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Original Article

Six-Minute Walk Test in Nigeria-Applicability and Usefulness: A Review of Current Literature.

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ABSTRACT

Background: The Six-minute Walk Test (6MWT) is a relatively widely applied simple, valid and reliable field exercise test used to determine the exercise capacity, factors limiting exercise performance and often the response to an intervention. It is still relatively unpopular in Nigeria despite its usefulness in the complete evaluation and care of cardiorespiratory patients. **Objectives:** This review aims to increase awareness, applicability and usefulness of this simple field walk test for the complete evaluation of patients with cardiorespiratory conditions in Nigeria. **Methods:** The available literature on the topic from PubMed, Medline, Google Scholar and other relevant internet sites were accessed, reviewed and inferences made. **Conclusion/Recommendation:** The applicability and usefulness of the 6MWT in the complete evaluation and care of patients with cardiorespiratory conditions in Nigeria remains scanty. Awareness of this simple test can boost its application in Nigeria and across the world.

Keywords: Six-minute Walk test, Exercise test, Cardiopulmonary, Usefulness, Current literature, Nigeria.

INTRODUCTION

The ability to embark on any physical activity implies a certain degree of health and fitness. Physical activity/exercise also has numerous benefits on overall wellbeing of an individual, most importantly, on the quality of life. Scientific evidence shows that exercise improves physical fitness as measured by cardiorespiratory and muscular functions, as well as, delay all-cause mortality and reduce the risk of diseases like cardiovascular diseases, coronary artery disease, and stroke.[1] Respiratory insufficiency, as seen in respiratory ailments, is a major limiting factor to an individual's ability to carry out physical exercise, sometimes impeding activities of daily living. Exercise testing is therefore a measure of assessing the fitness of an individual.[2] It is a controlled way to "force" the supporting cardiopulmonary, hematologic, neuromuscular systems to perform above a tolerable threshold and various physiologic parameters are measured and compared to their reference values.

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The clinical usefulness of exercise testing in respiratory medicine is expanding. Erhabor et al. assessed the energy expenditure among asthmatic patients while performing three different exercise protocols[3]. Similarly, Awopeju et al. assessed the asthma inducing capacity of three different exercise protocols.[4] The incorporation of exercise helps to unravel subtle or mild physiological abnormalities, for example, exercise pulmonary hypertension in unexplained dyspnea.[5]

Exercise capacity is determined by demographic, physiologic and anthropometric characteristic of individuals.[1] These factors such as age, gender, height, BMI, physical activity, heart rate, oxygen saturation are independent predictors of exercise and they determine variation in exercise performance in different populations. Testing their influence is a significant part of exercise test.[1]

Exercise tests are broadly classified into field and laboratory tests. The laboratory tests include the cardiopulmonary exercise test (CPET) while the field test include the 6MWT, incremental and endurance shuttle walk test (ISWT/ESWT).[6] Field walking tests have found tremendous application in the practice of respiratory medicine in recent times.[6] They may be performed to identify an individual's exercise capacity (peak exercise capacity, functional exercise capacity or endurance), factors limiting exercise performance (dyspnoea, subjective fatigue, musculoskeletal limitations) and often the response to an intervention. They can also be used to predict survival and the likelihood of a hospital readmission in respiratory diseases. [7] In rehabilitative intervention, the field test can identify a threshold for prescription of exercise intensity. The body of knowledge surrounding the 6MWT has increased faster than the ISWT/ESWT. The 6MWT is still relatively unpopular in Nigeria despite its important place in the management and complete evaluation of patients with cardiorespiratory diseases, as it is in other advanced parts of world. It is a form of exercise test that helps to determine the functional exercise capacity, evaluate the exercise tolerance and factors limiting exercise as well as monitoring response to treatment and prescription of exercise for pulmonary rehabilitation. [6,7]

The European Respiratory Society and American Thoracic Society (ERS/ATS) have produced a technical standard on the conduct of the 6MWT in chronic respiratory diseases. [6] The interpretation of results and findings of the 6MWT are subject to integrative comparison with reference values gotten from healthy populations. [8-10] The predictors of these reference values of the 6MWT include demographic, anthropometric and physiologic characteristics of the sample population, hence the need to derive reference values for various local populations as populations differ in characteristics. Reference equations have also been derived in order to determine the 6MWD in study populations. [9-11]

The Six-minute Walk Test

The 6MWT is a simple, valid, and reliable test that is gaining relevance in the field of pulmonology. It uses the advantage of being a self-paced test to assess the day-to-day activities of patients at submaximal levels. In addition, prognostication of patients with chronic respiratory diseases as well as pulmonary rehabilitation have been made possible through the use of this inexpensive and reliable test. [12,13] The main outcome measure of the test is the 6MWD. It is important to have reference values of the 6MWD in order to interpret 6MWT results of patients. [6] The 6MWD has important differences in its measurement across various studies possibly due to differences in methodologies or population characteristics.[14] Likewise, studies of reference values and prediction equations for reference values in healthy subjects show variability corroborating the influence of these internal characteristics, inherent within the subjects, and their external counterparts on the 6MWD.[15] One study also proposed an age-specific standard nomogram of the 6MWD for comparison with the 6MWD of patients with chronic respiratory problems.[16]

Factors known to Influence the 6MWD

The 6MWD has shown significant variability across populations. The reasons for this include demographic, anthropometric, physiological characteristics of the study population, environmental influences and methodologic differences in the testing.

a. Demographic Factors

The influence of demographic factors has been elucidated in many studies.[8-11,17-20] Males have been found to walk longer distances. Also, age has shown significant negative correlation with the 6MWD possibly due to reduced skeletal muscle mass and increased prevalence of debilitating diseases as seen in the elderly.[20] The influence of race may however be a function of anthropometric differences.

b. Anthropometric Factors

Anthropometric factors such as height, weight and BMI were predictors of the 6MWD observed in various studies. [8-11,17-20] The influence of height may be due to length of strides. Those with longer strides have longer walking distances. Subjects who weighed more walked lower distances possibly due to extra amount of work directed to lifting the weight. The six-minute walk work (6MWw), a product of 6MWD and weight, is thought to be sensitive and specific in assessing functional capacity.[10,21]

c. Physiologic Factors

The role of physiologic variables in predicting the 6MWD has been suggested in many studies. [9-11,17,22] They include heart rate (HR) and its derivatives, maximum heart rate (HRmax), change in heart rate (ΔHR) and oxygen uptake (Vo_2) which are markers of intensity of exercise and they predict the 6MWD. Fujiko Someya et al. asserted that the distance walked during the 6MWT correlated with heart rate, cardiac output and cardiac index.[22] Some reference equations include physiologic variables giving them a higher variability.[23]

d. Methodologic Factors

The 6MWT is generally preferred due to its simplicity, cost effectiveness, reliability and validity.

Methodological variation in the conduct of the 6MWT affects the measurement parameters. Standardization is therefore imperative in order to avoid these variation.[6,24] Course length substantially influences the results of the 6MWT conducted on a 10m versus 30m course in patients with COPD and these results were not interchangeable[25] possibly due to increased number of turns and other patient-specific gait mechanisms.

The 6MWT as a Submaximal Test

The 6MWT has been described as a submaximal test predicting day-to-day activities which can be illustrated by %HRmax achieved by the subjects. Mohamed-Kheireddine Bourahli et al., like other authors, reported a percentage predicted maximum heart rate (%HRmax) of healthy test participants after the 6MWT to range between 53-72%.[10,11,15,26,27] Despite being a test of functional day-to-day capacity, the 6MWT was found to not be so "submaximal" in patients with chronic respiratory diseases(28,29) and in older patients who achieved more than a mean of 80% of %HRmax.[17]

Uses of the 6MWT in Cardiorespiratory Medicine

a. *Assessment of Functional Capacity and Exercise Tolerance*

The 6MWT has been applied to screen for exercise impairment and determine functional status. The ability to embark on physical activities is a measure of functional capacity. Paul Enright et al., described the 6MWT as a generally safe and quick test that can be conducted to assess the functional status of stable elderly clients in the outpatient clinic setting.[20] Exercise intolerance which results from many factors including pathophysiological factors can be assessed through this safe and easy test.[30,31] The interplay of these factors including abnormal oxygen carrying capacity, pulmonary gas exchange abnormalities, ventilation capacity limitation to exercise, muscle metabolic disturbance, poor effort, deconditioning, excessive perception of symptoms result in exercise intolerance.[2]
One study found a strong inverse correlation between 6MWD and extent of deposition of extracellular matrix (ECM) in the left ventricle (LV) and postulates that the deposition of extracellular matrix in the left ventricle contributes in a multifactorial way with other inflammatory and comorbid processes to impede increase in cardiac output (CO) thereby resulting in exercise intolerance.[32] Low exercise capacity in patients with type 2 diabetes (T_2DM) was associated with higher age and adiposity.(30) Six minute walk distance has been correlated with oxygen uptake (Vo_2), ventilation and dyspnoea which are measures of exercise capacity and tolerance as recorded by the CPET.[33] In COPD subjects, Baty et al. found an independent association between Vo_2 recovery kinetics and exercise capacity using the submaximal 6MWD.[34] Dyspnoea limits functional capacity and quality of life and is a common symptom in idiopathic pulmonary fibrosis (IPF). Parameters of the 6MWT known to predict severity and survival in IPF, such as desaturation index and 6MWD have been strongly related to the MMRC chronic dyspnoea scores.[35]

