Original Article

A STUDY TO DETERMINE THE REFERENCE VALUES FOR TWO MINUTE WALK DISTANCE IN HEALTHY INDIAN ADULTS

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ABSTRACT

Background: The use of functional scales to assess the prognosis of the individuals is widely being encouraged by the International classification of Functioning, Disability and Health. Two, six and twelve minute walk tests are the existing functional walk tests, among which 6MWT is being considered as the gold standard. Patients in acute stages of illnesses and early stages of recovery, it is difficult and tiring to accomplish a 6MWT. 2MWT is presently being used as a pre and post-test. To comment on the status of the patient and the test results in the first attempt, it is necessary to look at the reference values of 2MWT.

Purpose of the study: This study aims to establish reference values for 2MWT in healthy Indian adults.

Objective of the study: To establish reference values for 2 minute walk distance in healthy Indian adults of 20-80 years age.

Methods: Three hundred subjects met the inclusion criteria through convenience sampling. Two trials of 2MWT were administered. Instructions for the test were adopted from American Thoracic Society guidelines for 6MWT. Out of the two trials, the one in which more distance was covered by the subject was taken for the analysis. Descriptive statistics were used to analyse the data.

Results: The mean 2MWD was 182.69 $\pm$ 32.40 meters. 2MWD had shown moderate significant negative correlation with age (r = -0.58) and weak but significant positive correlation with height (r = 0.35). The correlations with weight (r= 0.1) and BMI (r= -0.13) were found to be negligible. It was also found that males walked 21.55 $\pm$ 3.5 meters more than females and aye2MWD during the second trial was found to be 3.011 $\pm$ 1.44 meters greater than the first trial.

Conclusion: The average distance covered by a healthy Indian individual is approximately 182.69 $\pm$ 32.40 meters in 2 minutes duration.

Implication: Patients in early stages of rehabilitation, early post-operative period and patients with severe disability, found 6MWT difficult, intolerable, time consuming and too fatiguing. So, 2MWT is being used as an outcome scale of priority in these populations recently. It is clinically more useful when compared to 6MWT.

KEY WORDS: 2 minute walk test, Functional capacity, Indian population, Exercise capacity, Functional walking test.

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INTRODUCTION

The idea of being healthy in the terms of a common man is the ability to perform his daily activities without any hindrance. Their approach to the health care sector is when they notice any difficulty with their regular functional tasks.

Every individual's daily routine and tasks differ. But walking is a part of everyone's daily life. This made the basis for the discovery of functional walk tests that helps to assess the mobility, functional capacity and exercise tolerance of an individual [1]. With the growing importance for the International classification of functioning, disability and health (ICF), measures to improvise the assessment and rehabilitation on the basis of functional activities have gained lots of significance recently. Thus, assessing the functional capacity and reporting the prognosis on functional scales is considered more essential [2].

Functional capacity refers to the ability to perform activities of daily living and also to the mobility of an individual. Walking is one of the most common and important functional activities of daily life which indicates the health status, pain and fatigue of an individual [1]. Assessing walking capacity helps in determining the treatment effectiveness and in quantifying the prognosis of the patient. It also acts as a source of defining the functional performance and adds to the clinical judgement on readiness for discharge [3].

Presently, 2, 6 and 12 minute walk tests are the available functional walk tests. Major advantages of these tests are that they are reproducible, self-paced, easy to administer and cost effective [4]. They are being used not only in rehabilitation but also in general medical fields like paediatrics, neuro sciences etc. [5].

Prior to these functional walk tests, Cycle ergometry was considered to be the gold standard test to assess the exercise capacity and physical fitness [6]. As cycling is not a regular functional activity of every individual, there was a necessity for a valid tool to measure the functional capacity. This led to the invention of three functional walk tests – 2MWT, 6MWT, 12MWT in 1968. Thus, the evaluation of functional capacity gained importance lately.

