



## NORMATIVE VALUES OF INCREMENTAL SHUTTLE WALK TEST IN CHILDREN AND ADOLESCENTS: AN OBSERVATIONAL STUDY

VISHNU VARDHAN<sup>1</sup>, TUSHAR PALEKAR<sup>2</sup>, PRIYANKA DHUKE<sup>3\*</sup>, GAURANG BAXI<sup>4</sup>

<sup>1</sup>Assistant Professor, Cardio Pulmonary Physiotherapy Department, Dr. D.Y.Patil College of Physiotherapy, Dr. D.Y. Patil Vidyapeeth Pune, India

<sup>2</sup>Principal and Professor, Dr. D.Y.Patil College of Physiotherapy, Dr. D.Y. Patil Vidyapeeth Pune, India

<sup>3</sup>Post Graduate, Dr. D.Y.Patil College of Physiotherapy, Dr. D.Y. Patil Vidyapeeth Pune, India

<sup>4</sup>Associate Professor, Cardio Pulmonary Physiotherapy Department, Dr. D.Y.Patil College of Physiotherapy, Dr. D.Y. Patil Vidyapeeth Pune, India

### ABSTRACT

Introduction - Cardiopulmonary exercise testing is the criterion standard for assessing exercise capacity. It is an important tool that provides complete assessment of the respiratory, cardiac and metabolic system. Objective - The purpose of this study was to find out the reference values for incremental shuttle walk test in children and adolescents and to correlate age, height, and weight and body mass index with incremental shuttle walk test. Method - 180 subjects were selected from the age group of 10 -16 years. The participants in this study were recruited from Schools in and around Pimpri. Weight and height was measured by calibrated weighing scale and stadiometer by standard anthropometric methods. 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 ( $r = 0.430$ ,  $p = 0.000$ ), gender ( $p = 0.560$ ), and there was no significant correlation with BMI ( $r = 0.041$ ,  $p = 0.584$ ). The variables included in the predicted equation were age, gender, body mass index. The predicted value for girls is 0 and for boys is  $1. ISWT_{pred} = 28.930 + (40.784 * age) - (20.739 * gender) - (3.479 * BMI)$ . Conclusion - The reference values were generated for 10 to 16 years of age group. The purpose of the study established a prediction equation for ISWT which can be used as a reference to evaluate exercise capacity for children and adolescents.

**KEYWORDS:** Incremental Shuttle walk test, Reference values, Age, Height, Weight, Body mass index.



**PRIYANKA DHUKE\***

Post Graduate, Dr. D.Y.Patil College of Physiotherapy,  
Dr. D.Y. Patil Vidyapeeth Pune, India

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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.<sup>1</sup> 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.<sup>2</sup> Singh J et al did a study to assess to develop a standardized and externally paced field walking test to assess patients in Chronic Obstructive Pulmonary Diseases. They compared the usefulness of 12 level incremental shuttle walk test and six minute walk test. The study concluded that 12 level incremental shuttle walk test was a standardized incremental field walking test that provokes a symptom limited maximal performance and helps in assessing the functional capacity of patients.<sup>3-8</sup> However, the lack of literature in incremental shuttle walk test in normal healthy subjects aged 10-16 years hinders the usefulness of the test in this age group. As the incremental shuttle walk test was designed primarily for adults with chronic airways obstruction<sup>3</sup>, hence the reference equation in adults was developed, but incremental shuttle walk test has been less explored in this age groups. There is also lack of enough literature evidence with regard to such data in Indian population. Hence, the aim of this study was to find the reference values of incremental shuttle walk distance in children and adolescents of age group 10-16 years and correlate age, height, gender and BMI with Incremental Shuttle Walk Distance.

## MATERIALS AND METHODS

### Methods

Study Design - Descriptive Study  
 Sample Size - 180  
 Sampling Method - convenient sampling  
 Study Setting - In and around pimpr

### Materials

Countdown timer  
 Two small cones to mark around the turn around point  
 Inch tape  
 Weighing machine  
 Height stadiometer

### Procedure

The study was approved by the institution ethical committee of Dr.D.Y.Patil Vidyapeeth. Participants who met inclusion and exclusion criteria were included on the

study. The subjects in this study were recruited from local primary and secondary schools. Before recruiting a health talk was given to the school principal. An informed consent was taken from the school principal and parents. Before starting the test, the weight and height was measured by standard anthropometric methods. After completion of demographic data, ISWT was performed. Subjects were explained about whole procedure. During this test they would asked to walk between two cones spaced 10 meters apart. They would begin by walking at a very slow pace; this pace is set by a beep. Walking around the 10 meter course aiming to turn around a cone at the first beep, and around the second cone at the next beep. The test was conducted in the school playground. The walking course selected was 10 m in length and marked with cones. The subject was instructed before starting the test. The no. of laps covered by the subjects was calculated by measuring distance and VO<sub>2</sub> peak. After the completion of the test, the total distance covered by the participants and the peak VO<sub>2</sub> was calculated and noted down as the value using the formula:  $(4.19 + (\text{walking distance} * 0.025))(\text{ml}/\text{min}/\text{kg})$

### Outcome measure

1. Incremental Shuttle Walk Distance
2. VO<sub>2</sub> Peak  $(4.19 + 0.025(\text{distance}) \text{ ml}/\text{min}/\text{kg})$

## STATITICAL ANALYSIS

### Shapiro – wilk test

The test uses the principle of to check the normal distribution of population from taken samples.

### To check the normality following steps are carried out

Arrange the given data in ascending order Rearrange the data in ascending order so that  $x_1 \leq \dots \leq x_n$

### Regression and correlation analysis

Regression analysis helps to find out the relation between dependent and independent variables. As a model of relationship is used as hypothesized, and develop an equation of regression using the parametric values. To see the satisfactory various tests are used and if it is found to be satisfactory the equation is used for both dependent and independent variables to predict the value. As in correlation the analysis is done to estimate correlation coefficient of samples. It helps to analysis the correlation between the variables which can be positive or negative.

## RESULTS

Table 1  
 Demographical representation of age

Age	No. of subjects
10	10
11	48
12	56
13	39
14	16
16	11

**Table 2**  
**Mean BMI and Distance Covered in boys and girls.**

Age	Mean BMI	SD	Mean( distance) m
10	16.24	3.20	409m
11	17.19	3.27	421.45m
12	17.62	3.78	454.48m
13	17.81	2.26	466.41m
14	21.39	3.64	378.12m
16	19.66	2.82	750.90m

**Table 3.**  
**Mean Height and Distance Covered in boys and girls**

Age	Mean (height)	Mean(Distance)	SD
10	1.34	409	90.732
11	1.42	421.45	116.29
12	1.49	454.48	110.91
13	1.52	466.41	84.80
14	1.48	378.12	50.75
16	1.57	750.90	111.93

Table 3 shows that as the height increases the distance covered by both boys and girls also increases.

**Table 4**  
**Mean Vo2 Peak and Distance Covered and Height in boys and girls**

Age	Mean Vo2 Peak	SD	Mean(Distance)
10	14.41	2.26	409
11	14.73	2.90	421.45
12	15.58	3.01	454.48
13	15.85	2.12	466.41
14	13.64	1.27	378.12
16	22.96	2.79	750.90

Table 4 shows that as the age increases, the Vo2 Peak and Distance increases.

**Table 5**  
**Table between Gender and Mean BMI**

Gender	Mean bmi	Sd
Boys	17.67	3.61
Girls	18.06	3.27

Table 5 shows that BMI of Girls is more compared to boys which signify that distance covered by Boys were more compared to Girls