b. Assessment of Severity and Prognosis of Respiratory and Other Conditions

Various studies have utilized 6MWT to prognosticate outcome in various cardiorespiratory diseases. Celli et al. showed that at a 6MWD of 350m, COPD patients were at an increased risk of exacerbations, hospitalization and death.[7] The 6MWT was found to be an independent predictor of outcome in patients with heart failure with preserved ejection fraction (HFpEF) with the subjects with worse outcomes having significantly lower 6MWD(32) and when combined with CPET-derived variables, it had a high prognostic power.[33] Mene-Afejuku et al. in a study on hypertensive heart failure (HHF) patients found an increasing risk of adverse events and mortality in those with low 6MWD.[36]

c. Prescription of Exercise During Pulmonary Rehabilitation

Pulmonary rehabilitation (PR) is a core component of the management of patients with chronic respiratory diseases.[37,38] It offers a holistic management of patients with chronic respiratory diseases who have low health-related quality of life (HRQoL) such as COPD.[39] Cote et al. revealed an improvement by 19% in the BODE index after PR and a mortality of 7% in the PR arm of COPD subjects as compared to No-PR arm who had a mortality of 18% at 2 years.[40] PR can be prescribed through this simple, inexpensive and reliable assessment test. The 6MWT has been used to prescribe the tolerated intensity of cycle exercise training to COPD patients during pulmonary rehabilitation.[13]

d. Evaluation of Benefits of Therapeutic Interventions

The 6MWT is a responsive outcome measure to various modalities of treatment in pulmonary medicine. One study describes it as a biomarker where it was found to improve following lung volume reduction surgery (LVRS) in COPD patients.[7]

e. Assessment of Fitness for Medical and Surgical Intervention and Risk-Stratification

The complete evaluation of patients scheduled for medical and surgical interventions, such as lung transplantation, also involves the use of the 6MWT.[41,42] This can help to prognosticate outcomes post-treatment.

The Need for Reference Values for the 6MWT

Reference values and equations have found application in other aspects of respiratory medicine such as spirometric indices.[43–45] They provide a basis for comparing and answering questions as to the normality of patients results and to make important clinical decisions. It is important for reference values to reflect the characteristics of the local population and methodologies used for testing. Reference values of the 6MWT in healthy populations are variable due to factors mentioned above. Casanova et al. found a significant difference in the 6MWD of healthy subjects from seven different countries.[16] The need for reference values representing local populations for comparison is important.[17,18,46]

Predictive reference equations have also shown wide variations across populations. These equations consider demographic, anthropometric and physiological characteristics of the study populations for their multiple regression analysis. Several studies have found these reference equations to either over or underestimate the 6MWD when applied to other populations.[17] Olufunke Ajiboye et al. found that the measured 6MWD in their study was significantly less than the predicted 6MWD from regression equations derived in American and Asian populations.[18] A Brazilian study found only one predictive equation's validity close enough with those of its studied population.[14] In a study by Adrianopoulos et al. with COPD subjects, clear differences were found when applying the existing 6MWD reference equations.[31]

Indications For 6-Min Walk Test In Clinical Practice[2]

- Diagnosis of exercise-induced arterial desaturation
- Functional evaluation of patients with COPD, interstitial lung disease (ILD), primary pulmonary hypertension (PPH), and congestive heart failure (CHF)
- Prognostic evaluation of patients with COPD, ILD, PPH and CHF
- Functional evaluation of patients with cystic fibrosis (CF)
- Prognostic evaluation of patients with COPD or CHF prior to surgery (lung volume reduction surgery, transplantation)
- Evaluation of the benefits of therapeutic interventions (oxygen supplementation, rehabilitation, surgery).

