



**COMPARISON OF MAXIMAL AEROBIC POWER BETWEEN BOYS AND GIRLS  
OF THE INDIAN ADOLESCENTS**

**Badshah Ghosh<sup>1</sup>, Ph.D, Ghosh B. \* Ph.D**

<sup>1</sup>Department of Physical Education, Panskura Banamali College, West Bengal, India.

<sup>2</sup>Asst. Professor

**Abstract**

*The present investigation was undertaken by the investigator with an attempt to compare the maximal aerobic power between adolescent boys and adolescent girls of the central part of central zone of India. The subjects for this study were a total of 2010 subjects viz. 1005 boys and 1005 girls and their age were divided into three categories i.e. 12 to below 14 years, 14 to below 16 years and 16 to below 18 years of age. The selected physiological variable was considered important for research because it would provide us a true picture of cardiovascular endurance in general and  $VO_2$  max in particular of adolescent boys and girls of the selected area. To compare the maximal aerobic power between adolescent boys and adolescent girls of central part of central zone of India, the Descriptive statistics and t test was used. The average values of maximal aerobic power of boys: 12 to below 14 years ( $18.07 \pm 1.86$  ml/kg/min), 14 to below 16 years ( $26.21 \pm 2.68$  ml/kg/min) and 16 to below 18 years ( $37.15 \pm 3.54$  ml/kg/min) respectively. The average values of maximal aerobic power of girls: 12 to below 14 years ( $17.39 \pm 2.14$  ml/kg/min), 14 to below 16 years ( $25.17 \pm 2.73$  ml/kg/min) and 16 to below 18 years ( $35.83 \pm 2.78$  ml/kg/min) respectively. The present study reveals that significant difference exists between adolescent boys and adolescent girls at different age group (i.e. 12 to below 14 years, 14 to below 16 years and 16 to below 18 years of age) in relation to maximal aerobic power.*

**Keywords:** Maximal Aerobic Power, Central Zone, Maximum Oxygen Uptake, Adolescent.



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## **Introduction**

Fundamental to success in any facet of living is good health and it cannot be achieved in youth unless growth and development takes place in an acceptable manner. A sound body is necessary for the child to achieve his full potentiality.

The modern age is an age of space adventurism and technology. Machines which man built for the purpose of adding comforts to his life, have, now so much pervaded his existence that it is somewhat difficult to do away with the human dependence upon machines, they have become part and parcel of our life and in this process man himself has become an automation. Modern man in comparison to the primitive man is poorer and inferior with regard to physical fitness. Physical fitness is prime necessity to get the outmost out of life and to enable us to live most and serve best. The comment of late J. F. Kennedy, former President of United State of America, emphasized physical fitness as not one of the important keys to a healthy body but as the basis of dynamic and creative intellectual activity. Children are said to be the citizens of tomorrow and builders of the nation. Their smiles inspire the hope and they are the pioneers of a brighter tomorrow. But the state of children in this country is miserably languishing in innocence and silence. The findings of national and international organizations reveal the plight of our children and call for an all out effort to save these withering blossoms from further degeneration and disruption.

Both heredity and environment provide for greater variations in growth. These variations complicate the job of the educator, especially physical educator. An important step in establishing the educational process for children is to understand the nature of the child as revealed by his biological, psychological, emotional and social needs. Teachers, coaches and researchers, who work with children, must understand the needs and characteristics of these children that motivate and structure the behavior of the various age levels (Harold M. Barrow, 1991 ). The physical education teacher must understand the children and their level of physical development and maturity. Several research studies have been undertaken in this field to find out the degree of differences of boys and girls at the same age level in their physical development and maturation. In early childhood, the growth and development of the child goes in a uniform manner (Hagen, Dexter and Williams, 1951). A person with a high  $VO_2$  max necessarily has good function in each of these determinants. Conversely, a

sedentary person has relatively poor function for each determinant, which results in a low  $VO_2$  max (Mc. Ardle, Katch and Katch, 1991).

The  $VO_2$  max test provides important information on the capacity of the long-term human energy system. This measurement has significant physiologic meaning in that attaining a high  $VO_2$  max requires a high level of respiratory, cardiovascular, and neuromuscular functions. Therefore,  $VO_2$  max is an important measurement of fitness for athletes and coaches. It has been established that  $VO_2$  max is correlated with performance, especially in endurance sports.  $VO_2$  max is maximum oxygen that human can consume during exercise in one minute (Hill & Rowell, 1996). Peak  $VO_2$  increases with age in both boys and girls, both in absolute terms and with body size and composition accounted for but boy's value are higher than the those of girls even during pre-pubertal years (Maffulli et al., 2001).

There are numerous published charts of normative values for maximal oxygen uptake ( $VO_2$  max) that categorize aerobic fitness by percentiles based on age and gender. The most commonly used is a table of percentile values with specific reference to age and sex published by the American College of Sports Medicine. However, most of these charts are based on the general population of the United States and therefore are not relevant for use in other countries. Additionally, it is difficult to find a current normative value table for those under age 20. A literature review found some tables giving normative values for athletes in various sports, but there are several problems with these. But no literature has been found by the scholar where normative value table has been prepared on the Indian adolescents. For instance, tables published in Exercise Physiology textbooks currently used in university-level classes often use data that mixes professional, elite, collegiate, and Olympic athletes (Robergs, 2002), that to study taken on American citizen or data compiled from studies that are up to 40 years old (McCardle, 1997).<sup>4, 5</sup> Thus, there is a need for a new table that compares  $VO_2$  max among adolescent boys and adolescent girls of India.

### *1.1 Objective of the Research*

Sports have gained tremendous popularity all over the globe during the last few decades. The popularity of sports is still increasing at a fast pace and this trend is likely to continue in the future. India the largest democratic is not lagging behind in this aspect. India is often referred as the land of contrast with a population of over 1 billion. The diversity in its culture, customs, foods, languages and moods are glaringly visible. Since in India many youths and adults do not fully understand and appreciate the importance of health and fitness, a heavy responsibility rests on the shoulders of teachers and coaches. The main objective of the study

was to find out the true picture of cardiovascular endurance in general and VO<sub>2</sub> max in particular of the adolescents of the central part of the Central zone of India.

The outcome of the study would not only help the trainers to know the physical standard of the children for which accordingly they would be trained but also to develop health related physical fitness program or training schedule. This study would also help to know the strong and weak point of the selected population.

### **Materials and Methods**

The purpose of the study was to find out the difference between the maximal aerobic power of the adolescent boys and girls and then further divide the group into three age categories so that the cardiovascular efficiency could be assessed and then further compared in relation to the growth.

#### *1.2 Subjects*

The subjects for this study were a total of 2010 subjects viz. 1005 boys and 1005 girls. 1005 boys and 1005 girls were selected under three age categories i.e. 12 to below 14 years, 14 to below 16 years and 16 to below 18 years of age. Thus, each age group of boys and girls consisted of 335 subjects. The subjects of the study were selected at random. