



Review Article

## Normative reference values for the two-minute walk test derived by meta-analysis

RICHARD W BOHANNON, PT, EdD<sup>1)</sup>

<sup>1)</sup> Department of Physical Therapy, College of Pharmacy and Health Sciences, Campbell University, Lillington, NC, USA

**Abstract.** [Purpose] This meta-analysis was undertaken to establish normative reference values for the two-minute walk test. [Methods] Three database searches and a hand search were conducted. Meta-analysis was used to consolidate two-minute walk test data stratified by gender and age group. [Results] Data from four articles was consolidated. Normative two-minute walk test distances varied from 150.3 m (women, 70 to 79 years) to 217.9 m (men, 20 to 29 years). [Conclusion] Normative reference values derived using meta-analysis should provide a better standard than individual studies for interpreting the two-minute walk test performance of adults.

**Key words:** Walk test, Exercise capacity, Norms

(This article was submitted Aug. 29, 2017, and was accepted Sep. 25, 2017)

### INTRODUCTION

Walk tests are widely used as a means of quantifying functional exercise capacity<sup>1)</sup>. The duration of the tests varies, but the six minute duration has been recommended by the American Thoracic Society<sup>2)</sup>. Their recommendation notwithstanding, many individuals have difficulty walking for such a long period of time. As a consequence, shorter walk tests, the two-minute walk test (2MWT) in particular, are being used increasingly.

Interpretation of 2MWT distances achieved by individuals and groups requires that normative reference values are available. Several studies have purported to provide reference values or equations for the 2MWT<sup>3–5)</sup>. Other studies contain data that may be informative as to “normal” performance on the 2MWT<sup>6–8)</sup>. Together, these studies have the potential to provide normative reference values that are more informative than data of any one study alone. The purpose of this study, therefore, was to use meta-analysis to determine normative reference values for the 2MWT. The study focused on adults.

### METHODS

Three electronic databases (PubMed, CINAHL, and Scopus) were searched for studies reporting normative reference values for the 2MWT. The search was conducted on June 30, 2017 and involved the search string “two minute walk test” OR “2 minute walk test.” Thereafter, a hand search was conducted using article reference lists and personal files.

Consideration for inclusion required that a study reported 2MWT distances for healthy adults. Based on previous research showing that 2MWT distance is influenced by gender and age<sup>3–5)</sup>, studies were excluded if they did not stratify 2MWT distance by gender and decade of age or if 2MWT distance so stratified could not be obtained from the authors.

In addition to information on 2MWT distance, potentially relevant studies were scrutinized for information on the sample of adults tested, the walking course used, and instructions/feedback provided. The Comprehensive Meta-analysis (3.0) program was used to consolidate 2MWT distance data for each populated stratum (eg, 70 to 79 year old men) across studies. A random-effects model was used. Homogeneity was described by  $I^2$ .

Corresponding author. Richard W Bohannon (E-mail: bohannon@campbell.edu)

©2017 The Society of Physical Therapy Science. Published by IPEC Inc.



This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial No Derivatives (by-nc-nd) License. (CC-BY-NC-ND 4.0: <http://creativecommons.org/licenses/by-nc-nd/4.0/>)

The quality of included studies was graded using a custom 6-item (10 point) checklist. Similar checklists have been used previously in descriptive meta-analyses<sup>9</sup>.

## RESULTS

Figure 1 is a flowchart illustrating how 143 articles were culled from an initial 147 unique articles to yield 4 studies for inclusion in meta-analysis. Table 1 summarizes study specifics. The included studies contributed data from 40 to 3,075 participants who resided in the United States or India. All studies involved out-and-back courses with distances of 15.2 to 30.0 meters. The instructions indicated that participants should “cover as much ground as possible” or “walk as fast as you can.” Feedback was indicated in two studies; that is, “you are doing well” and 1 minute was left or remaining.