The 6MWT Measurements/Protocol

It is important to carry out the 6MWT according to ERS/ATS standard protocol.[6] The following measurement properties are important to test conduct –

- **6MWD**: This is the primary outcome of the 6MWT. It is the distance covered by the patient in metres as he walks as far as possible along a 30m flat course in a period of 6 minutes. It is known to have strong relationships with measures of peak exercise performance.[29,33] The reliability and sensitivity of the 6MWD as an outcome makes it an important measurement of response to treatment.[7,32]
- **Oxygen Saturation**: The SpO_2 is an important outcome measured throughout the 6MWT with a pulse oximeter. It provides information regarding exercise-induced desaturation, disease severity and disease progress.[24]
- **Heart Rate**: This is normally measured at the beginning and end of the 6MWT. Other forms of HR response reported are the change in HR (ΔHR) and HR recovery (the rate of reduction of the HR at the end of the test).[11,23]

Other outcomes of the 6MWT are dyspnoea, fatigue and 6-minute walk work, a product of the 6MWD and the body weight.[9,10] Test procedures are applicable to all field walking tests.

Equipment: [24]

Equipment required for conduct of field walking tests includes:

- At least one chair, positioned at one end of the walking course
- A validated scale to measure dyspnoea and subjective fatigue
- Sphygmomanometer for blood pressure measurement
- Pulse oximeter
- Stopwatch
- Pre-measured marks along the track/corridor
- Access to oxygen and telephone in case of an emergency
- An emergency plan

- Portable supplemental oxygen, if required by patient to perform exercise test
- Clipboard with reporting sheet and pen

Testing location and staffing:[2,6]

The test location should be a quiet place with a conducive temperature such as an outpatient clinic. Access to emergency services should be within close reach and access to a crash cart containing oxygen, sublingual nitroglycerine and salbutamol (metered-dose inhaler or nebulizer) for resuscitation must be available.

Patient Assessment:

Recommendations for patient assessment are similar with those of CPET[47] since the 6MWT provokes maximal measures of exercise performance. The suitability of the participant to perform the walk test is assessed as well as the presence/absence of contraindications. The contraindications to the 6MWT are as listed below and the requesting physician should note and provide rescue medications and guidance during conduct of test.[24] Patients can take their usual medications prior to test but these must be noted in the worksheet.

Contraindications: [6,24]

Absolute Contraindications

- Acute myocardial infarction (3–5 days)
- Unstable angina
- Uncontrolled arrhythmias causing symptoms or hemodynamic compromise
- Syncope
- Active endocarditis
- Acute myocarditis or pericarditis
- Symptomatic severe aortic stenosis
- Uncontrolled heart failure
- Acute pulmonary embolus or pulmonary infarction
- Thrombosis of lower extremities
- Suspected dissecting aneurysm
- Uncontrolled asthma
- Pulmonary oedema
- SpO_2 at rest ≤85% while breathing ambient air
- Acute respiratory failure
- Acute noncardiopulmonary disorder that may affect exercise performance or be aggravated by exercise (i.e., infection, renal failure, thyrotoxicosis)
- Mental impairment leading to inability to cooperate

***Relative contraindications*:**[6,24]

- Left main coronary stenosis or its equivalent
- Moderate stenotic valvular heart disease
- Severe untreated arterial hypertension at rest (200 mmHg systolic, 120 mmHg diastolic)
- Tachyarrhythmia or bradyarrhythmia
- High-degree atrioventricular block
- Hypertrophic cardiomyopathy
- Significant pulmonary hypertension
- Advanced or complicated pregnancy
- Electrolyte abnormalities
- Orthopaedic condition that prevents walking

Patient Preparation:[24]

The patients should wear comfortable clothing and appropriate shoes for walking. They should use their usual walking aids during the test, and this should be documented on the assessment form. Patients should not have exercised vigorously within 2 hours of beginning the test but should have taken their usual medications. All subsequent testing occasions should occur at about the same time of day to minimize intraday variability, including variability in self-paced tests (6MWT) associated with bronchodilator use. A warm-up is not permitted prior to commencing the test, neither is a shortened version of the test. If respiratory function tests are to be performed on the same day, this should occur prior to exercise testing, to avoid the confounding effects of exercise on these measures. The patients should then rest for at least 15 min before commencing an exercise test.[24]

Use of Oxygen:

When a test must be carried out with the patient on supplemental oxygen, the flow rate and delivery system should be kept constant and recorded in the assessment form. The flow rate and delivery system should also be kept constant if subsequent tests are to be conducted.[24]

Medications:

Patients are allowed to take usual medications and the type, dose and number of hours taken before test should be noted in the assessment form.

