HHS Public Access

Author manuscript

Aging Clin Exp Res. Author manuscript; available in PMC 2016 June 01.

Published in final edited form as:

Aging Clin Exp Res. 2015 June ; 27(3): 309–314. doi:10.1007/s40520-014-0287-y.

Performance on Fast and Usual-Paced 400m Walk Tests in Older Adults: Are They Comparable?

Brittney S. Lange-Maia, MPH[a], **Anne B. Newman, MD, MPH**[a], **Elsa S. Strotmeyer, PhD, MPH**[a], **Tamara B. Harris, MD, MS**[b], **Paolo Caserotti, PhD**[c], and **Nancy W. Glynn, PhD**[a]

[a]University of Pittsburgh, Graduate School of Public Health, Department of Epidemiology, Center for Aging and Population Health, Pittsburgh, PA

[b]Laboratory of Epidemiology, Demography, and Biometry, National Institute on Aging, Bethesda, MD

[c]University of Southern Denmark, Odense, Denmark

Abstract

Background and Aims—Fast and usual-paced 400m walking tests are often used to assess physical fitness or function, respectively, though it is not known how performance converges on these tests. This study aims to determine whether performance on the fast and usual-paced 400m walks varies based upon age and physical function.

Methods—Participants (26 men, 38 women aged 70–92) completed a fast and usual-paced 400m walk. The Short Physical Performance Battery was used to assess function (score range 0–12). Body mass index and health history were also assessed.

Results—Finish times for the fast and usual-paced 400m walks were 333.3 and 380.3 seconds, respectively ($p<0.0001$), and highly correlated ($r = .88$, $P < .001$). Higher functioning participants (SPPB >10) had greater differences between tests compared to lower functioning participants (SPPB ≤ 10) (52.9 vs. 26.2 seconds, $p=0.005$), as did younger participants (age <80) compared to those age 80 and older (56.8 vs. 32.8 seconds, $p=0.003$).

Discussion—Older and lower functioning participants had greater convergence on the fast and usual-paced 400m walks. Potentially some of these lower functioning and older adults may have already performing at their maximal capacity during the usual-paced walk, while the younger and higher functioning participants were able to walk substantially faster when asked.

Conclusions—Choice of walking test should consider the age and functional capacity of the population as well as whether function or fitness is of interest.

Corresponding Author: Nancy W. Glynn, PhD, 130 DeSoto Street, A531 Crabtree Hall, Pittsburgh, PA 15261, Phone: 412.383.1309, Fax: 412.624.7397, glynnn@edc.pitt.edu.

This work was presented as an oral presentation at the 66th Annual Meeting of the Gerontological Society of America on November 23, 2013 in New Orleans, Louisiana.

Conflict of Interest

On behalf of all the authors, the corresponding author states that there is no conflict of interest.

Keywords

physical function; measurement methods; gait speed; physical performance

Over-ground 400m walking tests are often incorporated into epidemiologic studies of older adults, with fast paced 400m walking tests often used to assess aerobic fitness [1], while usual-paced versions are primarily used to assess mobility [2]. The most commonly used fast paced 400m walk protocol is the Long Distance Corridor Walk (LDCW) [3] which has been validated against peak oxygen consumption [1], and is a field testing alternative to maximal exercise testing performed in a laboratory with costly equipment and specially trained staff. LDCW performance is independently associated with the development of cardiovascular disease, mobility limitations, mobility disability and mortality in older adults [4]. The usual-paced 400m walking test evolved as an objective version of the self-reported function question of whether participants have difficulty walking ¼ mile and is used to assess mobility limitation in older adults [5] Compared to self-reported function, it is less prone to ceiling effects in high functioning older adults [6]. Usual-paced 400m walks have been incorporated into notable studies of older adults and as the primary outcome of The LIFE Study randomized clinical trial [7].

The choice of test is usually decided based on the outcome of interest – fitness or physical function. In some epidemiologic studies, particularly physical activity intervention trials of older adults, both fitness and function may be of interest. However, it is unlikely due to time restraints, practicality, and participant burden, that both walking tests would be administered in one study protocol. Further, with increasing frailty and age, even usual-paced walking becomes more challenging to older adults and potentially could be tapping into maximal capacity. Therefore, it is important to examine how performance on both a fast and usual-paced walking test compare with each other, and whether these tests actually differ for older adults based on their age and functional capacity. Understanding the convergence between the fast and usual-paced over-ground walks can lead to more informed decisions when choosing the optimal 400m walk test for new study protocols.

Thus, the purpose of this study was to determine the correlation and agreement in performance for fast versus usual-paced 400m walking tests for older adults, and compare performance based upon age and physical function. We hypothesized that completion time on the fast and usual 400m walk would be positively correlated, with greater convergence between the two for older and lower functioning participants.

METHODS

Study Design and Participants

Community-dwelling older adults (age 70+ years) from the Pittsburgh area were recruited using the Pittsburgh Claude D. Pepper Older Americans Independence Center Research Registry for the Developmental Epidemiologic Cohort Study (DECOS) conducted at the University of Pittsburgh. Recruitment letters were mailed to 430 registry members across a range of self-reported function. There were 136 individuals who responded and telephone

screened for eligibility. Exclusion criteria included any self-reported health contraindication to physical testing and the inability to perform basic mobility tasks (e.g. severe pain, aching, or stiffness while walking). A total of 97 individuals were eligible, with 68 participants enrolling into the study, 14 cancelling out before Visit 1, one refused to sign consent, and 14 were on the waiting list because the study was full. The other 39 individuals who contacted us were either ineligible (n=22) or refused screening once the study was explained (n=17). Participants had two clinic visits scheduled 8 to 14 days apart, and 64 completed both visits. Of those 64 participants, five were unable to complete the fast 400m walk. All of the participants who completed the fast 400m walk (n =59) also completed the usual-paced 400m walking test. One did not attempt the usual 400m walk due to safety concerns and one attempted, but was unable to finish the entire usual-paced 400m walk.

The University of Pittsburgh Institutional Review Board approved this study and all participants provided written informed consent prior to participation. Participants were excluded if they had a Modified Mini-Mental State Exam [8] score of <80, which was administered at the beginning of the first visit.

400m Walk Protocols

At the first clinic visit, participants completed a fast-paced 400m walk administered by trained and certified staff. The course was in a dedicated long hallway with traffic cones on both ends spaced 20 meters apart. Participants wore a heart rate monitor (Polar Chest Transmitter, Warminster, PA) for safety purposes and for monitoring relative exertion.

The test had two parts: an 80m warm-up at usual pace (2 laps) and a 400m test (ten laps) at a fast pace. Participants were excluded for resting heart rate >110 or <40 beats per minute, or if they had systolic blood pressure >200 mmHg or diastolic blood pressure >110 mmHg. Time to complete the warm-up was recorded in seconds. For the fast 400m walk, participants were told to walk as quickly as possible without running at a pace they could maintain for ten laps. Completion times were recorded at the end of the fast 400m walk and each individual lap. Perceived exertion was recorded using the Borg Rating of Perceived Exertion (RPE) Scale (possible responses from 6–20, with higher responses indicating greater perceived exertion) [9]. RPE was recorded after lap 4 and at walk completion. A test was stopped if heart rate surpassed 170 beats per minute, or if the participant reported lightheadedness, dizziness, chest pain, shortness of breath, leg pain, or at their request.

The usual-paced 400m walk was administered during the second clinic visit. This test was administered identically to the fast 400m walk, with the exception that participants were instructed to walk at their usual, normal pace during the 400m walk portion.

Physical Function

Physical function was assessed using the Short Physical Performance Battery (SPPB) and included standing balance, chair stands, and a 6 meter usual-paced walk [10]. Each component had a possible score of 0–4. Total SPPB scores ranged from 0–12, with higher scores indicating better physical function.

Other Measures

Age, sex, race, self-reported health (excellent, very good, good, fair, or poor), self-reported ease of walking ¼ mile (very easy, somewhat easy, not that easy, or indicating any difficulty), and education were included as covariates. Body mass index (BMI) was calculated in weight in kilograms per squared height in meters using a stadiometer and a standard physician's balance scale.

