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Research Article

Normative data of distance covered, heart rate, blood pressure and rate of perceived exertion during 6 minute walk test on 20 meter long corridor among smokers

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ABSTRACT

Background-According to American Thoracic Society, the standardized length of corridor for conducting a 6 Minute Walk Test is 30 meter & it avoids the use of shorter corridor, since subject is required to take more turns and hence more exertion. The present study was planned to gather normative data of the distances covered, physiological vitals and subjective exertion rating on different lengths of corridor. Design: We performed an observational, pre-test and post-test study. Aim and objectives: Our aim was to gather the normative data of the distance covered, heart rate, blood pressure, respiratory rate and perceived exertion ratings during 6 minute walk test on 20 meter long corridor among smokers. Subjects and methods: 100 male smokers in the age group 20 to 50 years were considered for present study. Measurements of HR, BP, RR, and RPE on Modified Borg's scale, was taken before and after 6MWT on 20 meter length of corridor. 6MWD was also documented & compared at the end of 6MWT (as per ATS). Results: Normative data of the distance covered, heart rate, blood pressure, respiratory rate and perceived exertion ratings during 6-minute walk test on 20 meter long corridor among smokers.

1. Introduction

The six minute walk test (6MWT) is a quick and inexpensive way of measuring physical function is the ability to ambulate for a distance, as it reflects the capacity of a person to undertake physical activity**[1]**. The 6-min walk test (6MWT) evaluates functional exercise capacity, which is reflective of individual's capacity to perform the activities of daily living**[1,2]**. It is a form of clinical evaluation which measures the performance through a sub-maximal effort**[3]**. In clinical practice and research, functional exercise capacity is commonly measured by six-minute walk distance (6MWD)**[4]**.

The 6MWT is a practical and simple test, which requires only 100 ft (30 meter) hallway, and no exercise equipment or advanced training for technicians**[5].** The 6MWD is used to measure the maximum distance walked by a person in 6 minutes**[6]**. Evaluation of global and integrated responses of all the systems which are involved during exercise such as the pulmonary and cardiovascular systems, systemic circulation, peripheral circulation, blood, neuromuscular units, and muscle metabolism is done by 6MWT**[5].**

For the measurement of exercise functional capacity in a number of conditions such as severe COPD, chronic renal failure and pulmonary hypertension, the self-paced exercise test has been adopted**[7-9]**. The 6MWT is a useful tool in management and prognostication of pulmonary and cardiovascular diseases. Smoking of tobacco significantly reduces the cardio-respiratory functions**[10]**. Cigarette smoking is associated with low exercise capacity. A decline in exercise capacity with increasing age has been shown to be greater among smokers than non-smokers**[11]**. Smoking is the single most important cause of morbidity and mortality in industrialized countries**[12]**. In the year 2010, Rexhepi AM *et al.* investigated the influence of smoking and physical activity on pulmonary function, and the study revealed the effects of smoking and physical activity on decreasing, respectively increasing of respiratory abilities**[10]**.

6 minute walk distance (6MWD) is an important outcome measure of the 6MWT. The measurement of functional capacity by the 6MWD has been demonstrated to be reliable and valid to a good extent**[13-15]** and availability of published normative tables have enhanced its utility**[1-3]**. The applicability of 6MWT has been wide as it requires less technical expertise and little equipment, and it is also inexpensive and easy to administer**[13]**. The performance in elderly subjects and in patients with cardiopulmonary diseases can be affected by demographic anthropometric, clinical, and physiologic characteristics**[13,14]**. According to the American Thoracic Society (ATS), the variables used in the test, besides the walked distance, should evaluate the overall response of

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the systems involved, such as the cardiopulmonary and musculoskeletal systems[15]. The distance walked during the test is considered a criterion for prognosis of the functional capacity and length of the corridor can influence the distance covered[15-17].

Despite the ATS standardization for the length of the corridor during the test for adults 100 ft (30 meters), some studies have used different lengths in order to make test performance viable[16-18]. In the year 2011, Veloso-Guedes CA *et al.*[19] did a study on men on liver transplantation waiting list to validate 20 meter corridor for 6 Minute walk test. They concluded that a 20 meter corridor can be used safely and effectively as an alternative to 30 meter for the 6MWT for male patients with cirrhosis on the liver transplantation waiting list[19]. In the year 2010 a comparative analytical study of 6 minute walk test was done by Aquino ES *et al.*[20] in healthy children and adolescents, they concluded that there were differences in walked distance between the corridors; however they were less than 10% with no significant changes in the other measured parameters. Therefore, the 20 meter corridor had a good reproducibility for the population of this study. Weiss RA, *et al.* in the year 2000 presented a paper at ACCP Conference in which reliability and effect of walking course layout and length of 6 minute walk test in severe COPD patients was done. They concluded that Layout of the track had effect on the 6MWD. With regards to the distances between the start and the end points, it was found that from 50-164 ft, and there was no difference between walking distances[21].

