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Original Research Article

NORMATIVE VALUES FOR INCREMENTAL SHUTTLE WALK TEST IN RURAL CHILDREN AND YOUNG ADOLESCENTS: AN OBSERVATIONAL STUDY

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ABSTRACT

Background: Cardiopulmonary exercise testing is the criterion standard for assessing exercise capacity. It provides complete assessment of the respiratory, cardiac and metabolic system. As a cost effective way of assessing the physical function of an individual, Incremental shuttle walk test and Six minute walk test are most frequently applied in diagnostic as well as therapeutic purpose. It is especially important to understand how children and adolescents respond to exercise because fitness plays important role in management of obesity to develop lifelong healthy habits. With increased in number of children with obesity due to changes in lifestyle, physiological aspects such as growth and development is also getting affected. Hence assessing fitness in children as current need of society, reference values estimation implies significant role in betterment of younger population.

Objective: The purpose of this study is to find out the reference values for incremental shuttle walk test in age group 8 - 16 years and to correlate age, height, and weight and body mass index with incremental shuttle walk test.

Methodology: 180 subjects were selected from the age group of 8 -16 years. The subjects in this study were recruited from local and primary school. Before starting the test, weight and height was measured by calibrated weighing scale and stadiometer by standard anthropometric methods. The three trials were given to subjects and mean of measures was taken for further analysis of data.

Results: Data was checked for normality by using Shapiro-wilk test. Linear regression analysis using age, height, weight, and gender were applied with ISWT as a dependent variable. There was significant correlation with age (boys r= 0.8354, p< 0.0001 & girls r=0.808, p< 0.0001), Height (boys r=0.8475 & p<0.0001, girls r=0.8746 & p< 0.0001), and there was no significant correlation with BMI (boys r= -0.312 & p=0.148, girls r= -0.069 & p=0.956).

Conclusion: The reference values were generated for age group 8 to 16 years. It can be used as a reference to evaluate exercise capacity for children and adolescents in Indian rural population

KEY WORDS: Incremental Shuttle Walk Test, rural population, young adults, reference values.

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INTRODUCTION

Exercise constitutes a major physiological stress that can lead to untoward response in patients as well as in normal individuals [1].

Physical therapists are clinical exercise specialists who apply exercise as an assessment and diagnostic tool and treatment. Exercise testing provides information on the level of exercise that the subjects can perform without undue stress [2].

Exercise testing is useful to determine functional capacity. There are two types of exercise testing 1. Maximal exercise testing 2. Submaximal exercise testing.

Maximal exercise tests either measure or predict maximum oxygen consumption(Vo2) max and have been accepted in determining fitness [1].

Maximum oxygen consumption is dependent on the ability of the oxygen transport system to deliver blood and the ability of cells to take up and utilize in energy production [1].

A maximal test is defined by a plateau of Vo2 with further increase in work load.

Maximal exercise testing is considered the gold standard for assessing maximal aerobic capacity or functional work capacity but this test may be limited by complaints such as exertion, dyspnoea,fatigue,weakness and pain during their the activities of daily living; Maximal testing is often contraindicated or is of limited value [1].

Sub maximal exercise testing can be used to predict vo2 max,to make diagnosis and assess functional limitations, to assess the outcome of interventions such as exercise programs and to examine the effect of recovery strategies on exercise performance. Thus using sub maximal function test provide more realistic stimulation of one's physical capability, so it is a method of choice of physical therapist to assess the functional capacity of individual [1]. The treadmill and cycle ergometry are the most commonly used devices in clinical exercise testing, but they are not familiar and are very expensive.

Field test such as 'submaximal exercise tests' are started to be also used for prediction of walking performance for predetermined distance. They are significantly used over machines hence cost effective way of assessing the physical function of an individual. The test includes on an important component of day to day life such as quality of walking. Among submaximal tests, Incremental shuttle walk test and Six minute walk test are most frequently applied in diagnostic as well as therapeutic purpose. Clinicians can apply this test to assess the exercise capacity of healthy individuals as well as disease condition. Hence it can be used as important tool in pulmonary rehabilitation as well as cardiac rehabilitation.

It is especially important to understand how children and adolescents respond to exercise because fitness plays important role in management of obesity to develop lifelong healthy habits [3-6].

As obesity can be a great risk factor for cardiovascular disease, it is important need for taking preventive measures in controlling the epidemic of obesity.

Incidence of obesity among children was more found in the age group of 8-16 years. The factor responsible for this was highly correlated with lack of physical activity. Hence further leading to decreased aerobic capacity as well as many health problems [4-8]. According previous studies, the subjects of age group of 8-16 years are in the highest percentage of developing body fatness. Hence this age group can develop various risk factors such as high blood pressure, high total cholesterol and low physical activity index [3-6].

Earlier few studies in the incremental shuttle walk test were done in children, but in groups of subjects with physical dysfunction.[7-9]The test were used in individuals with cardio pulmonary diseases, neurological conditions, older population and athletes [10-12]. But before evaluating for children with impairment, it is necessary to evaluate its parameter in healthy subjects aged 8-16 years to find out their exercise tolerance and endurance. But as there is the lack of incremental shuttle walk test reference values in normal healthy subjects aged 8-16 years, there is limitation in using clinically in this age group. There is also limited literature evidence found with regard to such data in rural population. So the purpose of this study is to find out reference values of incremental shuttle walk distance in rural children and young adolescents and correlate to correlate age, height, weight and body mass index with incremental shuttle walk distance.

METHODOLOGY

Subjects who met inclusion and exclusion criteria were included in the study. Ethical clearance was obtained from the institutional ethical committee. The subjects in this study were recruited from local primary and secondary schools in and around Loni. Before recruiting a health talk was given to the school principal. An informed consent was taken from the school principal.

Before starting the test, weight and height was measured by calibrated weighing scale and stadiometer by standard anthropometric methods. After completion of demographic data, incremental shuttle walk test was performed.

The test was conducted in the school playground. The walking course was 10 m in length and marked with cones. The subjects were standing behind one of the lines facing the second line and began walking when instructed. This test involves continuous walking between two lines 10 meters apart (consider as one shuttle).They started walking at a very slow speed set by metronome. While walking around the 10 meter course, they had to turn around a cone at the first beep, and around the second cone at the next beep. The beeps were gradually getting faster and faster. Initially speed was 0.5m/s which increased by 0.17m/s each minute. The pace were continue to increase until they were not able to keep up with set pace, or until they felt too breathless to continue.

After completion of the test, total number of distance covered by the subjects were measured by total number of shuttles as outcome measure and also the distance were correlated with Age, height, weight, BMI and peak VO2 for incremental shuttle walk test.

Fig. 1: Participants performing Incremental Shuttle Walk Test.

Data Analysis: The statistical analysis was performed using the statistical packages SPSS 16.0. The normality of data distribution was checked by the Shapiro-Wilk test. Data were described as median (interquartile range 25% to 75%).The outcome parameters were compared with Wilcoxon test. Mann-Whitney U- test was used for the comparison of the subjects' characteristics between male and female genders. The correlation coefficients were calculated by spearman correlation. The model of multiple linear regression were applied for ISWT distance as dependent variable with other data such as, demographic and anthropometric data as independent variables since it presented as normal distribution. The level of statistical significance was considered as $p < 0.05$.

Table 1: Demographic representation of gender.

Gender	Total
BOYS	90
GIRLS	90

Table 2: Demographic representation of age.

AGE	No. of subjects
8	20
9	20
10	20
11	20
12	20
13	20
14	20
15	20
16	20

Table 3: Mean BMI and Distance covered (m) in Boys.

AGE	Mean (BMI)	MEAN(Distance)
8	17.91	194
9	17.725	284
10	18.01	261
11	21	330
12	19.825	469
13	20.421	567
14	20.41	586
15	21.93	657
16	19.146	718

Table 4: Mean BMI and Distance covered (m) in Girls.

AGE	Mean (BMI)	MEAN(Distance)
8	17.725	186
9	17.696	259
10	18.01	300
11	21	346
12	19.827	514
13	20.427	539
14	19.827	592
15	19.146	600
16	21	650

Table 5: Demographic representation between distance and gender.

