Topics in Geriatric Rehabilitation
Vol. 23, No. 2, pp. 155–160

Six-Minute Walk Test
A Meta-Analysis of Data From Apparently Healthy Elders

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Normative reference values are required if patient performance is to be put into perspective. This descriptive meta-analysis was undertaken to provide estimates of 6-minute walk test (6MWT) performance that could be used as normative reference values for individuals aged 60 years or older. Four bibliographic databases were searched online. Thirteen studies were identified that were usable. Meta-analysis demonstrated that reference values were best presented after grouping data by gender and age. Mean and 95% confidence intervals of 6MWT distances are presented separately for men and women in 3 age groups (60–69, 70–79. and 80–89 years). These consolidated values should provide a better estimate of normal performance than the individual studies from which they were derived. **Key words:** *aging*, *measurement*, *normative reference values*, *6-minute walk test*

THE 6-minute walk test (6MWT), a modification of the 12-minute walk test, was first described in 1985.[1] Since that time, it has been used widely to quantify functional capacity and endurance.[2] Although employed primarily in the evaluation of patients with pulmonary or cardiac pathology, the test has also been used with patients with other problems and with community-dwelling elders. Interpretation of an individual's performance on a test requires the availability of normative reference values.[3] Normative values for the 6MWT have been published by several groups of investigators, but the procedures used and samples tested differ. Before minimum standards of performance for elders can be proffered, an examination and consolidation of available data should be conducted. The purpose of this meta-analysis, therefore, was to summarize and mathematically coalesce the results of studies describing the 6MWT performance of individuals aged at least 60 years.

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The following individuals are gratefully recognized for their provision of clarification/elaboration regarding the data presented in their studies: Paul Enright, Ivan Bautmans, Elaine Cress, Geraldine Pellecchia, Claire Peel, Thierry Troosters, and VI Kalapotharakos.

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METHODS

Search strategy and selection criteria

The author conducted a search of the MEDLINE, Cumulative Index to Nursing and Allied Health, Science Citation Index, and EMBASE databases (1985–2005 [April]) to identify articles written in English that reported normative values for the 6MWT. The phrases "six minute walk" and "6 minute walk" were used in the searches. Apparently relevant articles were obtained and their reference lists were scanned for other potentially relevant articles. The titles and abstracts of articles identified by the searches were read and apparently relevant articles were obtained for further examination. Articles were retained for possible inclusion in the meta-analysis if they documented performance data for the 6MWT for apparently well individuals aged

60 years or older. Articles were excluded if subjects were clearly abnormal (eg, had heart disease or were frail), data could not be isolated for subjects 60 years or older, or data were known to duplicate (in whole or in part) those presented in another article.

Data consolidation and analysis

The author abstracted included articles for subject sample, procedures (course, instructions, encouragement, trials, and measurement used), and performance data. Where possible, performance data were divided by decade (eg, 60–69 years) and gender. Authors were contacted as necessary and possible to assist with this breakdown when it was not provided outright. In studies reporting more than one value for 6MWT performance, those obtained at baseline or on the first trial were used.

The Statistical Package for the Social Sciences (SPSS, Version 11.0) was used to create a database suitable for the meta-analysis. The following variables were input from each relevant study: age range(s), gender, and the mean and standard deviation (SD) of the 6MWT distance (in meters). The variance (SD^2) of the 6MWT distance was then computed, followed by calculation of the inverse of the variance. The syntax macros (meanes.sps and metaf.sps) provided by Wilson[4] were used to analyze the homogeneity of the data obtained from different studies and to calculate overall means and 95% confidence intervals for 6MWT norms.

RESULTS

Thirteen studies were found to include relevant data. For 12 of the studies, means and SDs for 6MWT times were either available or were made available by the authors.[5–16] For one study, the mean and SD for 6MWT times were derived from scatterplots made available by the authors.[17]

Study specifics are reported in Table 1. All studies employed convenience samples. Most (9) of the studies involved North American subjects, but 4 studies involved subjects from Europe. Procedural variables were often unreported. The courses described varied considerably. Corridors (hallways) of various lengths (50 ft = 82.3 m) were used most often, but several studies used circular courses. Instructions were generally compatible with one another, and encouragement, when described, was standardized. When reported, the number of trials varied from 1 to 6. The measurement used was often not stated, but when designated was often the first or only trial, the second trial, or the best trial.