Thus, the purpose of this study is to investigate the feasibility of a 20 meter 6MWT as a measure of functional status among smokers and to gather normative data during 6MWT on 20 meter long corridor.

2. Aims & objective

The aim of study was to gather normative data about the distance covered, heart rate, blood pressure, respiratory rate and perceived exertion ratings during 6 minute walk test on 20 meter long corridor among smokers.

SAMPLE

Sample size

A total of 100 subjects were selected for the study on the basis of inclusion criteria.

Source

All the subjects were recruited from the patient and their relatives or accompanists visiting HAHC Hospital, HIMSR, Jamia Hamdard, New Delhi.

The subjects were matched according to the following criteria.

METHOD OF SELECTION

INCLUSION CRITERIA

- Age: 20-50 years
- Both males and females.
- Current smokers.
- BMI →18 kg/m^2 -25 kg/m^2,
- Absence of any acute disease during six week preceding the study[21]
- Stable vitals

EXCLUSION CRITERIA

Subjects with:-

- Subjects taking oral tobacco
- Any health problem that might interfere with the ability to perform physical exercise or in which physical exercise is contraindicated.
- Exercising > 3 hrs/week
- Diabetes
- Hypertension, B.P ≥ 139/ 89 mm of Hg.
- k/c/o Coronary artery disease k/c/o Cor- pulmonale

VARIABLES

- Six minute walk distance
- Respiratory rate
- Heart rate
- Rate of perceived exertion.
- Blood pressure

Research methodology

Informed written consent was taken by all subjects. A randomized pre test-post test design was used. All subjects were studied between 9 am-1 pm on weekdays .Subjects were asked to abstain from caffeine for 4 hours before test session.

All the subjects underwent through the examination and investigation. After proper assessment of the subjects 30 minutes rest period was given. The 6-MWT was conducted according to ATS guidelines[13]. The subject's resting heart rate, blood pressure, saturation and rate of perceived exertion (RPE) were recorded prior to test. The subjects walked from one end to the other end of a 30 meters hallway at their own pace, while attempting to cover as much ground as possible in the allotted 6 minutes. Subjects were encouraged with the standardized statements like "You are doing well" or "Keep up the good work". Subjects were allowed to stop and rest during the test, but were resumed to walking as soon as they felt able to do. Heart rate, blood pressure, RR, & RPE were monitored.

CURRENT SMOKERS[3,4]

Those persons who had smoked ≥100 cigarettes in their lifetime, and have been smoking since 5 years and are currently smokers.

Cumulative smoking exposure in smokers is determined in terms of pack-years by multiplying the number of years smoked with the average number of packs per day.

Based on pack-years of smoking, subjects are classified as never smokers (0.0 pack-years), light smokers (0.1-20.0 pack-years), moderate smokers (20.1-40.0 pack-years), and heavy smokers (> 40 pack-years).

Statistical Analysis

Spearman rank correlation coefficient was used to evaluate the correlation between the parameters. For within group analysis, paired t test was used. A "p" value of 0.05 was considered to be significant. All values are presented as the mean (SD) and 95% confidence interval, unless stated otherwise.