Statistical Analyses

Participant characteristics were reported using means and standard deviation for categorical variables, and proportions for continuous variables. A Pearson's correlation coefficient was calculated for completion times between the two 400m walks. Agreement between the two 400m walks was illustrated using a Bland-Altman plot [11]. The difference in completion times was calculated by subtracting the fast 400m walk completion time from the usual-paced 400m walk completion time. Completion time, time to complete the second and ninth laps, rating of perceived exertion, and performance deterioration (slowing between laps 2 and 9) [12] were compared for the fast and usual-paced walk using paired t-tests. Fast and usual-paced 400m walk completion times and the time difference between tests (usual walk completion time – fast walk completion time) were also compared with t-tests between those age <80 and those ≥80, and between those with SPPB score ≤10 and those >10. Linear regression models were used to determine predictors of the time difference between tests, and factors reaching significance at $p < 0.10$ were included in the multivariable model. Analyses were performed using STATA version 12.1 [13] (STATA Corp, College Station, TX).

RESULTS

Demographic characteristics of the DECOS participants who completed both 400m walks can be found in Table 1. Participants (n=59) mean ± standard deviation 78.4 ± 5.8 years old (range 70–92 years); 58% were women, and the majority of the participants were white (91.5%) and college educated (83.1%). Mean BMI was 26.6 ± 3.8 kg/m^2, approximately half of the participants were former smokers, and nearly a third reported being in excellent health. The cohort was generally high functioning with a mean SPPB score of 10.6 (range 4–12). The majority of participants indicated that they had the ability to walk a quarter of a mile without difficulty (94.9%), and that walking ¼ mile was "very easy" (61.0%).

There were no significant differences in age, sex, or race between those who completed both 400m walks (n=59) versus non-completers (n=5), though participants who did not complete both 400m walking tests had lower mean SPPB scores than those who completed both (8.0 vs. 10.7, P<0.001) (data not shown).

Average completion times for the fast and usual 400m walks were 333.3 and 380.3 seconds, respectively (P <.001) (Table 2). Completion times for these tests were highly correlated, r = 0.88 (P <.001). The range of times for the fast 400m walk (221.3–566.0 seconds) was wider than the usual-paced 400m walk (264.6–557.9 seconds) (Figure 1). There was no difference in completion time for the warm-up between the fast and usual 400m walks (Table 2).

Participants walked faster during the fast walk during laps 2 and 9, and also had higher RPE for the fast walk after lap 4 and at completion of the test compared to the usual walk (P <. 001 for all). Overall, slowing between laps 2 and 9 was similar for the fast and usual-paced 400m walks.

Performance parameters for the fast and usual-paced 400m walks were stratified by age (<80 and ≥80 years) and physical function (SPPB score: < 10 vs. ≥ 10) and can be found in Table 3. Younger participants (age <80) walked faster on the fast 400m walk and had a greater time difference between tests compared to those age 80 and older (56.9 seconds vs. 32.8 seconds, P=0.003). The highest functioning participants (SPPB >10) walked faster on the fast 400m walk compared to lower functioning participants (SPPB ≤10). Also on the fast walk, lower functioning participants had greater slowing between laps 2 and 9 compared to the higher functioning participants. Higher functioning participants walked faster on the usual-paced 400m walk and also during the warm-up laps compared to lower functioning participants. Higher functioning participants completed the fast walk on average 53.6 seconds faster than the usual walk, while lower functioning participants only completed the fast walk on average 35.1 seconds faster than the usual-paced walk. Age and performance battery score predicted completion time difference (age: $\beta = -2.5$, $p < 0.001$; SPPB score $\beta = 7.8$, $p = 0.006$), yet only age remained significant in the final multivariable model.

The Bland Altman Plot (Figure 3) displays the agreement between the fast and usual-paced 400m walks by average completion time stratified by age. The mean difference was 47.04 seconds, indicating finish times were consistently faster for the fast walk. However, in general, participants age 80 and older tended to have slower average completion times and had a smaller time difference between tests—indicating greater convergence and better agreement in completion time — compared to participants younger than age 80. Average completion times and completion time differences were negatively correlated, ($r = -0.33$, $P = 0.01$) indicating that those with slower average completion times had a smaller time difference between the two 400m walks. Although the majority of participants completed the fast walk more quickly, four participants walked faster during the usual-paced walk. These participants were older (88.5 vs. 77.7 years, P <0.001), and were lower functioning (SPPB score 8.8 vs. 10.7, P=0.007) than the rest of the participants. When stratifying by physical function (SPPB score: ≤10 vs. >10), a similar relationship was found; those who were lower functioning had slower average completion times and a smaller time difference between tests compared to higher functioning participants (data not shown).