Twelve minute walk test was frequently used in the ancient days. It was validated against Cycle ergometry which is a gold standard test and was proved equally efficient to it in assessing exercise capacity. Further its use was commenced and encouraged by the clinicians to assess the functional as well as exercise capacity [7]. Gradually, it was realized that the 12 minute walking was time consuming and difficult for the patient to accomplish. A study compared the 3 established functional walk tests in subjects with respiratory disease and found that there was a good correlation and high reliability among these three tests with respect to the distance walked and maximal oxygen consumption [4]. In spite of similar efficiencies of these 3 walk tests, 6MWT was decided to be a sensible compromise by taking patient's comfort into consideration.

Literature revealed that exercise capacity depends on genetics, environmental variations, racial differences and various other factors [8, 9]. So, 6MWT was administered and assessed in different populations. Reference values, equations, reliability and validity of the 6MWT for clinical use and practise were identified [10, 11, 12, 13].

Patients in early stages of rehabilitation, early post-operative period and patients with severe disability, found 6MWT difficult, intolerable, time consuming and too fatiguing [14]. So, 2MWT is being used as an outcome scale of priority in these populations recently. It is clinically more useful when compared to 6MWT [15]. Its importance to grade the functional prognosis in the acute stages of recovery has augmented.

In the last decade, studies have shown increase in the use of 2MWT due to the above mentioned reasons. It is similar to 6MWT except for the duration of the test. It is being widely used for assessment and prognostic purposes in various fields of medicine and rehabilitation [1, 16]. A good co-relation was found between 2 minute walk test and physical functioning in the patients [15]. Till date, 2MWT is being used as a pre and post-test. The prognosis of the patient upon an intervention or surgery is based on the improvement or the deterioration in the subsequent 2MWD.

Reference values for 2MWT in American and Brazilian population have been established. However, according to our knowledge and reviewed literature, they are not found in Indian population.

It is crucial to establish values in Indian population for the following reasons:

· Indians exercise capacity differs from the other races.

· The body built, environmental variations, genetic differences, food habits etc. are some of the reasons for variations in the exercise capacity compared to Caucasians [17]. Caucasians are taller and have a wider chest which results in higher total lung capacity, thus in turn is responsible for larger forced vital capacity and larger forced expiratory volume when compared to Asians [18]. They have higher expiratory and inspiratory flow rates compared to Asians [19]. This implies that racial differences also have an impact on 2MWT which assesses the exercise capacity.

Taking into consideration, the drawbacks mentioned regarding 6 and 12 minute walk tests in specific populations and conditions; and also the benefits of 2MWT in the same, it is vital to establish normative values for 2MWD in healthy Indian population. Establishing reference values would help the clinicians in differentiating the test results as normal or abnormal. Thus, there was a strong need for the establishment of reference values for 2MWT in Indian population.

So, the purpose of this study was to establish reference values for 2MWD in healthy Indian adults for clinical use.

MATERIALS AND METHODS

Study Design: Prospective Cross-sectional study

Sample size estimation:

Based on the study conducted by Dr. Vyoma Bharat Dani in 2013, 523±70.6 was found to be the reference value for 6 minute walk distance in healthy Indian adults. Expecting the Standard Deviation (SD) and Mean to be 23.5 and 178.3 respectively, the sample size for this study is estimated as 297 with 1.5 relative precision, 95% Confidence Interval.

Sample size: 300 subjects.

Inclusion Criteria: Males and Females across 20 to 80 years of age group.

Exclusion Criteria: Subjects with any chronic disease or on any medication affecting exercise capacity, any acute illness < 6 weeks, any participation in competitive sports, pregnancy and lactating mothers.

Materials: Weighing scale, Stadiometer, Measuring tape, Pulse oxymeter, Sphygmomanometer, Stop watch / wrist watch, 2 cones, weighing scale.

Procedure: Subjects were interviewed verbally regarding their health status, recent hospitalizations and screened for eligibility to participate in the study. After screening, 300 subjects fulfilling the inclusion and exclusion criteria were selected to be part of the study. The 2MWT was conducted in a 30m corridor. Two trials of the test were performed with a rest of 10 minutes in between. Heart rate, oxygen saturation, respiratory rate, blood pressure, height and weight of the subjects were recorded. Heart rate and oxygen saturation were measured using Pulse oxymeter (Dr. Morepen, Model Md30063), blood pressure by automated sphygmomanometer (Omron, Model HEM 7120) and weight using weighing scale (Omron, Model HM 286). Instructions given to the subjects were adapted from the guidelines of the American thoracic Society 2002 for 6 MWT. Post-test, vitals and distance covered by the subject were recorded. The subjects were given a rest period of 10 minutes and the test was repeated. Out of the two trials, the one in which more distance was covered by the subject was taken as the final result.