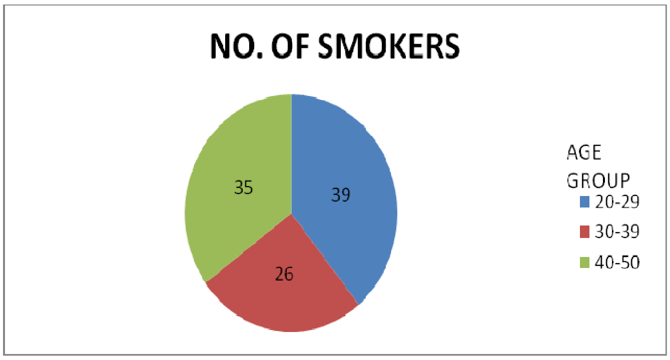
Result

SUBJECT CHARACTERSTICS

100 Asymptomatic smoker (male) subjects were included in the study within the age group of 20-50 years.

Table No. 1: Age group of smokers

AGE GROUP (in years)	NUMBER OF SMOKERS (N=100)
20-29	39
30-39	26
40-50	35



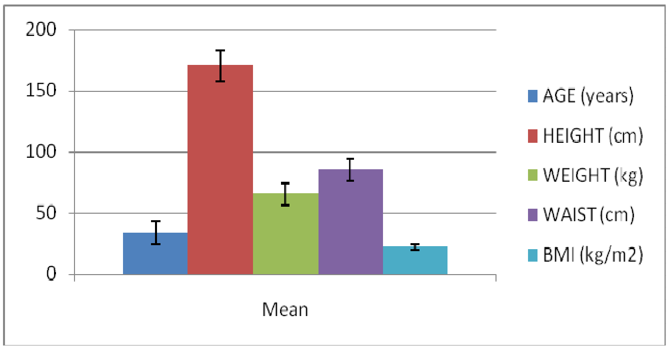
Graph No. 1: Age group of smokers

Table 2: Percentage of Smokers

N=100	% OF SMOKERS
BIDI	44%
CIGARETTE	49%
BOTH	7%

Table No. 3: Demographic data of smokers

DATA	MEAN ± S.D
AGE (year)	33.93 ± 9.34
HEIGHT (cm)	170.33 ± 7.38
WEIGHT (kg)	65.56 ± 8.91
WAIST (cm)	85.11 ± 8.90
BMI (kg/ m^2)	22.51 ± 1.94



Graph No. 2: Demographic data of smokers

Table No. 4: Resting & Post 6MWT HR during 6 MWT on 20 meter long Corridor

N=100	MEAN±S.D
PRE 6MWT HEART RATE (20)	76.3±8.0 beats/minute
POST 6MWT HEART RATE (20)	91.77±11.77 beats/minute

Mean 6MWD covered during 6MWT on 20 m corridor was 583.32±86.63 meter

Table No. 5 Resting & Post 6MWT systolic blood pressures during 6 MWT on 20 meter long Corridor

N=100	MEAN±S.D
PRE 6MWT SYSTOLIC BLOOD PRESSURE (20)	123.60±8.39 mm/hg
POST 6MWT SYSTOLIC BLOOD PRESSURE (20)	139.58±9.99 mm/hg

Table No. 6: Resting & Post 6MWT diastolic blood pressures during 6 MWT on 20 meter long Corridor

N=100	MEAN±S.D
PRE 6MWT DIASTOLIC BLOOD PRESSURE (20)	80.14±5.75 mm/hg
POST 6MWT DIASTOLIC BLOOD PRESSURE (20)	86.22±6.40 mm/hg

Table No. 7: Resting & Post 6MWT respiratory rates during 6 MWT on 20 meter long Corridor

N=100	MEAN±S.D
PRE 6MWT RESPIRATORY RATE (20)	18.41±3.70
POST 6MWT RESPIRATORY RATE (20)	25.76±4.32

Table No.8: Resting & Post 6MWT perceived exertion rates during 6 MWT on 20 meter long Corridor

N=100	MEAN±S.D
PRE 6MWT RATE OF PERCIEVED EXERTION (20)	0.15±0.11
POST 6MWT RATE OF PERCIEVED EXERTION (20)	1.39±1.48

Discussion

6MWT is a simple, reliable & economic tool to assess the functional capacity of a person, as it doesn't require instruments and special skill[2]. It has been found that chronic smoking affects young male smokers' cardiovascular fitness, impairing the economy and hence decreases the capacity of their circulatory system. The smokers have impaired exercise tolerance and their maximal exercise test duration time is shorter. So, 6MWT serves as one of the best tool in assessing the functional capacity of smokers. Current ATS guidelines prescribes the use of an indoor or outdoor corridor with a flat surface of 30 meter in length, however, not all institutions have such long corridors to perform the 6MWT, which hinders or prevents its application and the consequent realization of its benefits. So, a study was done in 100 smokers to gather normative data of HR, RR, BP, RPE and the distances covered during 6MWT on 20 meter long corridor. Pre and post test vitals were recorded prior to and post 6MWT conduction.

Similar study was conducted by Veloso Guedes CA *et al.*[19] & colleagues, they validated 20 meter corridor for patients with liver cirrohsis waiting for the liver transplant. In the present study, the 6MWD covered during different lengths of corridors did not show any significant difference. The 6MWD covered on 20 meter corridor was 583.32±86.63 meter. Aquino ES *et al.*[20] did a comparative study in children and adolescents by performing 6MWT in 20 meter and 30.5 meter corridors, and in present study the non-significant difference in the 6MWT vitals and 6MWD were similar to that. So, the present study was aimed at gathering normative data of HR, RR, BP, RPE and 6MWD in smokers during 6MWT when performed on 20 meter long corridor.

