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SIX MINUTE WALK DISTANCE AND SIX MINUTE WALK WORK IN NORMALWEIGHT AND OBESE YOUNG ADULTS

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ABSTRACT

Background: The six minute walk test (6MWT) is an example of a functional walk test that is practical and simple and only requires the ability to walk. The outcome of the 6MWT can also be expressed in terms of six minute walk work (6MWw) which is the product of body weight and 6MWD. **Objectives:** The study aimed to compare six minute walk distance (6MWD) and six minute walk work between normal weight and obese, to identify the determinants of 6MWD in normal weight and obese subjects. **Method:** After initial assessment 6MWT was conducted in 204 subjects (18-30 yrs), 102 normal weight and 102 obese subjects on a 30 m flat hard surface. 6MWw was calculated by: 6MWw (Kgm) = 6MWD (m) X Body Weight (kg). **Results:** 6MWD (m) in normal subjects was 867.41 ± 138.86 and in obese subjects was 785.39 ± 53.41. 6MWw (Kgm) in normal subjects was 40702.93 ± 11806.93 and in obese subjects was 67383.96±9273.87. Significant differences in 6MWD; 6MWw between normal weight and obese subjects were found. The determinants of 6MWD in normal subjects were gender and height. In obese subjects were BMI, gender and height were the determinants. **Conclusions**: It is important to consider factors influencing 6MWD in different weight categories, it will help in individualizing program for subjects of different stature.

KEYWORDS: Six minute walk distance, body weight, six minute walk work, functional capacity, obesity.

INTRODUCTION

Six minute walk test (6MWT) is a self-paced test that assesses the sub-maximal level of functional capacity.[1] It is an example of a functional walk test that is practical and simple and only requires the ability to walk.[2] The main outcome of the 6MWT is the distance walked (6MWD). The outcome of the 6MWT can also be expressed in terms of six minute walk work (6MWw) which is the product of body weight and six minute walk distance (6MWD) as it considers the energy required to move the body mass for a given distance.[2,3] It has been suggested that 6MWw can be used as an alternative means of measuring functional walking capacity.[4] In patients with lung disease, the 6MWw has demonstrated better sensitivity and specificity in identifying exercise intolerance than has 6MWD.[5]

Obesity increases the risk of developing severe cardiovascular, pulmonary and metabolic disorders. The World Health Organization has described obesity as one of the most abandoned public fitness problems, affecting all regions of the globe in the current times.[6] 6MWT is reproducible in obese subject proposing that it can be used to evaluate their global function. Some authors have recognized factors and devised equation demonstrating that body weight or the body mass index significantly affect the predicted 6MWD.[7] Obesity and its associated diseases are basically avertable by timely identification and treatment. There is an increased demand for clinical evaluation tools to assess functional capacity in obese subjects. Six minute walk test has been widely used to assess the functional capacity in diseased as well as normal individuals.

Thus the aim of this study is to compare the 6MWD and 6MWw among normal weight and obese young adults, Also to identify the factors influencing 6MWD and 6Ww in normal weight and obese young adults and to identify the determinants of 6MWD in normal weight and obese subjects.

MATERIALS AND METHODS

The study was carried out in 204 subjects (102 obese and 102 normal) randomly selected from among the students and staff of seven professional colleges in Kanpur city who were in the age group of 18 to 30 yrs. The study population was categorized into normal and obese based on the current lower cut-off points for BMI recommended by WHO. The BMI of normal subjects is between 18.5-24.9 Kg/m2 and obese is $\geq$30 Kg/m^2.

Subjects were included if they were asymptomatic with stable vital signs, life time nonsmoker, absence of any acute disease in the 6 weeks preceding the study. Criteria for exclusion from the study included resting heart rate (HR) ⩾100 beats per minute, systolic blood pressure >139 mmHg and diastolic blood pressure > 89 mmHg, any health problem or use of medication that might interfere with the normal walking ability (such as impaired sensation or cognition, metabolic, cardiac, neurologic or orthopedic disease, use of walking aids), individuals involved in regular exercise or sports, individuals with any answer as yes in PAR Q and YOU questionnaire, exposure of cigarette smoke in sleeping quarters, having stayed, for one year or more, in environments in which the concentration of dust was high and there was a risk of developing respiratory disease; having a history of exposure to smoke from wood-burning stoves, having history of tobacco use or present use of tobacco in any form, past or present consumption of alcohol in any form and pregnant females.

Body weight (in kg) was measured with a beam balance scale (Equinox, New Delhi, India) that was calibrated every month. Body height (in cm) was measured using a height scale (Avary Healthcare, Northampton, UK) and Body Mass Index (BMI = Weight/Height^2 kg/m^2) was calculated. Subject's systolic and diastolic blood pressures were also recorded using Digital Sphygmomanometer (HEM7111, Omron, Tokyo, Japan). Leg length was measured while standing and was taken from the greater trochanter of femur to the lateral border of the calcaneum.