DISCUSSION

As expected, most participants had faster completion times for the fast 400m walk compared to the usual-paced 400m. Overall, the tests were highly correlated, but not in agreement. Younger and higher functioning participants had greater differences in performance between tests, though older age was the only factor that remained independently associated in the multivariable model, likely due to its moderate correlation ($r = -0.49$, $p < 0.001$) with physical function. Essentially, those with larger time differences had the ability to walk faster than their usual walking pace, while others were already walking as fast as they could

or slowed during the fast 400m walk. The completion time differences between the fast and usual-paced 400m walks converged for older and poorer functioning older adults.

In general, the lowest functioning participants (n=5) were unable to complete the fast 400m walk, and two of these participants did not complete the usual-paced walk either. Although this was only a small subset of this study cohort, non-completion could have larger implications for studies with older, frailer adults, and should be considered during study design. Therefore, if estimating fitness is of interest, the fast 400m walk may be inappropriate for very old and low functioning participants, and a fitness survey or another objective measure may be needed in order to obtain an estimate of aerobic fitness.

Fatigue may be an alternate explanation as to why four participants walked faster on the usual than the fast 400m walk. Instead of walking consistently at a fast pace, these participants may have started quickly during the fast 400m walk, but then slowed due to fatigue. This notion is supported by the fact that these participants slowed down between laps 2 and 9 in order to self-pace to finish the task. The work by Simonsick and colleagues has shown that that mobility intact older adults who slowed during a fast 400m walk (i.e., performance deterioration) were also more likely to report symptoms of fatigue [12]. When an individual works close to maximal aerobic capacity, they must adapt their behavior in order to spare energy [14]. Careful examination of slowing patterns may explain performance deterioration during these walks.

Strengths of this study included having participants complete the two walks separated by at least 8 days to avoid excessive fatigue. Due to the ever changing health and energy status of older adults, any resulting differences could be a result of the participants' general health or feelings on a particular day. We found that the warm-up times were comparable at the beginning of each walk at the two different clinic visits, thus concluding that energy status leading up to each of the 400m walks was similar.

Some limitations of this work should be noted. Participants in this study were generally well-functioning and in good health, limiting our generalizability. However, since the goal was to compare the completion times between 400m walks, a higher functioning population was needed in order to obtain a sufficient number of completed tests, particularly for the fast 400m walk. We also did not examine a large number of chronic conditions in detail. However, age may be a proxy for a higher number of comorbid conditions.

Fast and usual-paced 400m walks are important for assessing aerobic fitness and function, respectively, in epidemiologic studies of older adults. In this cohort, completion times on these tests were highly correlated, but not in high agreement, except for the oldest and lowest functioning participants. Future work of measuring maximal aerobic capacity with a portable oxygen consumption machine during both of these walks would inform us as to whether the usual-paced 400m test represents a maximal effort for older, frailer adults. Choice of walking test in epidemiologic studies should consider the age and functional capacity of the population as well as whether function or fitness is of interest.

Acknowledgments

This research was supported by Pittsburgh Claude D. Pepper Older Americans Independence Center, Research Registry and Developmental Pilot Grant — NIH P30 AG024826 and NIH P30 AG024827 and National Institute on Aging Professional Services Contract HHSN271201100605P. This project was also supported, in part, by the Intramural Research Program of the National Institute on Aging. Brittney S. Lange-Maia is funded by a National Institute on Aging Training Grant T32-AG000181.

