

LONG DISTANCE CORRIDOR WALK TEST OF EXERCISE TOLERANCE

1. Background and Rationale

Insufficient cardiovascular fitness may be a major mechanism through which different behaviors and diseases contribute to functional decline; a key landmark on the pathway from independence to disability. As substantial decline in exercise tolerance may precede recognition of mobility-related difficulty, particularly in sedentary individuals, low exercise tolerance may be an early indicator of impending functional limitation.

Although maximum treadmill-based testing with measured oxygen consumption is considered the “gold-standard” method for ascertaining exercise tolerance and cardiovascular fitness, this approach may be unsuitable for many older adults. With increasing age the proportion of even apparently healthy ambulatory older persons who can satisfactorily complete a treadmill exercise test, decreases markedly, from 30% in those aged 75 to 79 years, to 25% in persons aged 80 to 84 years, to 9% for those over 85 years.¹ This situation is especially problematic in longitudinal studies of the aging process in which change in fitness and exercise capacity with age and disease progression are of great interest.

Self-paced corridor-based walking tests constitute a reliable and valid alternative to maximal treadmill-based assessments. Corridor walking is more natural and acceptable to older adults²⁻⁴ and is less likely to introduce biomechanical inefficiencies.⁵ Several purported disadvantages of self-paced walking tests relative to graded treadmill-based tests, including a low test ceiling,⁴⁻⁶ influence of subject motivation,⁷ and steep learning effects,^{7,8} can be diminished by adding a warm-up walk and using a target distance rather than time.⁹ The warm-up increases total testing time, allows some practice and provides a reference pace from which subjects can increase.

The Long Distance Corridor Walk (LDCW), a two-stage walking-based test of exercise tolerance and fitness level, developed for use in the Health ABC study, was designed to minimize shortcomings associated with self-paced walking tests.⁹ Key features consist of a 2-minute warm-up walk, in which the first 20 meters is timed, that also serves as a stepped-down test and the focus on distance (400m) in the second stage instead of time (e.g., 6 minutes). Four hundred meters is about the distance an average healthy older adult can cover in 6 minutes and is comparable to the reference distance (1/4 mile) of a commonly used self-report measure of mobility-related difficulty.

A recent report provides evidence of a strong association between time to complete the 400-meter component of the LDCW and presence of subclinical and clinical cardiovascular disease as well as physical activity level.¹⁰ Another report¹¹ provides

further validation by demonstrating a correlation of 0.85 between time to walk 400 meters “as quickly as possible” and VO₂max in persons aged 60 to 90 years.

1.1 Objective (*research objective in using this particular assessment approach*)

The primary objective of including a self-paced corridor walk test of exercise tolerance is to obtain an estimate of cardiovascular fitness at the lower end of the functional spectrum and to provide continuity of measurement of exercise tolerance as participants in the BLSA become unable to successfully complete maximal treadmill-based testing of VO₂max due to health and/or physical problems. The LDCW will facilitate examination of change over time, particularly loss of capacity with advanced age. In addition, by recording lap time during the 400 meter component, we hope to discriminate walking patterns – speeds-up, steady, and slows-down – and relate these to specific health conditions, such as knee and/or hip osteoarthritis and cardiovascular disease.

1.2 Recommended Protocol(s)

The Long Distance Corridor Walk (LDCW) developed for and field tested in the Health, Aging and Body Composition (Health ABC) study is the recommended protocol.

1.2.1 Strengths and weaknesses of selected approach

The LDCW has been validated against maximal treadmill-based testing with measured oxygen consumption in BLSA participants aged 60 to 91 years.¹¹ Comparable data now exists for persons aged 70 through 85 years participating in Health ABC.

1.2.2 Analogous (past) measures used in the BLSA (including time periods covered)

Treadmill-based assessment of exercise tolerance with or without measured oxygen consumption, beginning around 1978 through the present.

1.2.3 Reliability/Validity Studies

See references 9 through 11.

1.2.4 Key Variables (*to be obtained*)

Continuous: time to walk 400 meters, estimated VO₂max, gait speed over a long distance, heart rate and blood pressure response to exercise.

Categorical: capacity to walk 400 meters with or without symptoms, symptoms experienced while walking as quickly as possible, fitness category (e.g., very low, low, moderate, high, very high), walking pattern (speeds-up, steady, slows-down).

