 1990[96] Aoyagi 2000[78], Leiper 1991[97] Martin 1992[98] Ostrosky 1994[99] Blanke 1989[100] Elble 1991[101] Himann 1988[102] Bohannon 1996[103] Menz 2003[104]	0.60-1.45 m/sec
70-79 year olds by race	3041	Taaffe, 2003[39]	White women: 1.15 m/sec Black women: 1.01 m/sec White men: 1.25 m/sec Black men: 1.09 m/sec
Women, living independently, with a diagnosis of osteoporosis and vertebral compression fracture	185	Purser, 1999[105]	1.0 (.24) m/sec
Community dwelling older adults	417	Cress, 1995[106]	1.2(.26)
Women over 65 in study of osteoporosis 1986-88	9704	Seeley, 1995 [107]	1.03(.22) current oral estrogen (OE) use 1.03(.20) past OE use 1.00(.22) never OE use Current and past users are statistically different from never users
Rural (391) and Urban (570) community elderly in Sweden	570	Ringsberg, 1998 [108]	40-49yo 1.85(.32) to 1.92(.27) 50-59yo 1.57(.28) to 1.68(.35) 60-69yo 1.50(.24) to 1.60(.28) 70-79yo 1.32(.27) to 1.48(.28) 80-89yo 1.10(.30) to 1.15(.31) The categories can be divided into true urban, urban, rural and true rural. All groups had more than 20 per category
Persons with SCI (ASIA class C or D)	20	Wirz, 2005[109]	Mean gait speed of .55 (.03) m/sec
Healthy people with stroke and SCI (Class C & D)	SCI 10 Stroke 20 Healthy 40	da Cunha-Filho, 2003 [110]	SCI .55(.31)m/s Stroke .67(.32)m/s Healthy .90(.11)m/s
People with Parkinson Disease Matched controls	12 12	Bond, 2000[111]	1.15 (.19) m/sec 1.38 (.13) m/sec
Persons with PD[	56 195	Schenkman, 2000[112]	.98 m/sec 1.11 m/sec

Subjects	***N =***	***Resource***	***Comfortable Walking Speed***
Community dwelling people with stroke. These subjects did the 6MWT and 12 MWT.	25	Eng, 2002[113],	Self-selected speed of .80 (.26) m/s Interestingly, gait speed during the walk tests was relatively constant.
Hx of CVA within 6 months of data collection. Could walk at least 40 m with or without an assistive device (Mean age of 61)	20	Kim, 2003[114],	Mean = 0.45(.25) m/s
Higher functioning persons with hemiparesis Lower functioning persons with hemiparesis	6 6	Jonkers, 2008[115]	.78 m/s (SEM .04) .45 m/s (SEM .03)
History of stroke (mean age=57)	20	Teixeira da Cunha-Filho, 2003 [116]	.67 (.32) m/s
Nursing home residents in which 27 had no walking aid, 14 had canes, and 12 had walkers	53	Harada, 1995[51]	.56 (.26) m/s
Male nursing home residents	6	Sauvage, 1992[117]	.81 (.09) m/s
Nursing home clients, fallers vs. non-fallers	49	Wolfson, 1990[118]	Fallers: .37 (.17) m/s Non-fallers: .64 (.21) m/s
Ambulatory older adults without diabetes (Mean age 80) Ambulatory older adults with diabetes (Mean age 79)	439 119	Brach, 2008 [40]	1.02(.23)m/s .95(.25)m/s
Younger adults (18-28 yo) Older adults(65-85 yo)	17 18	Kang, 2008[119]	1.3(.10) m/s 1.29(.15) m/s
Community Dwelling Older Adults (Mean age 79)	2269	Talkowski, 2008[120]	.89 (.24) m/s

Subjects	***N =***	***Resource***	***Fast Walking Speed***
Healthy subjects over 60 years		Elble,1991[101] Bohannon, 1997 [121] Himann, 1988[102] Murray, 1969[122] Oberg, 1993[95] Ferrandez, 1990[96] Leiper, 1991[97] Bohannon, 1996 [103] Bohannon, 1997[121] Murray, 1969[122]	0.84-2.1 m/s
with History of CVA within 6 months of data collection and who could walk at least 40 m with or without an assistive device	20 (mean age of 61)	Kim, 2003[114],	0.69 (.35)m/s
Higher functioning persons with CVA Lower functioning persons with CVA	6 6	Jonkers, 2008 [115]	1.25 m/s (SEM.12) .62 m/s (SEM .03)
Older Japanese Men aged 71-93 with depressive symptoms	283 (Mean age 77)	Yanagita, 2006 [43]	Depressed group 75m/s Non depressed group =.87m/s Recalculated from data given.