References

1. Simonsick EM, Fan E, Fleg JL. Estimating cardiorespiratory fitness in well-functioning older adults: treadmill validation of the long distance corridor walk. J Am Geriatr Soc. 2006; 54 (1):127–132.10.1111/j.1532-5415.2005.00530.x [PubMed: 16420209]
2. Fielding RA, Rejeski WJ, Blair S, Church T, Espeland MA, Gill TM, Guralnik JM, Hsu FC, Katula J, King AC, Kritchevsky SB, McDermott MM, Miller ME, Nayfield S, Newman AB, Williamson JD, Bonds D, Romashkan S, Hadley E, Pahor M. The Lifestyle Interventions and Independence for Elders Study: design and methods. J Gerontol A Biol Sci Med Sci. 2011; 66 (11):1226–1237.10.1093/gerona/glr123 [PubMed: 21825283]
3. Simonsick E, Montgomery P, Newman A, Bauer D, Harris T. Measuring Fitness in Healthy Older Adults: The Health ABC Long Distance Corridor Walk. J Am Geriatr Soc. 2001; 49:1544–1548. [PubMed: 11890597]
4. Newman AB, Simonsick EM, Naydeck BL, Boudreau RM, Kritchevsky SB, Nevitt MC, Pahor M, Satterfield S, Brach JS, Studenski SA, Harris TB. Association of long-distance corridor walk performance with mortality, cardiovascular disease, mobility limitation, and disability. JAMA. 2006; 295 (17):2018–2026.10.1001/jama.295.17.2018 [PubMed: 16670410]
5. Rolland YM, Cesari M, Miller ME, Penninx BW, Atkinson HH, Pahor M. Reliability of the 400-m usual-pace walk test as an assessment of mobility limitation in older adults. J Am Geriatr Soc. 2004; 52 (6):972–976.10.1111/j.1532-5415.2004.52267.x [PubMed: 15161464]
6. Sayers SP, Guralnik JM, Newman AB, Brach JS, Fielding RA. Concordance and discordance between two measures of lower extremity function: 400 meter self-paced walk and SPPB. Aging Clin Exp Res. 2006; 18 (2):100–106. [PubMed: 16702778]
7. Pahor M, Guralnik JM, Ambrosius WT, et al. Effect of structured physical activity on prevention of major mobility disability in older adults: The life study randomized clinical trial. JAMA. 2014; 311 (23):2387–2396.10.1001/jama.2014.5616 [PubMed: 24866862]
8. Teng EL, Chui HC. The Modified Mini-Mental State (3MS) examination. J Clin Psychiatry. 1987; 48 (8):314–318. [PubMed: 3611032]
9. Borg G. Perceived exertion as an indicator of somatic stress. Scand J Rehabil Med. 1970; 2 (2):92–98. [PubMed: 5523831]
10. Guralnik JM, Simonsick EM, Ferrucci L, Glynn RJ, Berkman LF, Blazer DG, Scherr PA, Wallace RB. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol. 1994; 49 (2):M85–94. [PubMed: 8126356]
11. Bland JM, Altman DG. Comparing methods of measurement: why plotting difference against standard method is misleading. Lancet. 1995; 346 (8982):1085–1087. [PubMed: 7564793]
12. Simonsick EM, Schrack JA, Glynn NW, Ferrucci L. Assessing fatigability in mobility-intact older adults. J Am Geriatr Soc. 2014; 62 (2):347–351.10.1111/jgs.12638 [PubMed: 24417536]
13. StataCorp. Stata Statistical Software: Release 12. StataCorp. LP; College Station, TX: 2011.
14. Alexander NB, Taffet GE, Horne FM, Eldadah BA, Ferrucci L, Nayfield S, Studenski S. Bedside-to-Bench conference: research agenda for idiopathic fatigue and aging. J Am Geriatr Soc. 2010; 58 (5):967–975.10.1111/j.1532-5415.2010.02811.x [PubMed: 20722821]