2. Equipment and Supplies

- Heart rate monitor (Polar A1)
- 2 fluorescent orange traffic cones
- White cloth tape (for start/stop line)
- 10 cm-length tape to mark every meter between cones (on wall if possible)
- Digital stopwatch
- Conventional mercury sphygmomanometer*
- Blood pressure cuffs (small, regular, large and thigh cuffs)*
- Stethoscope: standard stethoscope and earpieces with bell, tubing no longer than 14 inches*

*See Blood Pressure chapter for maintenance of Blood Pressure equipment

2.1 Use and Maintenance of Heart Rate Monitor

- Wet the electrodes with water on the two grooved rectangular areas on the underside of the belt transmitter.
- Secure the belt transmitter as high under the participant's pectoral muscles as is comfortable.
- Have the participant wear the wrist receiver.

To begin using the monitor:

- Depress the button on the bottom of the wrist receiver face.
- The heart symbol will begin to pulse.
- After 5 seconds the heart rate will appear on the display.

At test completion:

- Immediately after the participant stops walking, depress the button on the bottom of the wrist receiver face to obtain the ending heart rate.
- Record this rate immediately (before you forget) as the receiver display will automatically begin to scroll through and provide the average heart rate, total exercise time, then OFF.

Care and maintenance: The belt transmitter will automatically activate when secured around the chest when the two grooved electrode areas are properly moistened. The

transmitter will shut off automatically when removed. Clean with mild soap and water between participants to remove perspiration residue. Do not use any other cleaning solution as damage to the unit may occur. Dry the transmitter with a soft towel. Remove the wrist receiver and wipe off any moisture. Store the heart rate monitor in a clean, dry place.

When the battery runs out, send the wrist receiver to an authorized Polar Service Center: 1-800-227-1314

2.2 Use and Maintenance of Stopwatch

For easy access, the examiner should wear the stopwatch around his/her neck. To use the stopwatch (pictured below), first press the middle (mode) button at the top to get into stopwatch mode. The primary or large display should read **00'00"00**. The secondary or top, smaller display should read [**0**]00'00" 00. To begin timing, depress the right-hand button labeled **START/STOP** at the top of the stopwatch and press again to stop. The total time will appear on the primary display as minutes'seconds''hundredths of a second. Record this time. When taking a split time (e.g., for the first 20 meters), depress the left-hand button labeled **SPLIT/RESET** bottom. The split time will flash for a 10 seconds on the primary display before the running time reappears. After the flashing stops, the top/secondary display will show the running time for the current split. The top display should have the number 2 in the brackets [**2**]. To stop timing, depress the **START/STOP** button. The total time will appear in the primary/large display on the stopwatch. Record this time for the full test. To get the time for the first part of the test (if required), depress the mode button at the top center of the stopwatch. The secondary/top display should have the number 1 in the brackets [**1**]. Record this time for the first part of the testing (e.g., time to complete 20 meters). To get the display to read **00'00"00** again, depress the mode button repeatedly until you get back to the lap time and then press **SPLIT/RESET**.



3. Safety Issues and Exclusions

If there is a borderline or unclear answer to an exclusion question the final decision to test rests with the medical supervisor. For participant safety, presence of any of the following is cause for exclusion from the any part of the LDCW or the 400 meter component.

Conditions determined by:

Ability to walk 6 meters: Participants unable to complete either the usual or rapid pace 6-meter walk without a walking aid are excluded from both the 2-minute and 400-meter components of the LDCW. Record that the participant did not complete either walk due to “excluded, unable to walk 6 meters unaided.”

ECG abnormality hardcopy references and radial pulse: Before administering the LDCW, check the participant’s ECG reading to determine if any of the following abnormalities were identified:

- Heart rate <40 (bradycardia) or >135 (tachycardia)
- Atrial fibrillation or atrial flutter (new onset)
- Wolff-Parkinson-White (WPW) or ventricular pre-excitation
- Idioventricular rhythm
- Ventricular tachycardia
- Third degree or complete A-V block
- Any statement including reference to acute injury or acute ischemia, or marked T-wave abnormality

If any of these conditions are present, record that the participant did not complete either walk due to “excluded, ECG abnormality.”

Standing blood pressure: Consult standing blood pressure data collected earlier in the clinic visit. If SBP >199 mmHg or DBP > 109 mmHg, record that the participant did not complete either walk due to “excluded, substantially elevated systolic or diastolic blood pressure.”