The 6MWT was performed following standardized guidelines.[1] Each subject underwent the 6MWT in undisturbed indoor corridor that was 30 m, flat, straight course with a hard surface. The end of course was identified by two cones indicating the turn around points. Ten minutes before the test the subjects were made to sit in a chair located near the starting position. During this time baseline values were recorded. Standardized instructions and encouragements were used.[1] The subjects were asked to walk as far down the length of the corridor as they could at their own pace for six minutes. Standardized encouragement was given every minute during the test in the local language.[1] Subjects were allowed to stop during the test if they developed symptoms of dizziness, dyspnoea, leg cramps, or chest pain but was encouraged to continue walking as soon as they could. At the end of the test the 6MWD covered during the test was recorded.

Before and immediately after each test the following data were recorded: Heart rate (HR) and oxy-haemoglobin saturation (Finger Pulse-oxymeter, MD300C2, Beijing, China) rate of perceived exertion (Borg Rating of Perceived Exertion). Six Minute walk work was calculated by using the formula: 6MWw (kgm) = 6MWD (m) X Body Weight (kg).

All the tests were conducted by the same person. Also, all the tests were conducted between 9 am and 12 noon to avoid intra-day variability.

STATISTICAL ANALYSES

Mean and standard deviation (SD) for all continuous variables were calculated. The 6MWD and 6MWw between normal and obese subjects was compared by using the independent t test. Correlations were estimated using Pearson's coeffi cient of correlation for parametric data and Spearman's Rank coefficient of correlation for non-parametric data. Variables found to be significant at univariate analysis were further analyzed on a step wise linear regression analysis in order to identify independent parameters that were significant predictors of 6MWD in normal and obese subjects. A p value < 0.05 was considered as statistically significant. All the analysis was done using the software SPSS 16(SPSS, Inc., Chicago, Illinois).

RESULTS AND DISCUSSIONS

The characteristics of the subjects are summarized in the table 1. None of the subjects was involved in any kind of competitive sports activities. No test was terminated prematurely and no subject stopped during the test.

Table 1: Baseline characteristics of the subjects.

Characteristics	Mean±Standard Deviation	
	Normal weight Subjects (n=102)	Obese Subject(n=102)
Age (years)	23.40±2.16	22.30±2.34
Height (cm)	157.36±10.28	157.15±6.37
Weight (kg)	51.12±7.87	77.53±7.33
Body Index Mass (kg/m$^{2)}$	20.61± 1.69	31.47±1.07
Mean Leg Length(cm)	80.10±5.6	79.29±3.41

The sample size (n=204) was within the range of most of the previous studies, sample size varying from 35[8] to 444.[9] As far as possible, we controlled the procedural factors that affect the six minute walk test variability[1] with respect of contraindications, schedule of the test, and choice of supervisor, choice of corridor distance, standardized encouragement.

6MWT results are summarized in table 2. The results from the study show that the pre-test (at rest) systolic blood pressure,, diastolic blood pressure and heart rate

were greater in obese subjects as compared to normal weight subjects as in previous studies.[10,11] Previous studies have reported that there is decreased respiratory reserve and exercise tolerance in obese individuals compared to normal subjects.[11]

In the present study, the distance walked by normal subjects was found to be significantly higher as compared to obese subjects. The lesser 6MWD covered by obese subjects could be due to reduced muscle strength and higher fat mass which puts increased load on the joints, as well as from skin friction from the rubbing of obese limbs[12] as compared to the normal weight subjects.[1]

6MWw has been proposed by Chuang et al. as the measure of assessing the functional capacity during a 6MWT.[4] In the present study, the 6MWw of obese subjects was found to be significantly higher as compared to normal weight subjects. The possible explanation of this could be that obese subjects have greater body mass hence greater 6MWw. Iwama et al. also proposed that obesity increases the walk work.[14]

The resting heart rate, resting systolic blood pressure, resting diastolic blood pressure and post test heart rate were all significantly lower in normal weight subjects as compared to obese subjects (table 1).

Table 2: Results of 6MWT.

Characteristics	Mean ± Standard Deviation	
	Normal weight Subjects (n=102)	Obese Subject (n=102)
Resting Heart Rate (bpm)	81.3±7.9*	83.7±5.33*
Resting SBP (mmHg)	126.9 ±7.4*	130.42±8.05*
Resting DBP (mmHg)	79.95±6.3*	82.7±4.4*
Resting Rate of Percieved Exertion	.00±.00	.00±.01
Resting Oxy-hemoglobin Saturation (%)	98.53±0.52	98.58±0.50
Post test Heart Rate (bpm)	98.05±12.21*	10.5±11.23*
Post test Rate of Percieved Exertion	.55±.28	.61±.314
Post test Oxy-hemoglobin Saturation (%)	97.6±.63	97.9±.64
6MWD(m)	867.41±138.86	785.39±53.41
Difference in 6MWD between normal weight and obese subjects (m)	82.02 ±49.85*	
6MWw (kgm)	40702.93±11806.93	67383.96±9273.87
Difference in 6MWD between obese subjects and normal weight subjects (kgm)	26681.02±1417.97*	