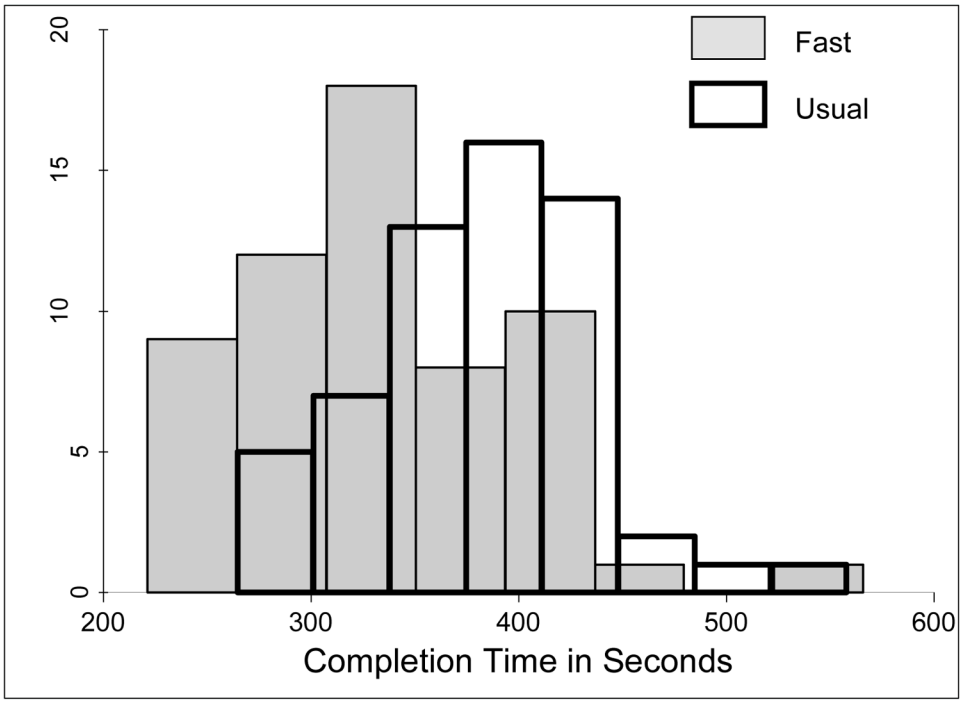

Figure 1.
Distribution of Fast and Usual 400m Walk Completion Times

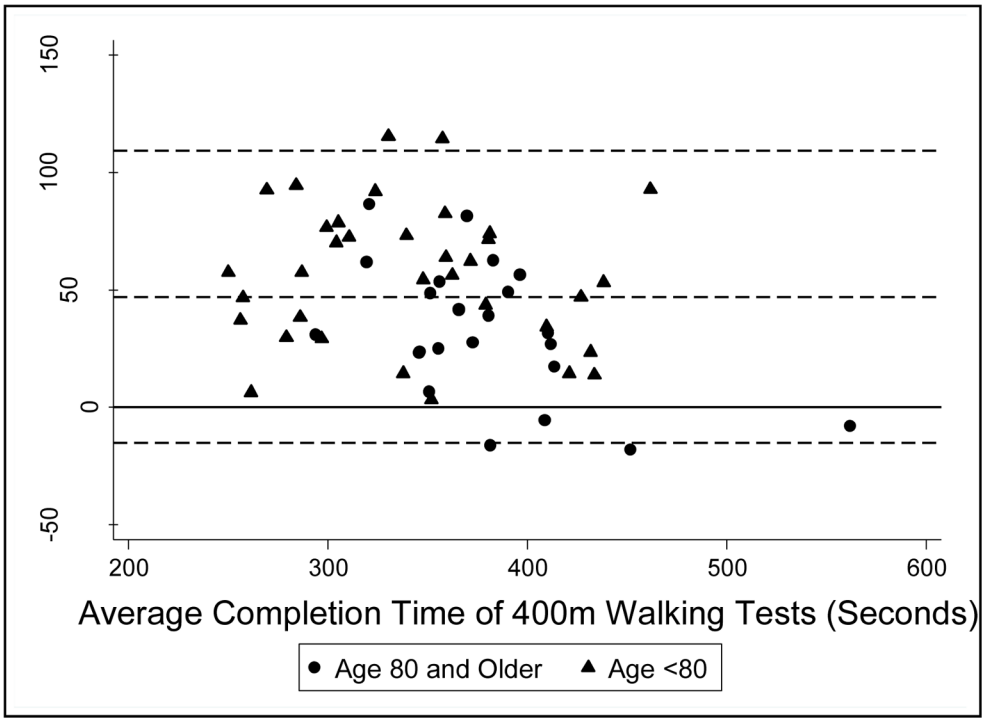

Figure 2.

Bland Altman Plot of Agreement between Fast and Usual-paced 400m Walks by Average Finish Time[a]

[a]The difference in completion times was calculated by subtracting the fast 400m walk completion time from the usual-paced 400m walk completion time. The dashed line at 47.0 represents the mean time difference, and the upper and lower bounds indicate the two standard deviations above and below the mean completion time difference. The line at the y-value of 0 represents perfect agreement.