Requires walking aid: Some participants who complete the short walks without a walking aid, may be uncomfortable and /or unwilling to attempt a longer walk without their walking aid. If this situation occurs, record that the participant did not complete either walk due to, “excluded, requires walking aid.”

Response to screening questions: The LDCW data collection form includes a series of standardized questions related to recent cardiac events, surgeries, treatments, and symptomatology. Participants who report: myocardial infarction, angioplasty, or heart surgery within the past 3 months, are excluded from all components of the LDCW. Record that the participant did not complete either walk due to “excluded, recent cardiac surgery or event.” Participants who report: new or worsening symptoms of chest pain or angina during the past 3 months are excluded from the 400 meter walk, but should be administered the 2-minute walk. For the 400 meter walk, record that the participant did not complete it due to, “excluded, recent increased cardiac symptoms.”

Elevated or low heart rate from heart rate monitor: Immediately prior to testing, after the heart rate monitor has been secured on the participant and the start button depressed, record the participant’s heart rate. If the heart rate is greater than 110 or less than 40, do not administer the LDCW. Record that the participant did not complete either walk due to “excluded, heart rate from monitor < 40” or “excluded, heart rate from monitor > 110”.

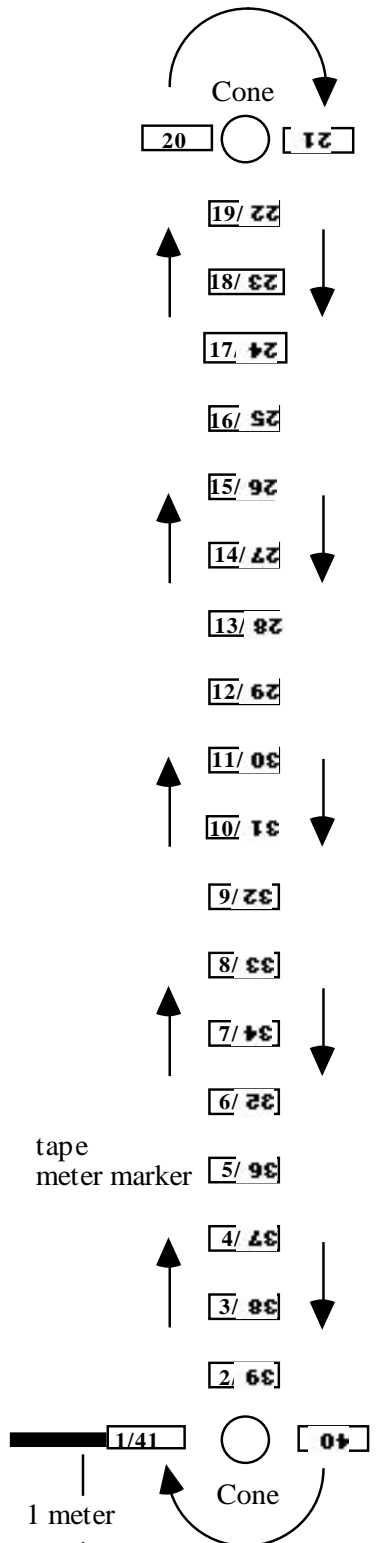
Assessment during/after the 2-minute walk: Participants cleared to initiate the LDCW may experience difficulties or symptoms during the 2-minute walk component. If any of the following should occur during or immediately following the 2-minute walk: heart rate < 40 bpm, heart rate exceeds 90% of estimated maximum heart rate for age ($.9 \times (220 - \text{age in years})$) or 135 bpm, if aged 70 years or older), or participant reports chest pain, tightness, or pressure; shortness of breath, feeling lightheaded, dizzy, or faint; or experiencing leg or any other pain during the 2-minute walk, do not administer the 400 meter walk. For the 400 meter walk, record that the participant did not complete it due to “excluded, elevated heart rate or symptoms during 2-minute walk.”

Stopping rules for the 400-meter walk: The above stopping criteria apply to both the 2-minute and 400-meter walks. If possible, the test should not be stopped cold. Tell the participant to slow down, quickly approach the participant, record heart rate, time, distance, and blood pressure. If necessary, bring a chair to the participant. Record reason for stopping the 400-meter walk on the data collection form.