The mean number of meters that subjects could walk in 6 minutes ranged from 310 for 80- to 89-year-old women[12] to 671 for 60- to 69-year-old men.[16] Table 2 presents the results of most of the meta-analysis. The analysis of all data (4809 subjects), without reference to age or gender, revealed the data to be homogeneous ($Q = 76.8$, $P = .097$) but not strongly. Therefore, data were compared between men and women. Not all studies presented separate 6MWT data for men and women, but an analysis of those that did, demonstrated a lack of homogeneity ($Q = 5.79$, $P = .0161$) between man and woman samples. Improved homogeneity was shown when analysis focused separately on men ($n = 1534$, $Q = 33.5$, $P = .299$) and women ($n = 3212$, $Q = 37.3$, $P = .138$). An analysis comparing age groups (60–69, 70–79, and 80–89 years) within each gender group found that the age groups did not provide homogeneous data for men ($Q = 8.48$, $P = .0144$) or women ($Q = 9.50$, $P = .0087$). Analyses of 6MWT data for the 3 age groups of each gender demonstrated improved homogeneity ($Q = 4.1$–8.0, $P = .516$–$.689$). Consequently, the weighted means (and confidence intervals) from these subgroup analyses are probably most suitable for judging the normalcy of individual 6MWTs.

DISCUSSION

The 6MWT is widely used as an indicator of functional aerobic capacity.[2] Although several publications have presented normative data,

Table 1. Alphabetical summary of 13 studies contributing to meta-analysis

Study	Sample	Procedural specifics	Meters walked* (*n*, gender, age [y])
Bautmans et al[5]	Convenience: community-dwelling Belgian men and women, independent in basic activities of daily living	Course: 121-m circle Instructions: cover maximum distance without running Encouragement: not stated Trials: 1 Measurement used: only trial	432 ± 137 (16, ♀, 75+) 549 ± 107 (5, ♂, 75+) 562 ± 133 (24, ♀, 65–69) 569 ± 179 (15, ♀, 70–74) 581 ± 166 (4, ♂, 70–74) 583 ± 154 (18, ♂, 65–59) 623 ± 161 (22, ♀, 60–64) 719 ± 302 (14, ♂, 60–64)
Cress et al[6]	Convenience: community-dwelling North American men and women, not excluded on the basis of medical factors	Course: not stated Instructions: not stated Encouragement: not stated Trials: not stated Measurement used: not stated	515 ± 85 (9, ♀, 80–89) 523 ± 64 (3, ♂, 80–89) 546 ± 85 (58, ♀, 70–79) 579 ± 45 (6, ♂, 60–69) 580 ± 63 (33, ♀, 60–69) 587 ± 57 (25, ♂, 70–79)
Enright et al[17]	Convenience: subset of community-dwelling North American men and women	Course: 100-ft hallway Instructions: cover maximum distance possible Encouragement: standardized Trials: not stated Measurement used: not stated	360 ± 89 (16, ♀, 80–89) 408 ± 101 (57, ♀, 70–79) 409 ± 104 (8, ♂, 80–89) 455 ± 101 (37, ♂, 70–79) 498 ± 86 (60, ♀, 60–69) 512 ± 112 (53, ♂, 60–69)
Gibbons et al[7]	Convenience: asymptomatic healthy North American men and women	Course: 20.0-m corridor Instructions: walk as quickly as possible to cover maximum distance Encouragement: standardized Trials: 4 Measurement used: best of trials	583 ± 53 (10, ♀, 61–80) 687 ± 89 (10, ♂, 61–80)
Harada et al[8]	Convenience: community-dwelling North American men and women, active	Course: 40-ft diameter circle Instructions: maximum distance at effort allowing talk without shortness of breath Encouragement: none Trials: 1 Measurement used: not stated	496 ± 95 (51, ♀ and ♂, 65–86)
Kalapotharakos et al[9]	Convenience: independent living Greek men and women, inactive, healthy, nonsmokers	Course: 100 m Instructions: as quickly as possible Encouragement: standardized Trials: 2 Measurement used: best	447 ± 53 (7, ♂, 60–69) 450 ± 35 (21, ♀, 60–69) 459 ± 46 (5, ♂, 70–74)
Kervio et al[10]	Convenience: community-dwelling French men and women, nonsmokers, free of chronic disease, not obese	Course: 18-m corridor Instructions: regular pace, covering maximum distance Encouragement: standardized Trials: 5 Measurement used: first	525 ± 19 (12, ♀ and ♂, 60–69)

(*continues*)

Table 1. Alphabetical summary of 13 studies contributing to meta-analysis *(Continued)*