Statistical Analysis: Statistical analysis was performed using the SPSS version 20. Descriptive statistics were obtained for demographic data. The Shapiro Wilk test was used to test the normality of the distribution. Skewness and kurtosis were analysed to check the homogeneity and distribution of the sample. Paired t test and was used to compare the 2 trails of 2MWT. The mean and standard deviation of the farthest 2MWD by all the subjects were calculated. Pearson's product moment correlation test was done to analyse the correlations between dependent variable 2MWD and independent variables like height, weight, BMI, age, resting heart rate, resting respiratory rate and RPE. Comparisons of distance walked among the age groups were performed using repeated measures ANOVA on each pair of groups, with the p value adjusted by the Bonferroni method. Independent t – test was administered to find the difference in 2MWD between males and females.

RESULTS AND TABLES

The Anthropometric data of the study sample mean and standard deviation for age, height, weight, BMI and 2MWD are presented in (Table 1). The mean distance and standard deviation of 2MWD in all the 4 groups is shown in (Table 2). Pearson's correlation was done to find out the association between 2MWD with age, height, weight and BMI (Table 3). It was found that 2MWD has a negative correlation with age (r= -0.586) but has a high statistical significance. Height also showed a positive correlation with r = 0.355 with a high statistical significance (Figure 1 and 2). Negligible correlation was found between 2MWD with weight and BMI. Independent student t-test was carried out to compare the means of two trials of 2MWD and was found that the subjects walked 3.01$\pm$ 1.44 m more in 2nd trial (Figure 3 and Table 4). Also, it was found that male subjects walked 21.55 $\pm$ 3.5 m more than the female subjects (Table 5 and Figure 4).

Thus, age was the variable that best correlated with 2MWD.

Table 1: Anthropometric data of the study sample.

	N	Minimum	Maximum	Mean	SD
Age (years)	300	20	80	45.78	14.95942
2MWD (meters	300	87	275.32	182.64	32.387
Height (meters)	300	1.4	1.95	1.63	0.0918
Weight (kg)	300	39	104	66.8867	12.50955
BMI	300	16.6	35	25.0813	3.74808

SD: Standard Deviation; BMI: Body Mass Index; 2MWD: 2 minute walk distance.

Table 2: The mean distance and standard deviation of 2 minute walk distance in the 4 groups.

Age	No. of subjects	Mean (meters) $\pm$ SD (meters)
20-29	53	214.88 $\pm$ 28.34
30-49	126	185.122 $\pm$ 26.74
50-69	104	169.968 $\pm$ 26.322
70-80	17	142.228$\pm$ 26.22

Table 3: Pearson's correlation with independent variables.

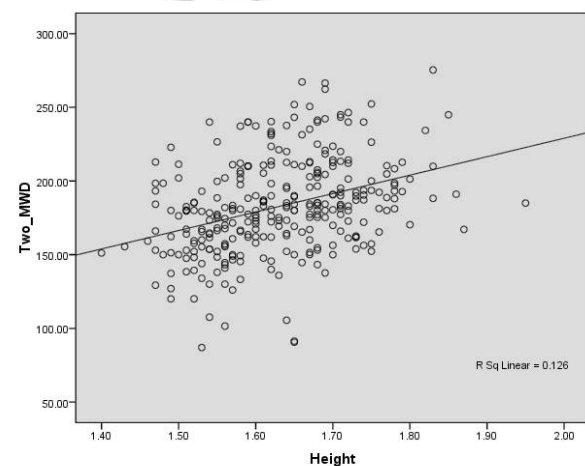|	Pearson's correlation (r value)	Sig (p)
Age	-0.586**	0
Height	0.355**	0
Weight	0.102	0.077
BMI	-0.131*	0.024