If the heart rate exceeds 90% of estimated maximum heart rate for age ($.9 \times (220 - \text{age in years})$) or 135 bpm, if aged 70 years or older), tell the participant to slow down, but continue walking the full 400 meters. If the participant indicates they are not feeling well (e.g., reports other symptoms), discontinue the test. Indicate on the data collection form that the heart rate exceeded 90% of the estimated maximum during the 400 meter walk and whether the participant completed the 400 meter walk or not. If the participant is not feeling well after the heart rate has exceeded 90% of the estimated maximum, notify the medical supervisor immediately.

4. Participant and Exam Room Preparation

COURSE ILLUSTRATION



Footwear: To reduce the effect of different footwear on test performance, the LDCW should be performed in tennis shoes or comfortable walking shoes with minimal or no heels. The participant should be instructed during the pre-visit instructions to wear or bring comfortable walking shoes to the clinic.

Course set-up: For consistency, the walking course length will be 20 meters and should be laid out in an unobstructed, dedicated corridor. Use fluorescent orange traffic cones to indicate the beginning and end of the 20-meter length. Measuring from the center of each cone, place the cones 19 meters apart (to allow for a 1 meter turn at each end). Place a 1/2 meter length of white cloth tape across the floor to the left of one of the cones to mark the start of the course. Participants are to walk in the clockwise direction. Place a numbered (as in course illustration) 10 cm length of tape marking every meter between the cones. The tape should be placed to the inside of the walking path, along the cone line, as illustrated.

5. Detailed Measurement Procedures (*include estimated preparation and administration time and frequency of repeat administration (e.g. every visit, every 3 to 4 years)*)

For most BLSA participants, full administration of the LDCW including administration of the screening questions, placement of the heart rate monitor and detailed instructions should take no longer than 20 minutes. This test is intended to be administered every visit.

5.1 Assessment of test eligibility and exclusion criteria.

1) Record standing blood pressure taken earlier in the clinic visit on the LDCW eligibility assessment form. *If the systolic blood pressure is > 199 mmHg and/or the diastolic blood pressure is > 109 mmHg, do not administer the 2-minute or the 400-meter walking tests.*

2) Examine ECG hard copy references for any of the following abnormalities that preclude testing: *heart rate less than 40 bpm, or greater than 135 bpm, Wolff-Parkinson-White (WPW) or ventricular pre-excitation, idioventricular rhythm, ventricular tachycardia, third degree or complete A-V block, or any statement including reference to acute injury or ischemia, or marked T-wave abnormality.*

3) Provide a brief, general description of the LDCW and then ask the participant the exclusion questions provided on the first page of the LDCW data collection form.

Script: “The next tests assess your physical fitness by having you walk quickly for 2 minutes and after that, having you walk about 1/4 mile at a steady pace.”

Script: “First I need to ask you a few questions to see if you should try the test.

“Within the past 3 months: Have you had a heart attack (angioplasty, heart surgery)?”

If the answer is “yes” to any of the above questions do not administer the LDCW.

“Within the past 3 months, have you seen a health professional or thought about seeing a health professional for new or worsening symptoms of chest pain (angina)?”

If the answer is “yes” to any of the second set of questions, administer the 2-minute walk component only.

4) Attach the heart rate monitor (see section 2 above):

Describe what the heart rate monitor does and why we are using it and attach it to the participant.

Script: “This device measures your pulse, or how often your heart beats.”

If the *heart rate on the monitor is below 40 bpm or above 110 bpm*, ask the participant to sit down. After 5 minutes, recheck the heart rate. If still below 40 bpm or above 110 bpm, do not perform the test.

5) Describe the testing procedure, demonstrate how to walk around the cone, and provide instructions about what to do if symptoms occur.

Script: “This walking test has two parts. For the first part, I want you to walk for 2 minutes, trying to cover as much ground as possible at a pace you can maintain. Starting at the line labeled START, walk to the cone at the other end of the hall, go around it and return, go around this cone, just like this and keep walking in the same fashion, until 2 minutes are up. When the 2 minutes are up I will tell you to stop. Please stay where you are so that I can record the distance you covered.”

Script: “Please tell me if you feel any chest pain, tightness or pressure in your chest, if you become short of breath or if you feel faint, lightheaded or dizzy, or if you feel knee, hip, calf, or back pain. If you feel any of these symptoms, you may slow down or stop. Do you have any questions?”