Table 1

Demographic Characteristics of the Developmental Epidemiologic Cohort Study

Characteristic	**Total (N= 59) Mean ± SD or % (N)**
Age, years	78.4 ± 5.8
Sex, Female	57.6 (34)
Race, White	91.5 (54)
Education, College Graduates	83.1 (49)
Smoking, Former Smokers	50.9 (30)
Body Mass Index, kg/m^2	26.6 ± 3.8
Self-Report Excellent Health	33.9 (20)
Self-Report No Difficulty Walking ¼ Mile	94.9 (56)
Self-Report Walking ¼ Mile Very Easy	61.0 (36)
Short Physical Performance Battery Score (0–12)	10.6 ± 1.4

Table 2

Comparison of Completion Results[a] for the Fast and Usual-paced 400m Walks (N = 59)

	Fast 400m	Usual 400m	P-value
Warm-Up Completion Time, sec	74.0 ± 1.4	74.9 ± 1.4	0.44
400m Completion Time, sec	333.3 ± 8.6	380.3 ± 7.3	<0.001
RPE at Lap 4	12.0 ± 0.3	10.2 ± 0.3	<0.001
RPE at Lap 10	13.8 ± 0.3	11.4 ± 0.4	<0.001
Lap 2 Completion Time, sec	32.5 ± 0.8	37.6 ± 0.8	<0.001
Lap 9 Completion Time, sec	33.4 ± 0.9	38.0 ± 0.8	<0.001
Time Difference Between Laps 2 and 9, sec	0.9 ± 2.1	0.5 ± 1.8	0.21

[a] All values are listed as Mean ± SD.

Table 3

Comparison of Completion Times for the Fast and Usual-paced 400m Walk Tests and Time Difference between Tests by Age and Physical Function

	Age			Physical Function		
	Age <80 (N=25)	**Age ≥80 (N=34)**	**P-value**	**SPPB >10 (N=38)**	**SPPB ≤10 (N=21)**	**P-value**
Fast 400m Walk						
Warm-Up Completion Time (Seconds)	73.2 ± 12.1	75.1 ± 7.5	0.51	72.3 ± 11.2	77.1 ± 8.1	0.09
400m Completion Time	313.0 ± 62.8	362.9 ± 60.7	0.004	309.7 ±56.2	371.1 ± 62.1	<0.001
RPE at Lap 4	11.7 ± 2.2	12.5 ± 2.0	0.16	12.2 ± 2.2	11.6 ± 2.1	0.28
RPE at Lap 10	13.6 ± 2.7	14.1 ± 2.5	0.49	14.0 ± 2.8	13.4 ± 2.4	0.43
Lap 2 Completion Time	30.9 ± 5.8	35.0 ± 6.0	0.01	30.4 ± 5.4	36.3 ± 5.8	<0.001
Lap 9 Completion Time	31.2 ± 6.6	36.7 ± 6.3	0.003	30.9 ± 5.7	38.0 ± 6.8	<0.001
Time Difference Between Laps 2 and 9	0.4 ± 1.7	1.7 ± 2.4	0.02	0.5 ± 1.8	1.6 ± 2.4	0.05
Usual-paced 400m Walk						
Warm-Up Completion Time (Seconds)	73.4 ± 11.1	76.6 ± 9.0	0.28	71.7 ± 9.6	80.3 ± 11.2	0.003
400m Completion Time	375.0 ± 60.7	395.7 ± 46.6	0.08	363.3 ± 49.1	411.2 ± 56.2	0.001
RPE at Lap 4	9.8 ± 2.2	10.7 ± 2.6	0.17	9.9 ± 2.2	10.6 ± 2.7	0.32
RPE at Lap 10	10.9 ± 2.2	12.3 ± 3.1	0.06	11.2 ± 2.3	11.9 ± 3.4	0.35
Lap 2 Completion Time	36.5 ± 6.6	39.2 ± 4.9	0.09	35.7 ± 5.4	40.9 ± 6.0	0.001
Lap 9 Completion Time	36.9 ± 6.2	39.6 ± 4.9	0.08	36.3 ± 5.0	41.2 ± 60.0	0.002
Time Difference Between Laps 2 and 9	0.5 ± 2.1	0.4 ± 1.4	0.94	0.6 ± 2.1	0.2 ± 1.2	0.48
Difference Between Fast and Usual 400m Walks	56.8 ± 29.7	32.8 ± 28.0	0.003	53.6 ± 30.9	35.1 ± 28.6	0.03