GENDER	Boys	Girls
MEAN	441	435
SD	181	172

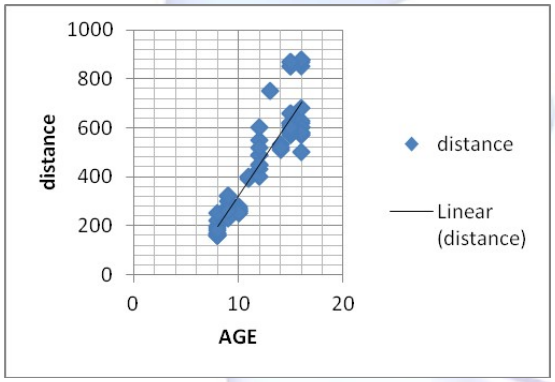
Table 6: Karl Pearson correlation between age and distance covered in boys and girls.

	Boys		Girls	
	r value	p value	r value	p value
Age vs Distance covered	0.8354	<0.0001	0.808	<0.0001

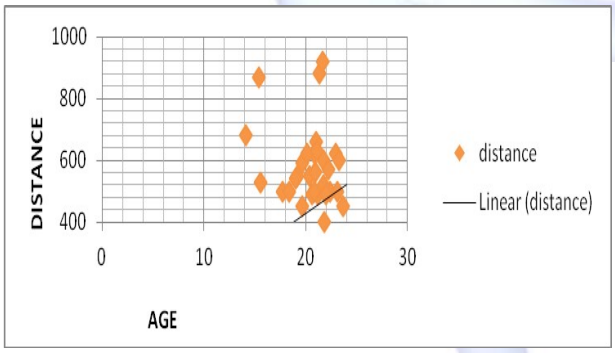
Distance: Age and distance covered in boys and girls shows a positive correlation with r values of 0.8354and 0.808.And considered extremely significant at p<0.0001 in boys and girls respectively.

Graph 1: Age and distance covered between the age group of 8-16 years in Boys and Girls.

BOYS.



GIRLS



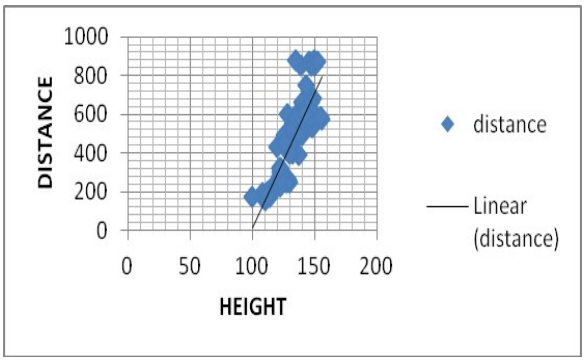
Results show that as the age increases, the distance covered by both boys and girls increased. Karl Pearson correlation was used to correlate age with distance. So there is a positive correlation between age and distance covered in both boys and girls.

Table 7: Karl Pearson correlation between Height and distance covered in boys and girls.

	Boys		Girls	
	r value	p value	r value	p value
Heightvs Distance covered	0.8475	<0.0001	0.8746	<0.0001

The height and distance considered extremely significant at p<0.0001 in boys and girls respectively.

Graph 2: Height and distance covered between the age group of 8-16 years in Boys.



Graph 3: Height and distance covered between the age group of 8-16 years in Girls.