5.2 2-minute walk administration.

1) Escort participant to the START line

2) Record the participant’s heart rate.

3) Ready the stopwatch.

Script: “Now let’s start the 2-minute walk. Cover as much ground as possible at a pace you can maintain. Ready? GO.”

4) Start timing with the first footfall over the starting line (when the participant’s foot touches the floor on the first step). Provide standard encouragement after each lap and tell participant how much time is remaining.

Suggested Scripts: “Keep up the good work.” “You are doing well.” “One and a half minutes to go.”

5) Throughout the test, draw a line through the number on the form that corresponds to each completed lap the participant walks.

When the stopwatch reads '1:30,' tell the participant, "30 seconds remaining." At 1:50, tell the participant "10 seconds remaining." Approach the participant so that you meet them at the 2:00 stop time.

6) When the stopwatch reads 2:00, say,

Script: "STOP."

Record heart rate, number of laps and meter mark on form (each meter is marked with tape on the floor. Please see diagram).

If the participant is not going on to the 400-meter walk due to stopping rules, record the reason and remove the heart monitor. If the participant stops during the 2-minute walk due to stopping rules, mark the box that indicates that the 2-minute walk was stopped, and record the reason on both the 2-minute walk section of the LDCW data collection form and the 400-meter walk section.

If a participant experiences symptoms after completing the 2-minute walk that are a contraindication for the 400-meter walk, complete the 2-minute walk portion of the form as usual. For the 400-meter walk, record "did not attempt due to symptoms during 2-minute walk."

5.3 400-meter walk administration.

1) Accompany participant to the START line and record the participant's heart rate.

2) Describe the 400-meter walk.

Script: "For the second part, you will be walking 10 complete laps around the course, about 1/4 mile. Please walk as quickly as you can, without running, at a pace you can maintain over the 10 laps. After you complete the 10 laps I will tell you to stop, and measure your blood pressure and heart rate."

"Start walking when I say 'GO' and try to complete 10 laps as quickly as you can, without running, at a pace you can maintain. Ready? Go."

3) Start the stopwatch and depress the SPLIT/RESET button when the participant completes each lap (first foot fall over the start/finish line). Record the time shown on the small/upper display for each lap (see use of stopwatch, above). After the participant

completes the LDCW, check the times recorded by scrolling through the lap splits displayed on the watch face.

4) Offer standard encouragement every lap, and call out the number of laps completed and the number remaining (e.g., 4 down, 6 to go). Record each lap on form.

Suggested Script: “Keep up the good work.” “You are doing well.” “Looking good.” “Well done.” “Good job.”

5) When the participant completes 400-meters (10 laps, first footfall across the finish line), stop the stopwatch.

6) If the participant’s heart rate exceeds 90% of estimated maximum heart rate for or 135 bpm if over age 70 and they have no other symptoms, tell them to slow down, but continue walking. Indicate on the data collection form that the heart rate exceeded 135 bpm during the 400 meter walk and whether the participant completed the 400 meter walk or not. If the participant reports chest pain, tightness or pressure in the chest, shortness of breath, feeling faint, lightheaded or dizzy, or reports leg or any other pain, stop the test. Record the reason on the 400-meter walk section of the LDCW data collection form. Record the number of laps that were completed and the number of meters.

7) Record time and heart rate. Restart the stopwatch to time the 2-minute recovery time.

8) Assess blood pressure. *(For instructions and certification requirements necessary to take blood pressure, please refer to the blood pressure chapter of the BLSA Operations Manual.)*

9) At 2 minutes, while the participant remains standing after the blood pressure assessment, record heart rate again.

10) Remove the heart rate monitor.

6. Procedures for Performing the Measurement at Home

Not applicable

7. Alert Values/Follow-up/Reporting to Participants

If the participant develops chest pain or other symptoms, the clinic supervisor should be notified immediately.