Table 2 summarizes 2MWT distances by study and stratum. The 12 strata incorporated data from 2 to 4 studies and 94 to 1209 individuals. The 2MWT distance varied by study and stratum, but overall it was greatest for 20 to 29 year old men (217.9 meters) and least for 70 to 79 year old women (150.3 meters).

Quality ratings (Table 3) ranged from 6 to 9 out of 10 possible points. Scores were limited by inadequate descriptions of the tested samples and of the 2MWT task.

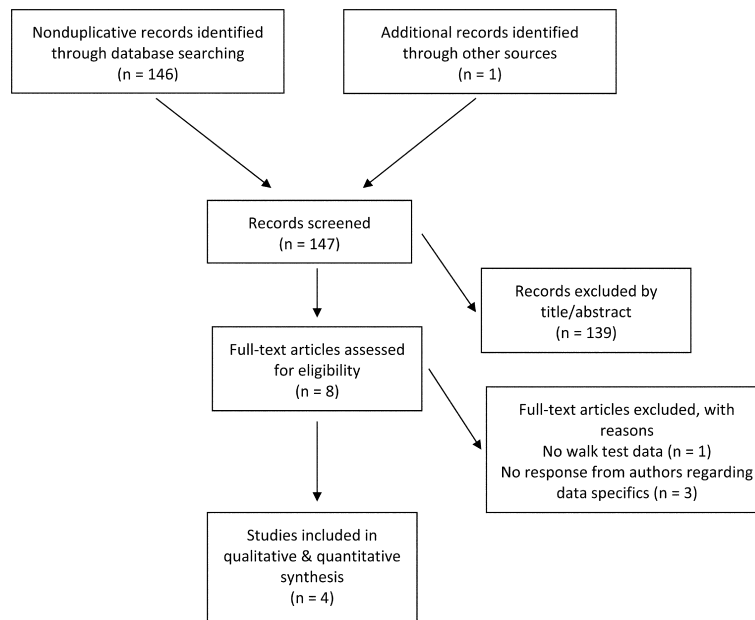


Fig. 1. PRISMA flowchart illustrating selection of articles for meta-analysis.

Table 1. Summary of four studies included in meta-analysis

Study	Sample	Course	Instructions/Feedback
Bohannon (2017) PhyStat 7	Community-dwelling adults (n=40) [United States]	Out-and-back (15.2 m)	“Cover as much ground as possible without running.” “You are doing well, you have 1 min remaining.”
Bohannon (2015) NIH Toolbox	Community-dwelling adults (n=1185) [United States]	Out-and-back (15.2 m)	“Walk as fast as you can.” “You are doing well, you have 1 min left.”
Priya & Verma (2015)	Healthy adults (n=300) [India]	Out-and-back (30.0 m)	Not stated
White et al. (2014) Health ABC	Well-functioning older adults (n=3,075) [United States]	Out-and-back (20.0 m)	“Cover as much ground as possible.”

## DISCUSSION

The intent of this study was to use meta-analysis to generate normative reference values for the 2MWT. The analysis was limited to adults whose data could be used to provide reference values for gender and age group strata. As the reference values derived in this study were based on multiple studies and relatively large total sample sizes, they should provide a better indication of normative performance than any one original study alone. The  $I^2$  values, which with 2 exceptions were all less than 40.0%, suggest that the data were homogeneous within strata and inter-study data consolidation was justified.

Like previous individual studies of the 2MWT, the present meta-analysis demonstrated that men walked further than women and younger age groups walked further than older age groups<sup>3-5</sup>). This is validating, as is the finding that normative walking distances derived in this meta-analysis are greater than the mean 2MWT distances reported for older adults residing in long-term care (77.4 m)<sup>10</sup> and comparably aged adults with various pathologies or conditions: lower limb amputations (27.9 m)<sup>11</sup>, chronic stroke (58.5 m)<sup>12</sup>, late-onset sequelae of poliomyelitis (136.0 m)<sup>13</sup>, cardiac disease (138.0 m)<sup>14</sup>, and chronic obstructive pulmonary disease (150.0 m)<sup>15</sup>.