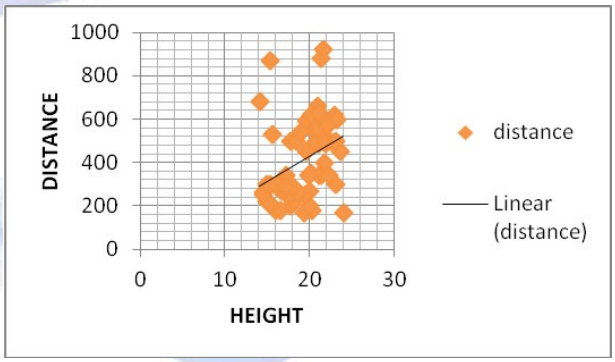
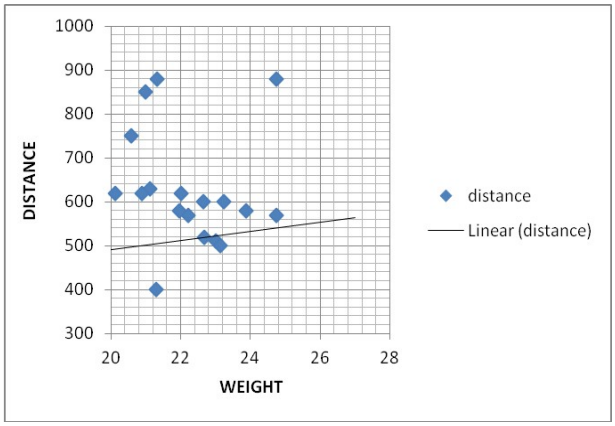


Table 8: Karl Pearson correlation between Weight and distance covered in boys and girls.

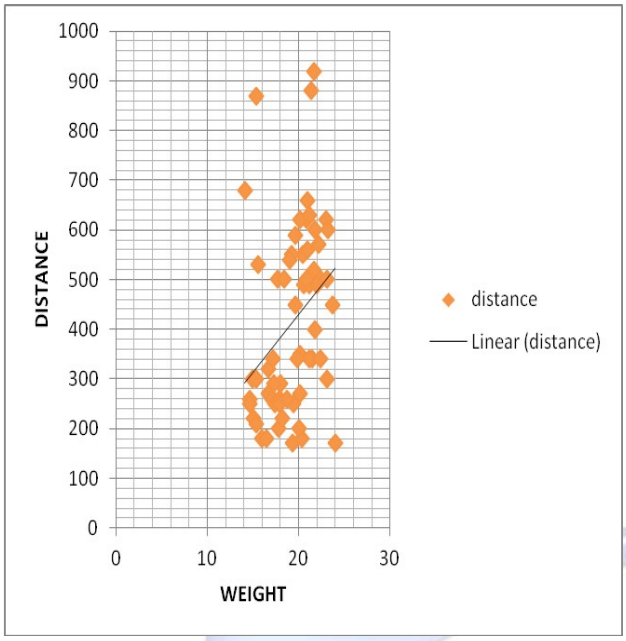
	Boys		Girls	
	r value	p value	r value	p value
Weight vs Distance covered	-0.139	0.527	-0.141	0.521

Results show that among the same age group, as the weight increases the distance covered is decreased in boys and girls. Hence, there is negative correlation between weight and distance.

Graph 4: Weight and distance covered between the age group of 8-16 years in Boys.



Graph 5: Weight and distance covered between the age group of 8-16 years in Girls.

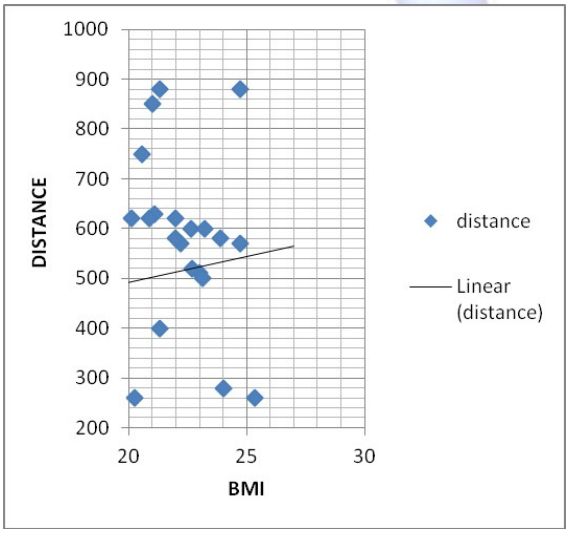


Results show that among the same age group, as the weight increases the distance covered is decreased in boys and girls. Karl Pearson correlation was used to correlate weight with distance. Weight correlated with distance within the same age group shows negative correlation. Weight correlated with distance between the age group of 8-16 years in boys and girls shows a negative correlation.

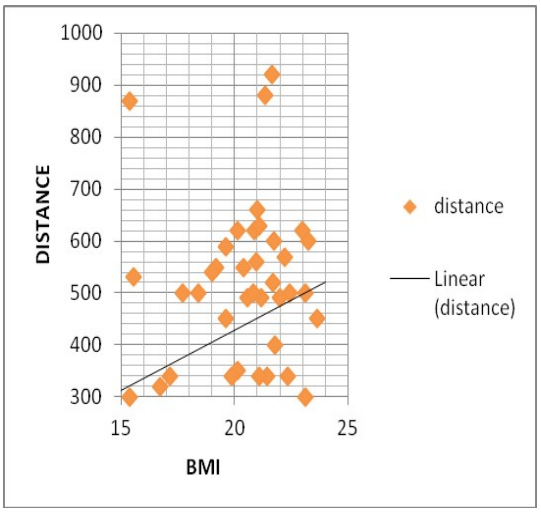
Table 9: Karl Pearson correlation between Body Mass Index and Distance Covered in Boys.

	Boys		Girls	
	r value	p value	r value	p value
BMI vs Distance covered	-0.312	0.148	-0.069	0.756

Graph 6: BMI and distance covered between the age group of 8-16 years in Boys.



Graph 7: BMI and distance covered between the age group of 8-16 years in Girls.



Results show that as the BMI increases the distance covered by both boys and girls were decreased. Karl Pearson correlation was used to find out the correlation between BMI and Incremental shuttle walk distance. BMI correlated within the same age group showed a negative correlation.

DISCUSSION

The study was intended to find out reference values for incremental shuttle walk test in healthy subjects aged 8-16 years and to find out the correlation of age, height, weight and BMI with incremental shuttle walk distance. As per the statistical analysis, reference values for incremental shuttle walk test was established in healthy subjects aged 8-16 years in boys and girls respectively of rural population.

In this study, boys were able to cover more distance compared to girls within the same age group due to more muscle mass resulting in higher levels of physical activity in boys when compared to girls. This increase in physical fitness influences increase in incremental shuttle walk distance. Another possibility is that boys were significantly taller than girls which could explain the gender difference in the distance covered in incremental shuttle walk test.

This study showed that as the age increases, the distance covered by both boys and girls increased. Hence, there is a positive correlation between age and distance covered in both boys and girls strongly significant with p less than 0.001 with a r value for the age group of 8-16 of 0.8354 and 0.808 for boys and girls respectively.

Hormonal changes such as increase in progesterone and testosterone is important factor for physical fitness in girls and boys respectively. Progesterone helps in increasing fatty deposition while testosterone increases muscle mass [13]. As a result of puberty in boys and girls and a better exercise tolerance as the age increases the distance covered were increased.

Comparison of height and distance shows directly proportional giving a positive correlation between height and distance covered extremely significant with p less than 0.01 with a r value 0f 0.8475 & 0.8746 for boys and girls respectively. The study done previously explains with longer stride length and step length due to increase height resulting in longer distance walked in taller boys and girls as well as difference in endurance levels [14].

The results of this study showed with increased in weight there is decreased in distance, hence negative correlation between weight and distance .The reason behind the negative correlation between weight and distance is that there is varying weights within same age group. Subjects who were under category of Higher BMI walked less distance due to the increase in body fat because their bouts of walking were shorter. Maffeis C et al studied the energy expenditure of obese and nonobese children and adolescents during walking and found that obese children and adolescents had an increase in absolute energy expenditure. The greater rate of energy expenditure in children was attributable to excess load from increased body weight. Exercise intolerance of overweight subjects could be attributed to increased energy demands as a re-sult of the extra load from excess adiposity [15].

When comparing BMI with incremental shuttle walk distance, as the BMI increases the distance covered is decreased. BMI correlated within the same age group shows a negative correlation. BMI correlated with distance between the age group of 8-16 years shows a negative correlation. The reason is applicable same as weight correlated with distance.

Subjects who were overweight, moving their lower limb significantly induced greater absolute oxygen uptake and lead to consumption of a significantly larger proportion of their cardiorespiratory reserve.Increased fat mass is associated with decreased exercise performance in overweight children and adolescents [16].

A larger waist circumference increases risk for a given BMI category [13]. Waist circumference reflects the role of abdominal visceral fat in increasing subjects risk for disease. An increase in waist circumference and BMI significantly resulted in decline in walking distance in obese subjects. Subjects, who had a higher mean BMI walked significantly less, took significantly fewer steps and ambulated at a lower speed. A subject with significantly lower fat mass walked with faster walking speed. A decrease in BMI was associated with increasing number of steps and distance covered.

CONCLUSION

Based on the statistical outcome and available literature, it is concluded that normative values for incremental shutlle walk test in rural children and young adolescents aged 8-16 years was established and age , height had a positive correlation with incremental shuttle walk distance while weight, BMI had a negative correlation with incremental shuttle walk distance.

Conflicts of interest: **None**

REFERENCES

[1]. Noonan V,Dean E.Submaximal exercise testing: Clinical application and interpretation.Phy Ther: 2000;80(8):782-807.

[2]. Karlman Wasserman,James E Hansen. Principles of exercise testing and interpretation.Third edition.1999.

[3]. Alison E Field,Nancy R. Cook,Mathew and W.Gillman.Weight status in childhood as a predictor of becoming overweight of hyper tensive in early adulthood.Obesity research 2005;13:163-169.

[4]. Jorge Mota,Luana Flores,Luis Flores ,Jose C Ribeiro,Mario P. Santos.Relationship of single measures of cardio respiratory fitness and obesity in young school children.Am J Hum Bio 2006;18:335-341.

[5]. Yanis Manios et al .Behavioral and physiological indices related to body mass index in a cohart of primary school children in Greece.Am J Hum Biol 2004;16:639-647.

[6]. Jose carlos Ribeiro,Sandra Guerra,Jose Oliveira,Lars Bo Andersen,Jose Alberto Duarte,Jorge Mota.Body fitness and clustering of cardiovascular risk factors in Portugese children and adolescents.Am J Hum Biol.2004;16:556-562.

[7]. W.Moalla,R.Gauthier,Y.Maingourd,S.Ahmaidi. The incremental shuttle walk test walking to assess exercise tolerance and cardiorespiratory responses during training program in children with congenital heart disease.Int J Sports Med 2005;26:756-762.

[8]. Swishner et al. Influence of lean body mass and leg muscle strength on. The incremental shuttle walk test performance in children with cystic fibrosis. Cardiopulmonary Physical Therapy Journal Sep 2005.

[9]. Gulmans V.A.M, Van Veldhoven N.H.M.J,De.Meer K,Helders P.J.M. The incremental shuttle walk test in children with cystic fibrosis:Reliability and validity.Pediatric pulmonology 1996;22:85-89.

[10]. Jurgensen SP, Antunes LC, Tanni SE, Banov MC, Lucheta PA, Bucceroni AF, et al. The incremental shuttle walk test in older Brazilian adults. Respiration. 2011;81(3):223-228.

[11]. Anne E Holland, MartijnA.Spruti, Milo A.Puhan.et all. An official European respiratory society/ American Thoracic society technical standard: field walking tests in chronic respiratory disease.erj. ersjournals.com 2014;44:1428-1446.

[12].Vanessa S, Probst, Nidia A. Hernandes, DenilsonC.Teixeira, Sally Singh.et all.Reference values for the incremental shuttle walking test. Res Med 2012;106:243-248.

[13]. Jack H. Wilmore, David L.Costill. Physiology of exercise testing and interpretation,3rd edition 1999.667-668.

[14]. Li A M et al. Standard reference values for the six minute walk test in healthy children aged 7-16 years.Am J Respir Crt Care Med 2007;176:174-180.

[15]. Maffeis C, Zaffanello. M, Pinelli. L, Schutz. Total energy expenditure and pattern of activity in 8-10 year old obese and non obese children. Journal of Pediatric Gastroenterology and Nutrition 1996;23(3):256-261.

[16]. Troosters T, Gooselink R and Decramer M. Six minute walk test in healthy elderly subjects.EurRespir J 1999;14:270-274.

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