Interpreting results:

Most studies have shown that healthy older adults, without known pathologies, have significantly slower gait speeds than young adults. Depending on the study, the comfortable walking speed of the older adults was an average of 71%-97% slower than that of the young adults and the fast walking speed of the older adults averaged from 71% - 95% of that of the young.[123] [122] [124] [99] [125] [101] [121] [102] [126] [95104] Older adults without known impairments are able to increase walking speed from 21-56% above a comfortable pace.[102 101 96 122 121] Young healthy subjects can vary gait speeds significantly more than older adults. [127]

Table 4 gives reference data for community-dwelling older adults (males & females), aged 60-89 years.[128] This reference data are similar to those of Bohannon [121] who also reported norms for 10-year age spans in community dwelling males and females using a stopwatch method. The values are a little higher than Lusardi (2003) who also uses 10 year age spans. She has reference data for (N=17) 90-101 year olds, CGS .71(.22), FGS 1.08(.31). [16]

Table 4: Comfortable and Fast Gait Speed: Means (X) and Standard Deviations (SD) by Age and Gender (m/sec) for Community Dwelling Elderly

			Comfortable			**Fast**			**Difference**	
Age (yrs)	**Gender**	**N**	**X**	**SD**	**CI**	**X**	**SD**	**CI**	**X**	**SD**
60-69	Male	15	1.59	.24	1.46-1.73	2.05	.31	1.89-2.22	.46	.34
	Female	22	1.44	.25	1.33-1.55	1.87	.30	1.73-2.00	.43	.21
70-79	Male	14	1.38	.23	1.25-1.52	1.83	.44	1.58-2.09	.45	.34
	Female	22	1.33	.22	1.23-1.43	1.71	.26	1.63-1.84	.39	.17
80-89	Male	8	1.21	.18	1.06-1.36	1.65	.24	1.45-1.85	.44	.27
	Female	15	1.15	.21	1.03-1.26	1.59	.28	1.43-1.74	.44	.19

Steffen TM, Hacker T, Mollinger L (2002). Age-and gender-related test performance in community-dwelling elderly people: Six Minute Walk Test, Berg Balance Scale, Timed Up & Go Test, and Gait Speeds. Physical Therapy 82 (2): 128-137.

Aoyagi (2000)[78] community-dwelling Japanese

	N	CGS	FGS
40-49 male	7	1.26(.18)	1.73(.15)
Female	57	1.26(.18)	1.66(.23)
50-59 male	10	1.10(.14)	1.59(.37)
Female	76	1.24(.17)	1.56(.21)
60-69 male	41	1.14(.17)	1.51(.22)
Female	146	1.12(.17)	1.43(.23)
70-79 male	32	1.00(.17)	1.42(.21)
Female	63	.97(.17)	1.24(.23)
80- male	6	1.08(.19)	1.49(.25)
Female	9	.84(.24)	1.15(.34)

The wide range of "normal" values reported for measures of walking speed suggests that measurement technique and environment might influence results (e.g. computer-aided video analysis vs. stopwatch method vs. electronic foot switches; long, open walkway vs. short walkway in a small hall or room).

Other

In a small study of 47 community-dwelling elderly (63-82 years old), significant increases in walking speed (9%) were observed in subjects who received reinforcement of positive stereotypes of aging. [129]
Walking speed required to safely cross at signalized intersections is 1.22 m/s. [130]

Patients' reports of slowing over 10- and 1-year periods correlate to actual gait speed. [131]

Similar outcomes for final walking speed were found for the different prevailing treatment methods for CVA. Simple "low technology" and conventional exercise to date is at least as efficacious as more complex strategies such as treadmill and robotic-based interventions. [132]

Studies are beginning to show that as sensory processing becomes more difficult, older adults who had been able to maintain performance in a single task context decrease performance when performing a secondary task. [50] Outcome measure of decline in gait speed was greater at aged 65 and older, and the magnitude of the performance gap between simple walks and complex walking tasks (CWT), was greater in older participants.[133]

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