Effect on heart rate (20 meter corridor)

In the present study, significant difference was found between the mean resting heart rate (76.3±8.0 beats/minute) and mean post 6MWT HR (91.77±11.77 beats/minute) (p=0.000). The significant rise in the heart rate was due to the fact that, heart rate increases immediately at the onset of activity as a result of parasympathetic withdrawal. As exercise continues, further increase in heart rate occurs due to the action of the sympathetic nervous system[22]. In the present study HR elevated immediately after the 6MWT, which was in correspondence to Fleck *et al*.[23], 1988 results which showed that HR increases significantly after a bout of exercise, which appears to be related to neural influences. Since we know that onset of light to moderate intensity exercise increases the SV and HR, thereby increase CO to meet the metabolic demand of the body. HR is also influenced by some other factors including body position, certain physical condition, state of health, blood volume and environment.

Effect on Blood Pressure (20 meter corridor)

In the present study there was found to be significant difference between the mean resting blood pressure and mean post 6MWT blood pressure.

Post 6MWT Mean systolic blood pressure (139.58±9.99 mm/hg) was found to be significantly higher as compared to the mean resting SBP (123.60±8.39 mm/hg) (p=0.000). The resting diastolic blood pressure (80.14±5.75 mm/hg) showed a significant rise post 6MWT (86.22±6.40 mm/hg). In the present study SBP as well as DBP increased significantly after 6MWT. Finding of this study, of increased SBP was supported by the various studies, but there is a very few literature support on increased post exercise DBP.

The increase in systolic blood pressure was due to increase in cardiac output. Cardiac output increases due to increase in both stroke volume (SV) and heart rate (HR). The increase in stroke volume results from an increase in venous return, which, in turn, increases the left ventricular end–diastolic volume (LVEDV) (preload). The increased preload stretches the myocardium and causes it to contract more forcibly in accordance with the Frank-Starling law of the heart. Contractility of the myocardium is also enhanced by the sympathetic nervous system, which is activated during physical activity. Thus, an increase in the left ventricular end diastolic volume and a decrease in the left ventricular end systolic volume (LVESV) account for the increase in stroke volume during light to moderate dynamic[24].

Jothi K *et al*.,[25] conducted the study on, fifteen male kabaddi players in the age group of 20 to 25 years had also suggested the same finding that systolic blood pressure rises with increasing dynamic work as a result of increasing cardiac output, whereas diastolic pressure usually remains about the same or may be heard to zero in some normal subjects. The slight decrease in diastolic blood pressure is primarily due to the vasodilatation of the arteries from the exercise bout. ACSM guideline (6th edition) for exercise testing has also given the similar interpretation for SBP in individuals which supported to our finding.

In the present study DBP also increased significantly. The significant increase in post test DBP of smokers in the present study results could be due to smoking behaviour. This hypothesis was supported by Aronow *et al.*[26], they demonstrated the positive effect of smoking on blood pressure and concluded the significant increase in SBP, DBP as well as pulse rate.

Effect on respiratory rate (20 meter corridor)

There was significant change in the resting respiratory rate (18.41±3.70) and post 6MWT respiratory rate (25.76±4.32) (p=0.000). This can be attributed to the fact that the ventilation increases linearly with increases in work rate at submaximal exercise intensities and the increase in pulmonary ventilation is attributable to a combination of increases in tidal volume and respiratory rate. Other theories are that the rise in body temperature may play a role, or that collateral branches of neurogenic impulses from the motor cortex to active muscles and joints may stimulate the brain stem and respiratory centre leading to hyperpnoea, & hence increase in respiratory rate[27].

Effect on perceived exertion rate (20 meter corridor)

Significant difference was found in the resting RPE values (0.15±0.11) and post 6MWT RPE values (1.39±1.48) (p=0.000). The increase in perceived value of exertion was in accordance with AACVPR findings, which states that the Borg rating increases linearly with HR and VO2 as exercise intensity increases. It correlates with ventilatory minute volume, CO_2 production, lactate accumulation, and body temperature. FEV1 r = 0.88. These investigators reported a strong linear relationship between Modified Borg Scale (MBS) ratings and respiratory effort when combined with exercise. Similar results were found in the study done by Wilson and Jones, who compared the use of a visual analogue scale and the MBS to measure dyspnea in healthy young volunteers during exercise. These investigators similarly reported that good correlation exists between the intensity of breathlessness described by MBS and the amount of work done during exercise. Belman *et al*.[28] found that the MBS was a reliable tool for quantifying dyspnea in subjects with COPD who were undergoing a 6-minute treadmill walk.

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