Study	Sample	Procedural specifics	Meters walked* (*n*, gender, age [y])
Lusardi et al[11]	Convenience: community-dwelling North American men and women, ambulating without a device	Course: 82.3-m hallway Instructions: usual or comfortable pace Encouragement: not stated Trials: not stated Measurement used: not stated	321 ± 114 (17, ♀, 80–89) 327 ± 77 (6, ♀, 90–99) 345 ± 69 (7, ♂, 80–89) 405 ± 110 (5, ♀, 60–69) 406 ± 95 (10, ♀, 70–79) 475 ± 93 (9, ♂, 70–79)
Peel and Ballard[12]	Convenience: community- and residential-dwelling North American women, able to live independently	Course: 50-ft hallway Instructions: cover maximum distance Encouragement: standardized Trials: 6 Measurement used: first	310 ± 67 (14, ♀, 80–89) 343 ± 80 (14, ♀, 70–79)
Peterson et al[13]	Convenience: community-dwelling North American men, without severe cognitive or mental health problems	Course: 45.7 m Instructions: as far as possible Encouragement: not stated Trials: one Measurement used: not stated	423 ± 168 (9, ♂, 80–89) 513 ± 118 (25, ♂, 70–79) 565 ± 121 (14, ♂, 60–69)
Rikli and Jones[14]	Convenience: functionally independent North American men and women, ambulate without regular use of device, no prohibitive medical conditions or limitations	Course: 45.7 m Instructions: not stated Encouragement: not stated Trials: 1 Measurement used: not stated	326 ± 115 (79, ♀, 90–94) 368 ± 135 (48, ♂, 90–94) 389 ± 118 (152, ♀, 85–89) 422 ± 107 (276, ♀, 80–84) 436 ± 130 (60, ♂, 85–89) 465 ± 104 (513, ♀, 75–79) 479 ± 110 (130, ♂, 80–84) 501 ± 90 (728, ♀, 70–74) 507 ± 115 (230, ♂, 75–79) 519 ± 92 (617, ♀, 65–69) 551 ± 77 (356, ♀, 60–64) 559 ± 93 (294, ♂, 70–74) 577 ± 94 (281, ♂, 65–69) 616 ± 84 (144, ♂, 60–64)
Steffen et al[15]	Convenience: community-dwelling independent North American men and women, nonsmokers	Course: 30-m hallway Instructions: as far as possible Encouragement: standardized Trials: 2 Measurement used: second trial	392 ± 85 (15, ♀, 80–89) 417 ± 73 (8, ♂, 80–89) 471 ± 75 (22,♀, 70–79) 527 ± 85 (14, ♂, 70–79) 538 ± 92 (22, ♀, 60–69) 572 ± 92 (15, ♂, 60–69)
Troosters et al[16]	Convenience: sedentary Belgian men and women; without injury, hospitalization or chronic illness influencing exercise capacity	Course: 50-m corridor Instructions: maximum pace, covering maximum distance Encouragement: standardized Trials: 2 Measurement used: best	527 ± 92 (3, ♂, 80–89) 537 ± 37 (9, ♀, 70–79) 576 ± 73 (16, ♀, 60–69) 637 ± 62 (18, ♂, 70–79) 671 ± 73 (30, ♂, 60–69)

*Meters walked is expressed as mean ± SD.

Table 2. Summary of descriptive meta-analysis of 6-minute walk distances

Category, y	Studies/groups (*n*)*	Total sample (*N*)	Meters walked†	Homogeneity *Q* (*P*)
All ≥60	13/63	4809	499 (480–519)	76.8 (.097)
Men ≥60	10/31	1534	524 (496–553)	33.5 (.299)
Women ≥60	10/30	3212	475 (448–503)	37.3 (.138)
Men 60–69	8/10	582	560 (511–609)	8.0 (.533)
Women 60–69	8/10	1176	505 (460–549)	6.9 (.648)
Men 70–79	9/10	661	530 (482–578)	7.5 (.584)
Women 70–79	8/9	1426	490 (442–538)	7.2 (.516)
Men 80–89	7/8	228	446 (385–507)	4.8 (.689)
Women 80–89	6/7	499	382 (316–449)	4.1 (.662)

*Most studies (see Table 1) contributed to multiple gender/age categories. The data in some studies could not be categorized into groups by gender or age.
†Mean (95% CI).

the norms were not obtained from multiple geographic locations and samples. In undertaking this meta-analysis, the author hoped to consolidate data from diverse studies and generate 6MWT standards against which individual patient's performance could be compared. Normative standards are provided for the entire sample, but values for men and women in 60–69, 70–79, and 80–89 years' age groups are probably most important if the intent is to judge the normalcy of performance of individuals aged between 60 and 89 years.

Granting that the normative values presented herein account for age and gender, which have been identified by the American Thoracic Society as determinants of 6MWT performance,[18] other determinants such as height could not be addressed in subgroup analysis. Procedures employed in the included studies varied considerably, with many being inconsistent with the recommendations of the American Thoracic Society guidelines; that is, use of a 30-m long course in a corridor, provision of standardized instructions/feedback, and recording of the time of a single trial after no more than one practice trial. Ideally, it would be best to have norms that were (1) gathered from a large random sample of apparently healthy individuals residing in different communities and (2) obtained using standardized procedures such as those recommended by the American Thoracic Society. In the absence of such norms, those presented herein should provide a reasonable estimate for clinical comparisons.

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