This study had several limitations, the principal being the limited number of studies contributing data to the analysis. This limitation was in part unavoidable; it stemmed from the small number of studies actually reporting 2MWT data. Nevertheless, it was aggravated by the inability to obtain necessary information from investigators who collected the required 2MWT data<sup>5, 7</sup>) but did not respond to requests for summary data stratified by gender and age group. Another limitation of this study was the lack of diversity in the nationality of participants in the studies contributing to it. A broader range of participant groups will be required if factors other than gender and age group are to be addressed.

For the time being, the normative reference values provided herein may prove useful for interpreting the 2MWT performance of adult men and women. However, the full value of the 2MWT will not be realized until normative reference values from multinational population based studies are completed.

**Table 2.** Summary of two-minute walk test distance stratified by gender and age from four studies

Group (n)	Bohannon (2017) Mean (SD) [n]	Bohannon, et al. (2015) Mean (SD) [n]	Priya & Verma (2015) Mean (SD) [n]	White et al. (2014) Mean (SD) [n]	Consolidated		
					Weighted Mean (SE) [n]	95% CI	$I^2$
Men 20–29	219.6 (25.0) [10]	210.2 (28.8) [67]	225.4 (26.4) [31]		217.9 (5.4) [108]	207.2–228.6	0.00
Women 20–29	203.2 (15.3) [10]	180.7 (24.9) [171]	199.9 (24.4) [22]		194.1 (8.4) [203]	177.7–210.5	0.00
Men 30–39		201.4 (29.7) [74]	204.2 (28.3) [24]		202.1 (3.0) [98]	196.3–207.9	0.00
Women 30–39		181.8 (27.1) [215]	179.3 (26.0) [33]		181.4 (1.7) [248]	178.1–184.8	0.00
Men 40–49		191.1 (30.1) [85]	194.6 (27.9) [31]		192.1 (2.7) [116]	186.8–197.5	0.00
Women 40–49		183.3 (29.4) [151]	170.3 (18.3) [38]		180.7(10.4) [189]	160.3–201.0	0.00
Men 50–59		189.1 (28.7) [73]	190.9 (20.4) [25]		189.8 (2.6) [98]	184.7–194.9	0.00
Women 50–59		178.8 (22.6) [99]	158.8 (24.1) [31]		169.1 (10.0) [130]	149.6–188.7	0.00
Men 60–69	219.5 (28.7) [4]	177.3 (34.2) [60]	174.9 (19.4) [30]		183.0 (7.0) [94]	169.3–196.8	61.3
Women 60–69	184.5 (25.0) [6]	161.9 (29.7) [75]	151.7 (25.9) [18]		163.7 (6.9) [99]	150.0–177.3	36.5
Men 70–79	183.9 (27.2) [6]	164.4 (30.1) [59]	138.7 (28.2) [13]	167.7 (30.1) [1,131]	163.1 (5.3) [1,209]	152.7–173.5	55.1
Women 70–79	166.3 (29.6) [4]	145.4 (27.5) [56]	153.3 (16.2) [4]	150.7 (27.9) [1,124]	150.3 (1.3) [1,188]	147.7–152.9	0.00

**Table 3.** Quality ratings of four studies included in the meta-analysis

Study	Sample Described (2)	Inclusion/Exclusion (2)	Task Described (3)	Measurement Described (1)	Summary Statistics (1)	Reliability (1)	Total (10)
Bohannon (2017)	1	2	3	1	1	1	9
Bohannon (2015)	1	2	3	1	1	1	9
Priya & Verma (2015)	0	2	1	1	1	1	6
White et al. (2014)	2	2	2	1	1	1	9

\*Items and scoring: 1) Sample adequately described: type, enrollment noted as consecutive or timeframe indicated, 2) Participant inclusion/exclusion criteria explicit, 3) Task described: instructions, feedback, course, 4) Measurement adequately described: criterion measure 5) Summary statistics (mean/median, SD/SE/range/ confidence intervals) provided, 6) Reliability of measures reported.

## Conflicts of interest

The author has no conflicts of interest to declare.