**Table 6**  
**Table between Gender and Distance**

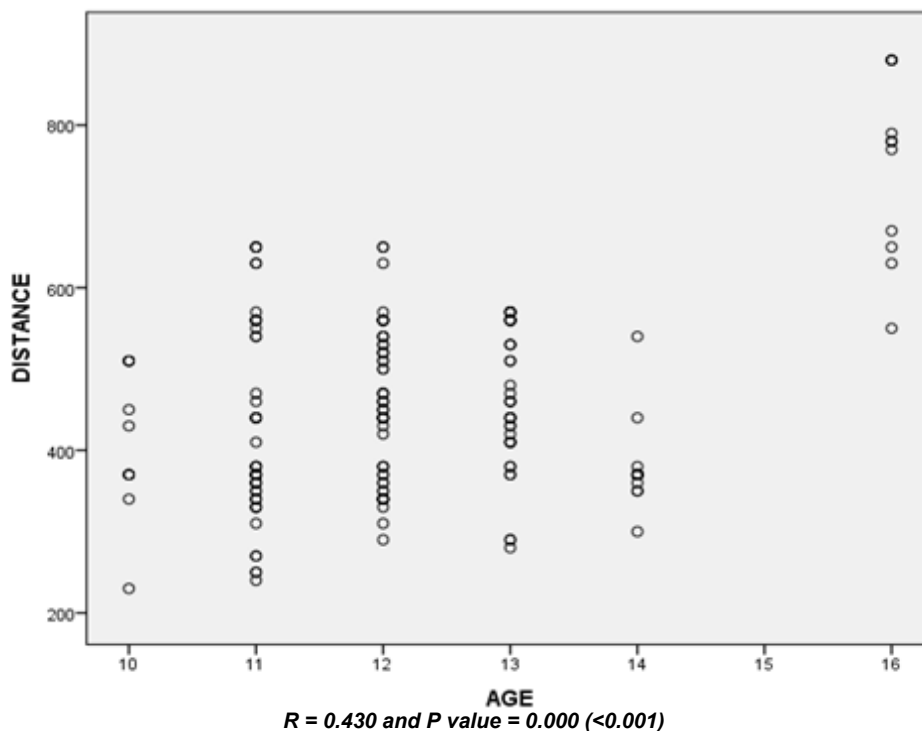
Gender	Mean distance	SD
Boys	450.36	124.76
Girls	445.32	85.59

Table 6 shows that the distance covered by boys is more as compared to girls.

**Table 7**  
**Table between Gender and Vo2 Peak**

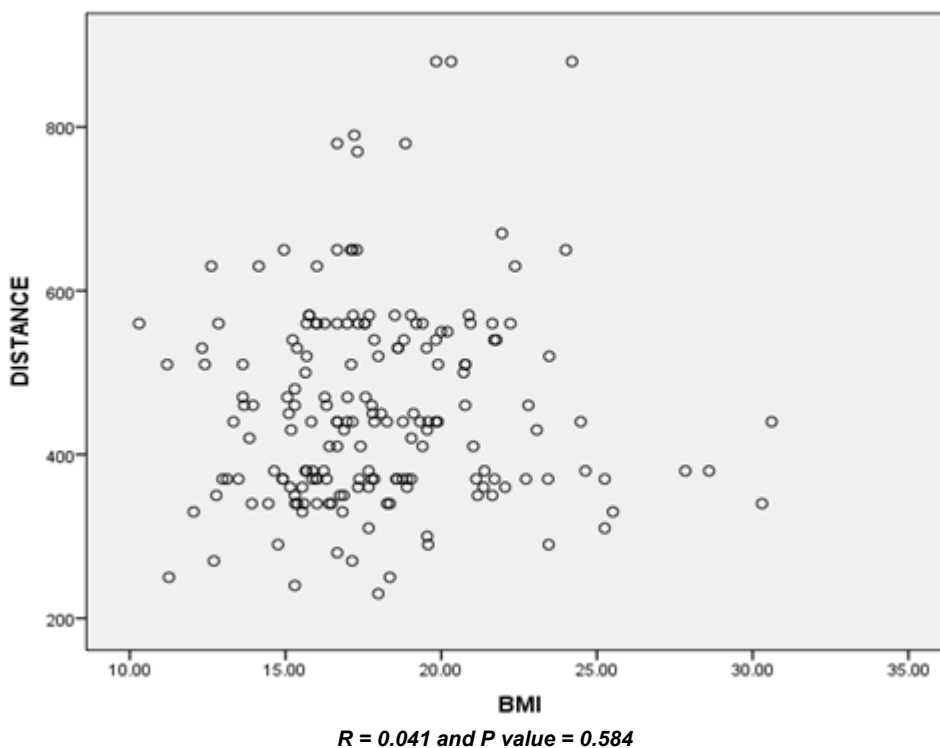
Gender	Mean Vo2 Peak	SD
Boys	15.46	3.10
Girls	15.33	2.13

Table 7 shows that there is an increase in Vo2 Peak in Boys compared to Girls



Graph 1 show that as age increases the distance covered by both girls and boys is increased and is significant

**Graph 1**  
**Correlation of age with ISWT**



**Graph 2**  
**Correlation of BMI with ISWT**

Graph 2 shat Incremental shuttle walk distance and BMI has no correlation and is not significant.