Measurements:

With the patient seated on a chair close to the starting point, the SpO_2, HR, BP, dyspnoea and fatigue levels are taken prior to commencement of the test as described below.

Immediately prior to the test:

The patient should be positioned at the starting point and timer started as soon as the patient starts walking. Assessors should walk behind the patient so as not to pace the patient as well as to be able to take the end-test HR and SpO_2 readings immediately. The instructions given to patients verbally are as shown below.

Standardized Instructions for the 6-min Walk Test:[24]

- The aim of this test is to walk as far as possible for 6 minutes. You will walk along this hallway between the markers, as many times as you can in 6 minutes.
- I will let you know as each minute goes past, and then at 6 minutes I will ask you to stop where you are.
- 6 minutes is a long time to walk, so you will be exerting yourself. You are permitted to slow down, to stop, and to rest as necessary, but please resume walking as soon as you are able.
- Remember that the objective is to walk AS FAR AS POSSIBLE for 6 minutes, but don't run or jog.
- Do you have any questions?

Post-Test Assessment:

Immediately on Test Cessation(6)

The SpO_2 and pulse rate should be recorded from the oximeter, and the patient should be asked to rate their dyspnoea and subjective fatigue on the standardized scale. The systolic and diastolic blood pressures should be taken. In addition, the 6MWD is measured from the 30m track.

Reasons for the Assessor to stop the test(48)**:**

The 6MWT is generally safe, however some precautions when observed averts any adverse events. The test can be stopped when the SpO_2 drops to < 80%, when there is chest pain, intolerable dyspnoea, leg cramps, staggering, diaphoresis and a pale or ashen appearance. A physician evaluation is necessary at this point and other resuscitative measures as appropriate.

Test Repetition:

If the 6MWT is carried out to observe for change over time or response, a repeat test should be done and the one with the highest value of 6MWD taken. Adequate rest of at least 30mins should be allowed between test and heart rate and SpO_2 should return to baseline values before the second test.

Quality Control:

Quality control must be ensured with the assessor being peer reviewed.[49] This is done by carrying out the test on patients with various functional exercise capacity. The equipment must be working according to manufacturer's guide, likewise all physiological measurements and their documentation must be ensured.

Test Conduct of the 6MWT[6]

***Course*:**

The test is carried out on a 30 meter or more flat, straight course with a hard surface with little pedestrian traffic. The ends of the course should be marked that they are easily visible to patients.

Conduct:[50]

With the participant at the beginning of the start line, the stop clock is started as soon as the word "Go" sounds, and he/she commences the walk test. Standardized phrases of encouragement (as in the table below) are to be used by the assessor during the test every 60 seconds. When the patient stops for rest, the timer should not be stopped. A chair may be provided during rest as the patient prefers. The time that the patient stopped and recommenced test should be recorded.

Standardized Encouragement for the 6MWT[24]

Recording Performance of the 6MWT:[50]

The 6MWD is the primary outcome of the 6MWT. The number of laps and any additional distances covered is calculated and rounded to the nearest metre or feet as the 6MWD. Other parameters recorded are as shown in the sample recording form appendix seven.

1min	You are doing well. You have 5 minutes to go.
2min	Keep up the good work. You have 4 minutes to go.
3min	You are doing well. You are halfway.
4min	Keep up the good work. You have only 2 minutes left.
5min	You are doing well. You have only 1 minute to go.
6min	Please stop where you are.

If the patient stops during the test, once every 30s – Please resume walking whenever you feel able.

The Six-minute Walk Test in Medical field in Nigeria:

In the medical field in Nigeria, the 6MWT, despite its increasing usefulness and awareness, has not achieved widespread applicability. A few reference values and prediction equations from various age groups have been generated while evaluating for the influence of different anthropometric, physiologic and psychosocial factors on the sample population[18,51,52]. Other researchers have used this easy and safe test to assess and correlate exercise capacity of patients with chronic cardiorespiratory and metabolic conditions[3,30,53,54]. Ubuane and colleagues narrated a chronological historical evolution of the 6MWT from pre-existing exercise tests to its present status[55].

Conclusion/ Recommendation:

The applicability and usefulness of the 6MWT in the complete evaluation and care of patients with cardiorespiratory conditions in Nigeria remains scanty. Awareness of this simple, valid and reliable test can boost its application in Nigeria and across the world.

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