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ORIGINAL RESEARCH

Predictive validity analysis of six reference equations for the 6-minute walk test in healthy Brazilian men: a cross-sectional study

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Abstract
Background: The six-minute walk test (6MWT) is an important tool for evaluating functional capacity and exercise tolerance. The reference equations for the 6MWT in healthy subjects were established on the basis of American and European populations, but reference equations have been proposed with different variables for the Brazilian population.
Objective: To analyze the predictive validity of six reference equations for the six-minute walking distance (6MWD) in healthy adult men.
Methods: We evaluated 103 individuals in relation to level of physical activity (IPAQ), respiratory symptoms (MRC), handgrip strength, and 6MWD test. The data were submitted to a normality test, then the Bland–Altman agreement test was used to compare individual 6MWD values with that expected for each equation.
Results: The subjects were active, with a mean age of 34.12 (SD = 8.88) years and no respiratory symptoms. The mean of the 6MWD was 663.43 (SD = 93.01) m. The 6MWD's predicted values came closest to the walked distance covered by Britto et al.'s equation (using BMI) of 647.62 (SD = 38.62) m.
Conclusions: The equation proposed by Britto et al. using BMI was the closest to the 6MWD for the individuals studied and could be widely used as a reference tool during the 6MWT in healthy Brazilian men.

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Introduction

The six-minute walk test (6MWT) is the test most often used to assess functional exercise capacity, which allows the diagnosis of global exercise response.[1] This test is easy, inexpensive, and reliable.[2,3] The protocol for the 6MWT recommends that the individual walk as quickly as possible without running for 6 min on a flat walkway measuring 30 m or 100 ft.[4–7]

The 6MWT is used to classify the individual's functional capacity by means of reference equations, which consider factors such as gender, age, height, weight, and handgrip strength.[8–10] Among the many reference equations proposed in the literature,[6,11–14] that of Enright and Sherrill[15] is the most widely used and internationally cited. Enright and Sherrill proposed their predictive equation for healthy adults after assessing 290 American men and women aged 40–80 years.[15]

Predictive equations have also been proposed for the Brazilian population. Iwama et al.[16] proposed an equation that takes into account anthropometric and demographic factors and tested it on 61 individuals over the age of 13. Soares and Pereira[17] developed one predictive equation in healthy individuals of both genders, which included 66 individuals aged 20–80. Dourado et al.[18] proposed two different reference equations for the calculation of 6MWD, which included 98 individuals aged 40–60 years, one of them considering handgrip strength test and the other gender. The most recent Brazilian reference equation described by Britto et al.,[19] which included 617 healthy individuals from various regions of Brazil, ranging 27–68 years, takes into account demographic and physiological characteristics. The study proposed two equations, the first taking into account gender, age, and body mass index (BMI), and the second considering gender, age, height, and heart rate.[19]

Although several other predictive equations proposed in the literature have good methodological quality and an adequate sample,[6,11–19] none of them compared these predictive equations to determine which might be particularly appropriate for use for the Brazilian population. Although these Brazilian equations have been tested to determine which variables can explain the 6MWT, no study[16–19] reported the predictive validity to determine which is closest to the walking distance. We believe it is fundamentally important to identify which one might be the most appropriate to be used in the Brazilian population.[16–19]

The 6MWT is a simple, fast, inexpensive, and non-invasive test with good clinical applicability and high accuracy for evaluating an individual's functional capacity.[2–4] Therefore, the present study aimed to analyze the predictive validity of six equations with reference to a 6MWD proposed for a healthy Brazilian adult population.[16–19]

Methods

Study design

This is a cross-sectional study of 103 healthy males aged 18–55, employed in general services, maintenance, operations, and industry, recruited from two universities and a foundry between February and September 2014.[20,21]

The current study is part of a larger project entitled ''Influence of Aging and Work Experience in Physical Performance, Biopsychosocial Aspects, and Motor Workers' Strategies,'' approved in the Public Notice released by the Ministry for Science and Technology (process no. 557752/2009-4) and authorized by the Research Ethics Committee of Universidade Cidade de São Paulo (UNICID), São Paulo, SP, Brazil (protocol 0048.1.186.000-10).

Procedure

The participants were enrolled from a convenience sample. All individuals were healthy, having no cardiorespiratory, metabolic, neuromuscular, or musculoskeletal diseases, and were able to walk without assistance devices. They received information about the study and agreed to participate by signing the consent form.

First, the weight and height of participants were measured using a scale (Salvapé Produtos Ortopédicos Ltda., São Paulo, SP, Brazil) and a stadiometer (Sanny, American Medical do Brasil Ltda., São Paulo, SP, Brazil) in order to calculate the BMI. Next, the participants answered three questionnaires: a manual-dominance test,[22] which preceded the handgrip strength test; the Medical Research Council (MRC) dyspnea scale[23]; and the International Physical Activity Questionnaire (IPAQ),[24] to assess the level of physical activity for tasks performed at home, at work, and at leisure. The participants were categorized as either active for more than 150 min (2 h and 30 min) of moderate-intensity aerobic activity each week or sedentary (less than 150 min).[24]

The handgrip strength test was measured by maximum strength of the hand flexors, using a hydraulic hand dynamometer (SH5001, Saehan Corp., Korea). Forty-five individuals were assessed following the recommendations of the American Society of Hand Therapists (ASHT).[25] Each participant was seated comfortably in a chair, with legs at a 90° angle, feet resting on the floor, back straight and supported by the chair, shoulders slightly adducted, elbows flexed to 90°, forearms neutral, without using the chair for support. Each participant was instructed to grip the handle using his maximum strength, without moving the arm or elbow, for a period of up to 5 s. A single evaluator standardized the verbal instruction. Three measurements were performed, with rest periods (5 min) between them, and the highest measure obtained was used for analysis.[22,25]

The 6MWT was performed according to the recommendations of the European Respiratory Society/American Thoracic Society.[7] All participants received instructions about the test procedures, and each one was told that if he had any discomfort or pain, he would be allowed to rest for as long as necessary. Two tests were performed, with an interval of about 1 hour between them, in order not to mask the effect of learning.[7] Before and after each 6MWT, blood pressure, heart rate, oxygen saturation, dyspnea sensation, and limb fatigue (by the Borg Scale[26]) were measured. Delta heart rate (ΔHR) represented the difference between final and initial heart rate obtained in the 6MWT.

The 6MWT was performed on a flat surface 30 m in length. Each meter was marked, and cones were positioned at the beginning and at of the end of the path. Each participant was instructed to walk, not run, as fast as he could for 6 min.

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