**DISCUSSION**

Studies of Incremental Shuttle walk test values are largely based on data from individuals more than 40 years of age, effectively excluding data of children from

10 to 16 years. As the gender is also influenced by distance walked during Incremental shuttle walk test because of greater muscle strength, girth of muscle and height of boys in comparison with girls, the distance covered by boys was more compared to girls in the same age group. Li et al study states that due to greater

muscle mass and their ability to achieve higher levels of physical activity boys were able to cover more distance than girls. Physical fitness was higher among boys when compared to girls as an important determining factor for incremental shuttle walk distance. Another possibility is that boys were significantly taller than girls which could explain the gender difference in the distance covered incremental shuttle walk distance.<sup>9</sup> When comparing age with distance covered, statistical analysis showed that as the age increases, the distance covered by both boy and girls increased. After puberty boys increase muscle mass and girls increase fat mass under the influence of testosterone and oestrogen respectively. As we grow the gap in the maximal strength measures widens between boys and girls, as maturity progresses becoming more evident in upper body and lower body locations. As a result of puberty in boys and girls and a better exercise tolerance as the age increases the distance covered were increased. This may be the positive reason as the age increases the distance covered are increased. When comparing height with incremental shuttle walk distance covered, as the height increases, the distance covered by both boys and girls increased. So there is a positive correlation between height and distance covered. The reason behind as the height increases the distance covered is increased is specifically due to tall height is associated with longer stride length and step length which makes walking more efficient, probably resulting in longer distance walked in incremental shuttle walk distance.<sup>9</sup> When comparing BMI with incremental shuttle walk distance, as the BMI increases the distance covered was decreased. 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. A larger waist circumference increases risk for a given BMI category stated by Wilmore.<sup>10</sup> 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.<sup>11</sup>

The present study shows that as the height of the

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individual increases, the distance covered by the participant increases. This is due to longer stride length. This results in an increase in VO<sub>2</sub> peak. Even as the age increases the VO<sub>2</sub> peak increases because of the distance covered by them. The aim of having reference value for the VO<sub>2</sub> peak from the ISWT is to see the maximum performance achieved during field test. The subjects maximum walking speed can also be a reliable indicator of the intensity of endurance exercise. The incremental increases in HR, inspiratory flow and VO<sub>2</sub> during the test explain that the shuttle walking test provokes a gradual increase in physiological response during exercise. The progressively increase in intensity signifies the low risk of test. Hence, by this study normative values for Incremental Shuttle Walk distance for children and adolescents in the age group 10 -16 years.

## CONCLUSION

Reference values for Incremental shuttle walk distance were generated for children and adolescents. Incremental Shuttle walk test is a standard test for assessing the functional capacity. 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. By establishing normative values for Incremental Shuttle walk distance, this test can be used to assess the physical capacity in Children and adolescents.

### Limitations

The primary limitation of this study is small sample size. Unequal gender distribution of the students included. Study was done from one school only. Unequal number of subjects in different age group. Time limit of physical education period.

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## CONFLICT OF INTEREST

Conflict of interest declared none

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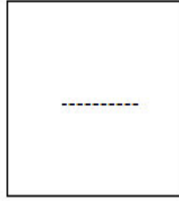
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## Reviewers of this article



**G. Deepthi**

Lecturer, Dept of Physiotherapy, Saveetha University, Chennai, Tamilnadu, India.



**Dr. Manisha A. Rathi, Mpht, Ph.D**

Professor, Dept. of Community, Physiotherapy, Dr.D.Y. Patil college of Physiotherapy, Pimpri, Pune.



**Prof. Dr. M. Ranga Priya, M.Pharm., Ph.D., R.Ph.**

Professor, Dept of Pharmaceutics, Sun Institute Of Pharmaceutical Education & Research, Kakupalli, Nellore Rural, Nellore, Andhra Pradesh 524346



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Asst. Editor, International Journal of Pharma and Bio sciences.



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