8. Quality Assurance

8.1. Training Requirements

Clinical experience with blood pressure measurement is required. Examiners must follow the training procedures for blood pressure and be certified in blood pressure measurement. Training should also include:

- Read and study manual
- Attend BLSA training session on techniques (or observe administration by experienced examiner)
- Practice on volunteers
- Discuss problems and questions with local expert or QC officer

8.2. Certification Requirements

- Complete training requirements
- Recite ECG exclusion criteria
- Recite other exclusion criteria and stopping rules
- Conduct exam on two participants while being observed by QC officer using QC checklist

8.3. Quality Assurance/Certification Checklist

Preparation

- Checks for abnormal ECG
- Records heart rate after taking radial pulse measurement
- Refers to Blood Pressure recorded on eligibility assessment form (SBP>199 mmHg &/or DBP> 109 mmHg exclusion
- Asks if participant has had a heart attack, angioplasty or heart surgery in the past 3 months
- Asks if participant has seen or thought about seeing a health professional for new or worsening symptoms of chest pain, or angina during the past 3 months
- Clearly delivers key points from script for each test
- Heart rate measured properly
- Correctly demonstrates walking the course (around the cone)
- Correctly describes the test
- Explains stop symptoms

- Reviews form for completeness

2-Minute Walk

- Records participant's heart rate
- Instructs participant to walk at a pace they can maintain
- Encourages participant every lap
- If heart rate exceeds the pre-determined stop value, stops test; has participant rest and restarts test after 5 minutes. If the heart rate remains elevated the second time, tells the participant to slow down, but continue walking.
 - After 2 minutes:
 - Says "Stop"
 - Records number of laps completed and meter mark
 - Records heart rate (if above predetermined safe level or <40 bpm, do not go on to 400 m walk)
 - Records whether or not the heart rate exceeded predetermined safe level
 - Records whether or not the participant completed the walk and if not, why not
 - Reviews form for completeness

400-m Walk

- Stops and clears stop watch and lap counter after 2-minute walk
- Instructs participant to start walking and to try to complete 10 laps as quickly as possible without running at a pace they can maintain for the complete course
- Provides standard encouragement every lap
- After 10 laps completed:
 - Stops watch and records time and heart rate
 - Measures and records blood pressure properly

After Testing Completed

- Records heart rate at 2 minutes
- Removes heart monitor
- Records whether or not the participant completed the walk and if not, why not
- Asks participant whether they had symptoms and records answers on data collection form
- Reviews form for completeness
- Correctly completes form

9. References

1. Gill TM, DiPietro L, Krumholz HM. Role of exercise stress testing and safety monitoring for older persons starting an exercise program. *JAMA*. 2000;284:342-349.
2. Peeters P, Mets T. The 6-minute walk as an appropriate exercise test in elderly patients with chronic heart failure. *J Gerontol Med Sci* 1996;51A:M147-M151.
3. Guyatt GH, Sullivan MJ, Thompson PJ, et al. The 6-minute walk: a new measure of exercise capacity in patients with chronic heart failure. *Can Med Assoc J* 1985;132:919-923.
4. Lipkin DP, Scriven AJ, Crake T, Poole-Wilson PA. Six minute walking test for assessing exercise capacity in chronic heart failure. *Br Med J* 1986;292:653-655.
5. Swerts PMJ, Mostert R, Wouters EFM. Comparison of corridor and treadmill walking in patients with severe chronic obstructive pulmonary disease. *Phys Ther* 1990;70:439-442.
6. McGavin CR, Gupta SP, McHardy GJR. Twelve-minute walking test for assessing disability in chronic bronchitis. *Br Med J* 1976;1:822-823.
7. Bittner V, Weiner DH, Yusuf S, et al. Prediction of mortality and morbidity with a 6-minute walk test in patients with left ventricular dysfunction. *JAMA* 1993;270:1702-1707.
8. Swinburn CR, Wakefield JM, Jones PW. Performance, ventilation, and oxygen consumption in three different types of exercise test in patients with chronic obstructive lung disease. *Thorax* 1985;40:581-586.
9. Simonsick EM, Montgomery PS, Newman AB, Bauer DC, Harris T. Measuring fitness in healthy older adults: The Health ABC long distance corridor walk. *J Am Geriatr Soc* 2001;49:1544-1548.
10. Newman AB, Haggerty CL, Kritchevsky SB, Nevitt MC, Simonsick EM. Walking performance and cardiovascular response: Associations with age and morbidity – The Health ABC study. *J Gerontol Med Sci* 2002;58A:715-720.
11. Simonsick EM, Fan E, Ahmed S, Fleg J. Estimating fitness in older adults: Treadmill validation of a self-paced walking test. American College of Sports Medicine, June 2001, Baltimore, MD