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

Fig. 1: Correlation between the 2 MWD and Age.
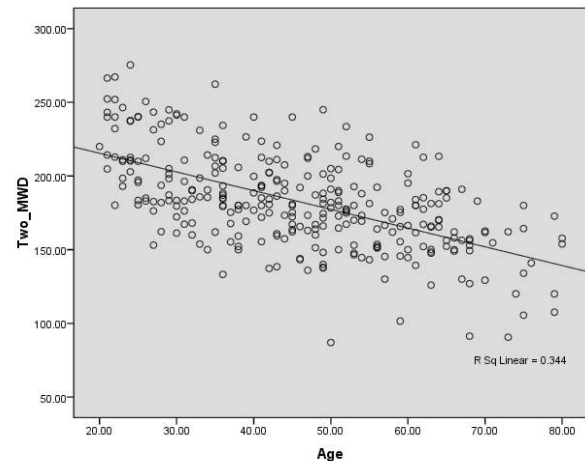
The above figure shows a negative correlation between age and 2MWD

Fig. 2: Correlation between the 2 MWD and Height.

The above figure shows a positive correlation between height and 2MWD.

**Table 4:** Comparison between two trials of 2MWD.

	Trial 1 Mean $\pm$ SD	Trial 2 Mean $\pm$ SD
Distance (meters)	179.16 $\pm$ 31.62	182.17 $\pm$ 32.05
Difference in distance (meters)	3.01 $\pm$ 1.44	

The mean distance covered by 300 subjects during the first trial was 179.16 $\pm$31.62 meters and during the second trial was 182.17 $\pm$ 32.06 meters. Thus, the mean difference between the two trials was found to be 3.01 meters with a standard deviation of 1.44 meters.

Table 5: Comparison between 2MWD of males and females.

	Gender	N	Mean	SD	Std. Error Mean
2MWD	Males	154	193.13	33.953	2.736
	Females	146	171.58	26.577	2.2

Fig. 4: Difference between 2MWD of males and females.
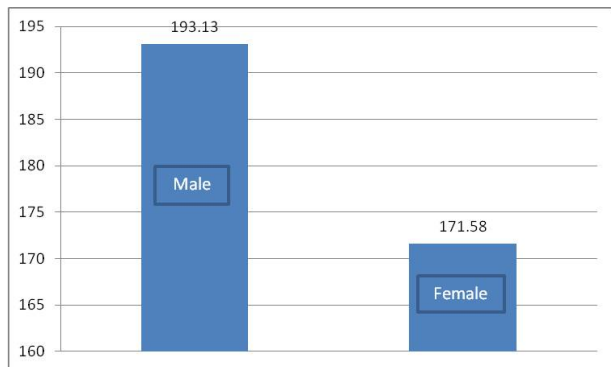
DISCUSSION

From the results of the current study, it was found that the mean 2MWD in Indian adults is 182.64 $\pm$ 32.38 meters. It was observed that age, sex and height have explained 50% of the variance in 2MWD which is consistent with the results of the previous studies [8, 11, 13]. The positive correlation between height (r = 0.35) and 2MWD can be attributed to the greater stride length in taller individuals [6, 10, 11, 20]. Gradual decline in muscle strength, muscle mass, maximal oxygen uptake and exercise capacity with age explains the inverse relationship between 2MWD and age [21, 22]. Men have greater muscle strength, muscle mass and height compared to women and this explains the reason why men walked farther distance during the 2MWT compared to women [23].

Further, no significant correlations were found between 2MWD and other anthropometric variables. Literature states that, greater body weight and high BMI has an inverse relation with exercise capacity due to their low resting metabolic rate and less physical activity [24]. But the results of the study showed weak and insignificant correlation of 2MWD with body weight (r = 0.1) and BMI (r = -0.13). The reason for negative correlation between 2MWD and BMI is thus explained. But, the reason for the weak positive correlation obtained between the 2MWD and weight is unknown according to the literature. These results coincide with the results of Enright et al. 2003, and Casanova et al. 2011. Higher body weight of an individual can be due to various reasons like fat accumulation or metabolic disorders or high bone density or greater muscle mass. Based on the results, it can be estimated that the positive relationship between weight and 2MWD can be either due to high bone density or greater muscle mass which in turn affected the exercise capacity of the individuals.

