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RESEARCH REPORT

Prediction equations for 6-minute walk distance in apparently healthy Nigerians

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Abstract The aims of this study were to determine the 6-minute walk distance (6MWD), establish prediction equations for the 6MWD in apparently healthy Nigerians, evaluate any effects regarding participant sex, and compare measured 6MWDs with the predicted 6MWD from reference equations derived from other populations. Four hundred and twenty two (422) apparently healthy Nigerians participated in the study. The 6-minute walk test was carried out according to the American Thoracic Standard-standardized protocol. The 6MWD obtained from the study was compared with reference values from other foreign populations. There were no significant differences between the mean age and mean weight of the male and female participants. However, significant difference existed in the mean height and mean body mass index (BMI; $p < 0.001$) of these participants. Male participants covered a statistically significant longer distance than female participants ($p < 0.001$). The mean 6MWD measured in Nigerian participants (517.6 $\pm$ 72.2 m) was statistically lower than 6MWD in Americans, Brazilians, and Tunisians and was higher than in Arabians ($p \leq 0.002$), respectively. The 6-MWD in healthy Nigerians cannot be predicted by established reference equations from other populations. The regression equations established in this study may better predict the distance for Nigerians.

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Introduction

The use of field-walk tests in patients with cardiorespiratory diseases results from the adaptation of the 12-minute run fitness test developed by Cooper [1]. This test was developed with the objective of verifying the level of physical fitness of the United States of America Armed Forces personnel. The test involved running the longest possible distance in 12 minutes. In the 1970s, McGavin et al [2] adapted Cooper's run fitness test into a 12-minute walk test (12MWT) with the objective of evaluating the exercise tolerance of patients with chronic bronchitis. In most patients with chronic illnesses, the 12MWT was adapted to shorter distances (e.g., 2, 4, and 6 minutes), mainly because it was strenuous for patients [3]. By contrast, the 2- or 4-minute tests presented limited responsiveness, especially in less debilitated patients [3]. In this sense, the 6-minute walk test (6MWT) became the most popular among the tests with controlled duration, and it consists of walking as fast as possible for 6 minutes. The 6MWT was first introduced as a functional exercise test by Lipkin et al [4]. The 6MWT is a useful assessment instrument for exercise capacity and it has been shown to provide a clinically useful index of functional capacity in chronic heart failure (CHF) [5] and other chronic illnesses. Its results highly correlate with those of the 12MWT from which it was derived and with those of cycle ergometer- or treadmill-based exercise tests [3,6,7]. Because exercise is a physiological form of stress, dynamic exercise testing has become a valuable noninvasive method for diagnosis and evaluation of heart diseases in children and adults [8]. In clinical practice, an objective estimate of performance and fitness can be obtained through standardized exercise tests [9]. Such tests provide objective and reliable estimate of physical working capacity and maximum oxygen uptake and provide clues to the mechanism that limit physical working capacity [9].

The 6MWT was originally developed to evaluate the functional capacity, monitor the effectiveness of several treatments, and establish the prognosis of patients with cardiorespiratory diseases [10]. Patients with such dysfunctions presented with exercise intolerance due to malfunctioning respiratory and/or cardiovascular systems and peripheral and respiratory skeletal muscle dysfunction [3]. However, more recently, the test has been used to assess functional exercise capacity in several disease conditions such as CHF, chronic cardiopulmonary conditions, and stroke [11—13] even in sub-Saharan African populations. In patients with cardiorespiratory diseases, oxygen consumption during the 6MWT does not significantly differ from the maximum oxygen consumption (VO_{2max}) obtained during incremental laboratory tests performed using cycle ergometer [14]. Therefore, it is possible to adequately estimate the VO_{2max} by the distance walked using the 6-MWT or 6-minute walk distance (6MWD). Thus, the 6MWT is a simple and less expensive tool to assess the cardiorespiratory fitness [10]. The 6MWT is well-tolerated by patients and is more representative of the activities of daily living in comparison with other walk tests [15]. It is frequently used as an outcome measure in cardiopulmonary and cardiovascular rehabilitation and as an assessment tool in the selection of patients for lung and heart surgery [16,17]. The 6MWT is a popular and widely accepted modality of objective evaluation of functional exercise capacity as it is inexpensive and simple to perform [18].

Several demographic, anthropometric, and physiological factors can influence the 6MWD in healthy individuals and in patients with chronic diseases. Shorter individuals and women present a shorter step length and, consequently, a shorter 6MWD [19]. Elderly and obese individuals commonly have reduced lean body mass and, consequently, a shorter 6MWD. The 6MWT has been found to be influenced by external complicating factors, such as effort spent and motivation [20]. Thus, the instructions and the encouragement given to the participants must be carefully standardized and the demographic, anthropometric, and nutritional differences observed among the different ethnicities evaluated must be considered [10]. Greater height and higher amount of lean mass observed in whites have a significant impact on the 6MWD [21]. Therefore, the American Thoracic Society (ATS) encourages the scientific community to use the standardisation of the 6MWT suggested in its consensus and to develop reference values of the 6MWD for several ethnicities.

Despite the popularity of the 6MWT in the clinical setting, there is a paucity of 6MWD reference values obtained from healthy participants [10,22]. This limits the interpretation of 6MWD in patients and poses problems for clinicians wishing to provide patients with a measure of their expected 6MWD in the absence of disease [23]. Recent studies have established regression equations to predict the 6MWD in healthy Asians [22,24], Americans [25], Brazilians [26], North Africans [27], and Arabians [28]. However, regression equations have not been established for the Nigerian population. This study was therefore aimed at determining the 6MWD in a healthy sample of Nigerians aged between 21 and 67 years, identify factors contributing to distance covered in 6 minutes (6MWD), establish regression equations for a Nigerian population, and to compare measured 6MWD with predicted 6MWD from existing reference equations derived from American, Asian, North African, and Arabian participants.

Materials and methods

Participants

A total of 422 apparently healthy Nigerian participants (224 males, 198 females) with no history of cardiovascular, pulmonary, or musculoskeletal disorders participated in the study. Those who were involved in sports and vigorous exercises were excluded from participating in the study. The participants were volunteers from staff and relatives of patients in Lagos University Teaching Hospital (LUTH), Lagos, Nigeria.

A 'rule of thumb' was adapted to calculate the sample size for this study [29,30].

$(N > 104 + m)$ [30]

The sample size to number of predictor ratio was calculated from the following formula: