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Original Article

Study of the Six Minute Walk Test in Healthy Adults of 17 to 50 Years

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ABSTRACT

Background and Aim: Six minute walk test tells about the functional exercise capacity. Six minute walk test can be used in both normal as well as diseased individuals The aim of the present study was to find out effect of six minute walk test in healthy adults of 17-50 years. **Methods:** The present study is observational and cross section study.240 healthy participants who volunteered to participate were between age of 17-50 years, free from Injury and with no History of hospitalization or chronic disease influencing their exercise capacity were recruited. Anthropometric variables (age, weight, height and Body Mass Index (BMI), were recorded before and after the test along with SpO_2), Heart Rate (HR), Blood Pressure (BP) as well as Borg's Scale. **Results:** The statistical analysis of the data clearly shows that all the parameters like SpO_2, Systolic BP, Diastolic BP and heart rate, significantly increased after the 6 min walk test. The mean values of all the parameters like SpO_2, systolic BP, diastolic BP and heart rate after the 6 min walk test were calculated and compared with the mean values of same parameters before the 6 min walk test was performed. The difference in 6 min walk test among different variable like visceral fat, subcutaneous fat, skeletal muscle mass, total body fat as well as BMI were statistically significant except Waist Hip Ratio (WHR). Physiological responses of parameters like SpO_2, Systolic BP, Diastolic BP and Heart rate before and after 6 minute walk test were statistically significant. ($P<0.05$). **Conclusion:** Six minute walk test is beneficial to determine cardiac efficiency and early detection of cardiac diseases.

Key words: Anthropometry, Exercise test, Physiology, Six minute walk distance, Walking, Indian population.

INTRODUCTION

There are several modalities available for the objective evaluation of functional exercise capacity. Some provide a complete assessment of all systems involved in exercise performance (high tech), whereas others provide basic information but are low tech and are simpler to perform. The modality used should be chosen based on the clinical question to be addressed and on available resources.The most popular clinical exercise tests in order of increasing complexity are stair climbing, a 6MWT, a shuttle-walk test, detection of exercise-induced asthma, a cardiac stress test (e.g., Bruce protocol) and a cardiopulmonary exercise test. Assessment of functional capacity has traditionally been done by merely asking patients the following: "How many flights of stairs can you climb or how many blocks can you walk?" However, patients vary in their recollection and may report overestimations or underestimations of their true functional capacity. Objective measurements are usually better than self-reports.[1] In the early 1960s, Balke developed a simple test to evaluate the functional capacity by measuring the distance walked during a defined period of time.

A recent review of functional walking tests concluded that "the 6MWT is easy to administer, better tolerated and more reflective of activities of daily living than the other walk tests.[1]

The 6MWT is a practical simple test that requires a 100-ft hallway but no exercise equipment or advanced training for technicians. Walking is an activity performed daily by all but it is impaired severely in most patients. This test measures the distance that a patient can quickly walk on a flat, hard surface in a period of 6 mins (the 6MWD).[1]

It evaluates the global and integrated responses of all the systems involved during exercise, including the pulmonary and cardiovascular systems, systemic circulation, peripheral circulation, blood, neuromuscular units and muscle metabolism. It does not provide specific information on the function of each of the different organs and systems involved in exercise or the mechanism of exercise limitation, as is possible with maximal cardiopulmonary exercise testing.

The self-paced 6MWT assesses the sub maximal level of functional capacity. Most patients do not achieve maximal exercise capacity during the 6MWT; in-

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stead, they choose their own intensity of exercise and are allowed to stop and rest during the test. However, because most activities of daily living are performed at sub maximal levels of exertion, the 6MWD may better reflect the functional exercise level for daily physical activities.

The present study is to investigate the effect of demographics and anthropometrics parameter on the 6MWT (performed in accordance with American Thoracic Society guidelines) in healthy participants of 17-50 years of age group.

MATERIALS AND METHODS

Prior Permission was taken from Institutional Review Board (IRB) of Government Medical College, Bhavnagar before starting the study. The subjects were enrolled into the study with prior written informed consent (in local language) according to Inclusion and exclusion criteria described below. The 6 Min Walk Test (MWT) was performed in the lobby of the Department of Physiology at the 4th floor of the building of Government Medical College, Bhavnagar. The walking course was 30 m in length. The length of the corridor was marked every 3 m and marked on the floor using brightly colored. The test was conducted on 240 healthy participants who volunteered for the study. The participants were between 17-50 years of age and free from any cardiopulmonary disease that may have affected exercise capacity and for statistical analysis, patients were divided into three Groups:- (1) 17-28 years (2) 29-38 (c) 39-50 years. Tests were performed between 9:00 am to 12:00am in morning. The following instructions were given to the participants on the day of test just before the start of the study. Comfortable clothing should be worn. Appropriate shoes for walking should be worn. The patient will be allowed to take a light meal before early morning tests. Patient will not be allowed to exercise vigorously within 2 hrs of beginning the test. A "warm-up" period before the test will not be performed.

Inclusion criteria

Age 17-50 years

Male and female

Ready to give written informed consent

Exclusion criteria

Who are not willing to give written informed consent.

Have difficulty in walking.

Having Hypertension.

Taking any drugs

Dehydration

History of any acute disease in last six weeks

Use of walking Aids.

Sleep disorder

Having diabetes

Being underweight (BMI < 18 kg/m^2) or presenting with class III obesity (BMI > 35 kg/m^2).

All anthropometric measurement (height, weight) were obtained in such a way that the subject wearing light clothing and barefoot and at room temperature. Standing height was measured in centimeters without shoes, with the feet together, standing as tall as possible with the eye level and looking straight ahead, using the an accurate measuring device to nearest 0.1cm.Body weight was recorded in kilograms on a standardized weighting scale. The weight measurement was recorded to nearest 0.1 kg. Total body weight, BMI, Visceral fat, subcutaneous fat, skeletal muscle mass, total body fat, RMR were measured by Body Fat Analyzer. 5 kHz to scan the Whole Body to derive Total body weight, BMI, Visceral fat, subcutaneous fat, skeletal muscle mass and total body fat Composition. The subjects were asked to rest during which Borg scale was explained as follow and was instructed to assess himself/herself as per this scale before and immediately after test.

The participants were instructed to seat on a chair in resting condition, located near the starting position for at least 10 minutes before starting the test. On completion of 10 minute rest blood pressure, SpO_2 and heart rate was measured and recorded. The blood pressure was recorded by mercury sphygmomanometer. Both systolic and diastolic pressure of each participant was recorded by first palpatory and then auscultatory method. It was measured in sitting position. The BP cuff was tied at the mid arm, cuff size 12 cm wide and 23cm long, with the rubber tube on lateral side and directing downwards. First, the radial pulse of the participant was palpated before inflating the cuff. Then the cuff is inflated and after inflating, the air was allowed to escape gradually and felt for the radial pulse to start and systolic pressure was measured. For auscultatory method, the cuff was again inflated at least 40-50 mmHg more than the systolic pressure recorded by the palpatory method. Again air was allowed to escape gradually and both systolic and diastolic blood pressure recorded. SpO_2 and heart rate was recorded by fingertip pulse oximeter in right finger in sitting position. Instructions about the procedure were given i.e. walk as fast as possible, ask if any symptoms and reason for pause if any during 6MWT (Participants fatigue perception, breathlessness) was documented. Chest pain, intolerable dyspnoea, pain in leg, hip, dizziness and leg cramps, diaphoresis and fall were additional criteria for immediately stopping the test. Instructions and verbal encouragement was given to the subjects in local language.

As Per ATS (American thoracic society)[1] guideline as mentioned below was strictly followed by participant and investigator. The participants were positioned at the starting line. The investigator also stood near the starting line during the test. The investigator had not to talk to anyone during the walk. The investigator had not to walk with the participant.

As soon as the participant started walking, the timer was started. An even tone of voice was used when using the standard phrases of encouragement. When the timer showed 3 minutes remaining, the patient was told the following in vernacular language: "You are doing well. You are halfway done. When the timer showed last 10 seconds remaining from completion, the Participant 'Stop the walking'. Then the timer rung, the investigator had said this: "Stop!" The investigator was then walked over to the patient and offered a chair if required. Immediately the SpO_2, heart rate and blood pressure were recorded. The Borg's scale was recorded as explained previously. After marking the distance covered, using the markers on the lobby as distance guides.

RESULTS

The study was carried out in total 240 healthy participants. The participants were between 17-50 years of Age (Table 1), with equal sample of male and Female (Table 2) and for statistical analysis, participants were divided into three Groups:- (1) 17-28 years, (2) 29-38years, (3) 39-50 years.

Table 3 shows all anthropometric parameters, the participants were also divided according to their different age group.

Height, weight and Waist and Hip circumference were statistically significant (P <0.0001), statistically not significant was WHR (P>0.9961)

Table 4 shows all body fat parameters the participants were also calculated according to their different age group.

Visceral fat, Subcutaneous fat, total body fat were statistically significant P Value is (<0.0001). Resting metabolic rate and Skeletal muscle mass were statistically not significant.

Table 5 shows BMI and 6MWT of all the subjects calculated according to their different age group.

Table 1: Age wise distribution of Participants (*n*=240).

No.	Group	Number of participants	Percentage
1	17-28 years	80	33.3
2	29-39 years	80	33.3
3	40-50 years	80	33.3
	Total	240	100.0

Table 2: Gender wise distribution of Participants (*n*=240).

Sex	Number of Participants	Percentage
Male	120	50.0
Female	120	50.0
Total	240	100.0

Table 3: Anthropometric parameters of different age group (*n*=240).

parameters	Group (1) 17-28 year mean±SD	Group (2) 29-39 year mean±SD	Group (3) 40-50 mean±SD	*P* value
Height(cm)	160.281±9.05323	59.96875±10.49007	158.1584±8.35304	<0.0001*
Weight(kg)	56.28±11.338	159.74±10.37	65.36378±10.57449	<0.0001*
Waist(cm)	78.95±9.0164	83.0687±8.101889	87.61728±9.067205	<0.0001*
Hip(cm)	92±7.48	93.30625±8.393852	96.8929±9.64949	<0.0001*
W:H ratio	0.846±0.103	0.892464±6.059463	0.882243±0.048481	<0.9961

Table 4: Body fat parameters of different age group (*n*=240).

Parameter	Group-1 17-28 year mean±SD	Group-2 29-39 year mean±SD	Group-3 40-50 mean±SD	*P* Value
Visceral fat (%)	3.7875±2.9540	7.62±3.7179	11.2639±4.591961	<0.0001*
Subcutaneous fat (%)	19.871±7.1166	21.91±7.1271	25.7679±7.22060	<0.0001*
Total body fat (%)	24.9387±7.1714	27.4225±6.7636	30.8849±6.0291	<0.0001*
Skeletal muscle Mass (%)	30.1625±4.6903	29.9112±5.7000	30.37775±7.06460	<0.8823
Resting metabolic rate(kcal)	1291.288±229.3394	1336.875±176.6559	1335.226±213.6436	<0.2914

Table 5: Effect of BMI and 6MWD on different age groups (*n*=240).

Parameter	Group-1 17-28 year mean±SD	Group-2 29-39 year mean±SD	Group-3 40-50 year mean±SD	*P* Value (one way ANOVAs with post-test)
BMI(kg/m^2)	21.7446±3.19876	23.4178±3.26379	25.6370±3.46684	<0.0001*
6WMD (m)	537.76±54.846	519.58±59.899	462.75±63.898	<0.0001*

Statistically Significant difference was found in BMI among different age groups. Significant difference was found in walking distance among different age groups. There was statistical significance of BMI and 6MWD (P <0.0001) with one way ANOVA with post-test (post Hoc test).

Table 6: Total Effect on SpO_2, SBP, DBP and HR Before and After 6MWT (*n*=240).

	Before 6 MWT Mean±SD	After 6MWT Mean±SD	*P* Value (Paired T-test)
SpO_2 (%)	97.74±1.072	98.55±0.785	<0.0001*
SBP (mmHg)	114±9.812	125.61±10.451	<0.0001*
DBP (mmHg)	77.04±6.789	82.97±5.340	<0.0001*
HR (bpm)	84.54±11.085	99.31±12.077	<0.0001*

Table 6 shows the physiological response of the parameters:-SpO_2, systolic BP, diastolic BP and heart rate before and after the 6 min walk test. All the parameters like SpO_2, systolic BP, diastolic BP and heart rate showed significant difference before and after the test. There was statistical significance in SpO_2, systolic BP, diastolic BP and heart rate (P <0.0001).

Table 7 shows the physiological response of the parameters - SpO_2, systolic BP, diastolic BP and heart rate before and after the 6 min walk test in males. There was statistical significance of SpO_2, systolic BP, diastolic BP and heart rate (P<0.0001) in males.

Table 8 shows the physiological response of the parameters - SpO_2, systolic BP, diastolic BP and heart rate before and after the 6 min walk test

Table 7: Effect on SpO_2, SBP, DBP and HR Before and After 6MWT in Males (n=120).

Male(120)	Before 6 MWT Mean±SD	After 6MWT Mean±SD	*P* Value (Paired T-test)
SpO_2 (%)	97.71±1.198	98.51±0.733	<0.0001
SBP (mmHg)	116.55±9.934	128.05±10.670	<0.0001
DBP (mmHg)	77.98±6.945	83.73±5.727	<0.0001
HR (bpm)	84.22±12.421	100.53±13.687	<0.0001

Table 8: Effect on SpO_2, SBP, DBP and HR Before and After 6MWT in Females (n=120).

Female(120)	Before 6 MWT Mean±SD	After 6MWT Mean±SD	*P* Value (Paired T-test)
SpO_2 (%)	97.77±0.932	98.60±0.834	<0.0001
SBP (mmHg)	113.42±9.471	123.17±9.669	<0.0001
DBP (mmHg)	76.09±6.521	82.20±4.826	<0.0001
HR (bpm)	84.86±9.608	97.78±10.089	<0.0001

in females. There was statistical significance in SpO_2, systolic BP, diastolic BP and heart rate (P<0.0001) in Females.

DISCUSSION

The present study provides reference values for the variables measured in the 6MWT in healthy subjects of 17-50 years of age. Sample consists of people who are randomly chosen from the general population. Although the individuals included were selected primarily by age, they had a variety of occupations and were of different socioeconomic strata. Various conditions that can affect ambulation and cardio respiratory function constituted the exclusion criteria. Therefore, the volunteers that were included met the criteria for a sample to be used in the establishment of reference values.[2]

Because our sample comprised only those individuals who had never smoked and who had no signs or symptoms of respiratory disease (as determined with a validated respiratory epidemiology questionnaire), Spirometry was not performed. The exercise capacity of individuals without respiratory disease is limited by the cardiovascular and musculoskeletal systems rather than by pulmonary function.

This study applies the 6MWT protocol proposed by the American Thoracic Society guidelines.[1] In these guidelines, some recommendations and suggestions concerning technical aspects and quality assurance of the 6MWT are given. We used recommended length of the corridor was 30m so as to avoid too many turns during the test. One practice walk was taken to allow for the learning effect and encouragement was given regularly to ensure maximal motivation and performance.

In this study, we found that Heart rate, Systolic Bp and Diastolic Bp values before and after the 6MWT were significantly higher in males as compared to Females. (Table 7,8) Previous studies showed gender related differences in heart rate and reported an increase in resting heart rate in women.[3] additionally; Jones[4] reported higher heart rates in women following sub maximal exercise when compared to those of men. Difference in male and female can be explained by different in Baroreflex. Baro reflex heart rate regulation may be different between women and men and the effects of estrogen on baroreflex regulation can also occur in humans.[3]

The sample was well distributed according to age, considering the three age groups of (17-28) years, (29-39) years and (40-50) years with 80 individuals in each age group.(Table 1) The changes were recorded not only in the HR at the end of the test but also in the SBP, DBP and SpO_2. (Table 6)

In the present study, SpO_2 at the end of the 6MWT dropped no more than 2 points, a result that is in agreement with those of other studies involving normal individuals. (Before SpO_2=97.74±1.072 and After SpO_2=98.55±0.785). (Table 6) While in other studies consider that oxygen desaturation during exercise to be significant when there is a drop of ≥ 4% in baseline saturation.[5] Decrease in oxygen saturation less than 2% may be because of healthy subjects.

In the present study, systolic blood pressure and diastolic blood pressure changes at the end of 6MWT (DBP: Before 77.04±6.789 and after 82.97±5.340, SBP-before 114±9.812 and After 125.61±10.451) (Table 6) was found.

During exercise, Heart rate and systolic blood pressure goes up, because cardiac output increases to pump more blood and oxygen to working muscle. In people without hypertension, most types of exercise can push systolic blood pressure up to the range of 160 to 200mmHg and intense exercise such as weight lifting can temporarily push systolic blood pressure to even higher levels. Exercise also causes vasodilatation, or the widening of blood vessels, which increases blood flow and decreases peripheral resistance, which, in healthy people, prevents the rising of diastolic blood pressure during activity.

The present study showed the 6MWD of healthy Participants aged 17-50 years the Mean 6MWD was 506.70±510 m and range 350-670m. While a other study showed considerable variability in the 6MWD of healthy subjects aged 25-80years, 6MWD was Mean 495.09±83.85 m (range: 294-691m).[6]

In the present study, the variance in the distance covered during the 6MWT was explained by gender, age, height, Weight, BMI, Waist, Hip changes during the test. (Table 3)

Age, height, weight and BMI significantly influenced the 6MWD of our volunteers. These findings agree with previous studies.[3-9] The negative influence of advanced age on the 6MWD might be explained by the gradual reduction in muscle mass, muscle strength and maximal oxygen uptake that typically occurs with aging. (Table 3,4)

Other confounding factors may be racial, cultural differences, ethnic variances and difference in day to day physical activity. One such source is the psychological status related to exercise capacity in healthy Participants.

Another potential source of variance was the muscle strength of the participants, since we included in this study both physically active and sedentary healthy Participants.

CONCLUSION

The present study confirmed that several demographic and anthropometric factors can influence the 6MWT performance in healthy Participants. Moreover, the shorter distance walked by the older participants in present study may be explained by changes in skeletal muscles, as compared to the younger Participants. A gradual reduction of skeletal muscle mass and strength has been demonstrated in the elderly; however our findings suggest that the decline in skeletal muscle function can occur earlier.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

ABBREVIATIONS

MWT: Minute walk test; **SBP:** Systolic blood pressure; **DBP:** Diastolic blood pressure.

SUMMARY

Six minute walk test tells about the functional exercise capacity. Six minute walk test can be used for both normal as well as diseased individual. The aim of the present study was to find out the effect of six minute walk test in healthy adults of 17-50 years. The present study is a observational and cross section study. 240 healthy Participants who volunteered to participate were between the age of 17-50 years, free from Injury and with no History of hospitalization or chronic disease influencing their exercise capacity were recruited. Anthropometric variables (age, weight, height and Body Mass Index (BMI), were recorded before and after the test along with SpO_2), Heart Rate (HR), Blood pressure (BP) as well as Borg's Scale. The statistical analysis of the data clearly shows that all the parameters like SpO_2, Systolic BP, Diastolic BP and heart rate significantly increased after the 6 min walk test. The mean values of all the parameters like SpO_2, systolic BP, diastolic BP and heart rate after the 6 min walk test were calculated and compared with the mean values of same parameters before the 6 min walk test was performed. The difference in 6 min walk test among different variables like visceral fat, subcutaneous fat, skeletal muscle mass, total body fat as well as BMI were statistically significant except Waist Hip Ratio (WHR). Physiological responses of parameters like SpO_2, Systolic BP, Diastolic BP and Heart rate before and after 6 min walk test were statistically significant. (P<0.05). Six minute walk test is beneficial to determine cardiac efficiency and early detection of cardiac diseases.

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