**p = Significant at p < 0.05 (2 tailed), 6MWT= Six Minute Walk Test, BMI = Body Mass Index, SBP = Systolic Blood Pressure, DBP = Diastolic Blood Pressure, 6MWD = Six minute walk distance, 6MWw = Six minute walk work.*

The correlations of 6MWD in normal weight and obese subjects are summarized in table 3 and 4 respectively. Consistent with the previous studies, we found age correlated negatively with 6MWD in both the groups. Previous reports have hypothesize that the shorter distance walked as age increased can be explained by decreases in muscle mass and strength and the maximum oxygen consumption, inherent to the aging process.[14,15]

Height was found to have significant positive influence on 6MWDin both the groups but height had better correlation with 6MWD in normal weight group as compared to obese subjects. Mean leg length had significant correlation with 6MWD only in normal weight subjects. Previous studies have attributed positive relationships between height and 6MWD to increase leg length, which generates a longer stride which makes walking more efficient.[14] It is proposed that obese subjects have greater body weight and hence this puts increased load on the joints, as well as from skin friction from the rubbing of obese limbs.[12]

In the present study, weight was found to have a positive significant correlation with the 6MWD in normal weight subjects.[16] The positive relation of weight with distance walked may be due to the fact that our subjects were normal, lifetime non-smokers with absence of any disease and in BMI range of 18.5-25kg/m^2, a finding in line with previous studies. Weight negatively correlated with 6MWD in obese subjects as higher body weight decreases the distance walked.[14]

BMI had no significant correlation in normal weight subjects. This finding in consistent with previous studies.[16] However in obese subjects there was negative correlation of BMI with 6MWD as obesity decreases the distance walked.[17] .

In the present study it was found that the better the chronotropic response, the greater the 6MWD, also in agreement with previous findings.[9,16,21]

Table 3: Correlations of 6MWD in normal weight subjects.

Characteristics		Age (years)	Height (cm)	Weight (kg)	BMI (kg/m^2)	Mean Leg Length (cm)	Resting heart rate (bpm)	Post test heart rate (bpm)
6MWD(m)	r	-0.290	0.501	0.490	0.085	0.214	0.053	0.280
	p	0.003	0.0001	0.0001	0.398	0.032	0.596	0.005

r= correlation coefficient, p= level of significance, significant at p < 0.05 (2 tailed)

Table 4: Correlations of 6MWD in obese subjects.

Characteristics		Age (years)	Height (cm)	Weight (kg)	Mean Leg-Length (cm)	BMI (kg/m^2)	Resting heart rate (bpm)	Post test heart rate (bpm)
6 MWD	R	-0.223	0.451	-0.563	0.125	-314	-0.180	0.20
	P	0.04	0.001	0.0001	0.120	0.001	0.166	0.03

r= correlation coefficient, p= level of significance, significant at p < 0.05 (2 tailed), BMI=Body mass index.

The determinants of 6MWD in normal weight subjects were gender and height and obese subjects were gender, BMI and height (table5 and table 6). Both the equations showed relatively low variance. BMI did not influence 6MWD in normal weight subjects as proposed by previous studies that that inclusion of individuals with wider range of BMI is required for BMI to evaluate an effect on distance walked.[18] The findings of the present study are consistent with some of the previous which explained relatively low variance in the 6MWD (20-50%).[3,17,18,19,20]

Table 5: Determinants of 6MWD in normal weight subjects.

Model for normal weight subjects	Coefficients	Significance
(Constant)	201.71	.03
Gender (0 for male and1 for female)	-88.23	.004
Height (cm)	3.91	011
Dependent variable is six minute walk distance Variance is 0.31		

Table 6: Determinants of 6MWD in obese subjects.

Model for obese subjects	Coefficients	Significance
(Constant)	342	0.023
Gender (0 for male and1 for female)	31.1	0.0001
BMI	-0.08	0.001
Height	2.11	0.005
Dependent variable is six minute walk distance	Variance is 0.34	

The present study has some strength. As per our knowledge we were not able to locate any literature in India assessing the normal values and differences of 6MWw particularly in young adults of normal weight and obese group. The previous studies have documented that 6MWw assesses the functional capacity better than the 6MWD and also reflects the work energy expenditure. It has also been reported that normal values are used as standard and are required for quantification of magnitude of data. We were also able to see the demographic and physiological factors that influenced 6MWD in normal weight and obese subjects. We proposed determinants of 6MWD in normal and obese group of young adults. We studied only demographic and physiological features that were easy to be obtained accurately in routine clinical settings and were not time consuming.

Limitations of the study were: The sample size was small and included only young adults. Variables which have established their effect on exercise performance like lean body mass, psychological factors, such as anxiety and depression, peripheral muscle strength (specially hamstring, quadriceps and gastrocnemius), level of motivation, walking efficiency were not studied and can be taken into account in future studies. Prospective validity of the developed reference equation has not been checked.

In conclusion, different factors contribute to 6MWD in normal weight and obese subjects. Thus, it is important to consider the factors influencing the 6MWD in different weight categories as will help in individualizing the exercise program for subjects. 6MWw should also be considered for widespread assessment of walking ability.

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