Variables like resting HR, resting RR, post-test HR, post-test RR, physiological cost index (PCI) were explored, if they influence the 2MWD. None of them had shown a trend or a significant correlation with 2MWD. These results were parallel to the results published by Casanova et al. 2011 for 6MWD reference values, Bohannon et al. 2014 for 2MWT normative values in American population and Jessyca P R Selman 2013 for 2MWT reference equation in Brazilian population.

A new finding in the present study is that there was a trend observed in 2MWD with RPE. Subjects with high score on modified Borg scale walked less distance compared to the subjects with low score. It is an accepted fact that RPE is a subjective measure to estimate the exercise intensity in healthy as well as patient population (European Association of Cardiovascular Prevention and Rehabilitation Committee for Science Guidelines et al. 2010).

Similarly, the changes observed in the HR and RR values pre and post 2MWT indicate that, cardio-pulmonary system of an individual is being stressed during the test. This statement does not deny the fact that the other systems of the body are not being challenged. But there were no objective measures used in this study to confirm its effect on them. Based on these findings it can be concluded that 2MWT has a key role in evaluating the functional capacity and exercise tolerance of an individual.

The results obtained show that majority of the subjects performed their best during the 2nd trial of 2MWT. The reason for performing better in the subsequent trial can be attributed to learning effect [8, 11, 20].

On observation of reviewed literature, 2MWT was administered mostly in the phases of early mobilization in the intensive care or during the early phase of rehabilitation i.e. post cardiac surgery, recovery from acute stroke, severe stages of COPD, immediately after lower limb amputation - post prosthesis fitting etc. The sensitivity of the scale was found to be the least when compared to 6 and 12 minute walk tests

in mild and moderate stages of COPD, stable stroke patients who were under rehabilitation for a long time. Based on these findings, it can be interpreted that this scale can only be used as a reliable scale during early mobilization stages or immediately after critical care but not in the later stages. And, 2MWT is advantageous to assess the walking capacity, but not the other characteristics of gait like quality and parameters of gait, balance etc.

Looking at the reference values obtained in this study, a trend was observed in 2MWD in relation to age. But there was no significant difference in the 2MWD (Table 2) of the 4 strata (20-29 years, 30-49 years, 50-69 years, 70-80 years). Ten meters was the maximum difference observed between each strata. According to this, 2MWT is a not a sensitive scale to identify the changes in age.

Data was collected only from 17 samples in 70 – 80 years subset. This was due to the difficulty in finding individuals without any impairment in that age group. So generalizing the results of this stratum to a larger population is not recommended.

Fifty per cent of the variance in 2MWD is explained by the demographic and anthropometric variables. But the other 50% of the variance could not be explained. This could be due to the variations in the daily routine and physical activities of the individuals; psychological factors like depression and anxiety which were found to effect the exercise capacity [25].

Higher standard deviation in the results could not be avoided due to large sample size. This resulted in extensive gap between the two extremes of the reference values of 2MWD (Table 2), making the clinical decision tough. Due to this reason, it is advisable to limit the results of the scale to particular populations who are in the phases of early mobilization during or immediately after intensive care; or in conditions where the subjects cannot accomplish a 6MWT due to the severity of their conditions.

CONCLUSION AND IMPLICATIONS

This study has revealed that 134 - 231 meters is the range for 2MWD in Indian adults of 20-80 years. Males walked 21.55 $\pm$ 3.55 meters more than females. The variability in 2MWD can be elucidated by the anthropometric and demographic attributes. This data can help the therapists to use 2MWT as an important outcome scale in acute illnesses as well as in early stages of rehabilitation, to assess the functional ability of the patients.

LIST OF ABBREVIATIONS

2MWT – 2 minute walk test
2MWD – 2 minute walk distance
6MWT – 6 minute walk test
12MWT – 12 minute walk test
HR – Heart rate
RR – Respiratory Rate
RPE – Rate of perceived exertion
SPO_2 – Oxygen saturation
BMI – Body mass index
ATS – American Thoracic Society
VO_2 max - Maximal oxygen uptake
PCI – Physiological Cost Index
COPD – Chronic Obstructive Pulmonary Disease

Conflicts of interest: None

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