## REFERENCES

- 1) Riebe D (editor): ACSM's Guidelines for Exercise Testing, 10th ed. Philadelphia: Wolters Kluwer, 2018, p 139.
- 2) ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories: ATS statement: guidelines for the six-minute walk test. *Am J Respir Crit Care Med*, 2002, 166: 111–117. [[Medline](#)] [[CrossRef](#)]
- 3) Bohannon RW, Wang YC, Gershon RC: Two-minute walk test performance by adults 18 to 85 years: normative values, reliability, and responsiveness. *Arch Phys Med Rehabil*, 2015, 96: 472–477. [[Medline](#)] [[CrossRef](#)]
- 4) Priya TK, Verma S: A study to determine reference values for two minute walk distance in healthy Indian adults. *Int J Physiother Res*, 2015, 3: 1208–1214. [[CrossRef](#)]
- 5) Selman JP, de Camargo AA, Santos J, et al.: Reference equation for the 2-minute walk test in adults and the elderly. *Respir Care*, 2014, 59: 525–530. [[Medline](#)] [[CrossRef](#)]
- 6) White DK, Neogi T, King WC, et al. Health ABC study: Can change in prolonged walking be inferred from a short test of gait speed among older adults who are initially well-functioning? *Phys Ther*, 2014, 94: 1285–1293. [[Medline](#)] [[CrossRef](#)]
- 7) Mulla AS, Varghese J: A study to investigate test-retest reliability of two minute walk test to assess functional capacity in elderly population. *Indian J Physiother Occup Ther*, 2015, 9: 108–113. [[CrossRef](#)]
- 8) Bohannon RW: The PhyStat 7. A new test battery for characterizing the physical status of older adults. *Top Geriatr Rehabil*, 2017, 33: 84–88. [[CrossRef](#)]
- 9) Bohannon RW, Crouch R: Minimal clinically important difference for change in 6-minute walk test distance of adults with pathology: a systematic review. *J Eval Clin Pract*, 2017, 23: 377–381. [[Medline](#)] [[CrossRef](#)]
- 10) Connelly DM, Thomas BK, Cliffe SJ, et al.: Clinical utility of the 2-minute walk test for older adults living in long-term care. *Physiother Can*, 2009, 61: 78–87. [[Medline](#)] [[CrossRef](#)]
- 11) Brooks D, Parsons J, Hunter JP, et al.: The 2-minute walk test as a measure of functional improvement in persons with lower limb amputation. *Arch Phys Med Rehabil*, 2001, 82: 1478–1483. [[Medline](#)] [[CrossRef](#)]
- 12) Hiengkaew V, Jitree K, Chaiyawat P: Minimal detectable changes of the Berg Balance Scale, Fugl-Meyer Assessment Scale, Timed “Up & Go” Test, gait speeds, and 2-minute walk test in individuals with chronic stroke with different degrees of ankle plantarflexor tone. *Arch Phys Med Rehabil*, 2012, 93: 1201–1208. [[Medline](#)] [[CrossRef](#)]
- 13) Stolwijk-Swüste JM, Beelen A, Lankhorst GJ, et al. CARPA study group: SF36 physical functioning scale and 2-minute walk test advocated as core qualifiers to evaluate physical functioning in patients with late-onset sequelae of poliomyelitis. *J Rehabil Med*, 2008, 40: 387–394. [[Medline](#)] [[CrossRef](#)]
- 14) Brooks D, Parsons J, Tran D, et al.: The two-minute walk test as a measure of functional capacity in cardiac surgery patients. *Arch Phys Med Rehabil*, 2004, 85: 1525–1530. [[Medline](#)] [[CrossRef](#)]
- 15) Gloeckl R, Teschler S, Jarosch I, et al.: Comparison of two- and six-minute walk tests in detecting oxygen desaturation in patients with severe chronic obstructive pulmonary disease—A randomized crossover trial. *Chron Respir Dis*, 2016, 13: 256–263. [[Medline](#)] [[CrossRef](#)]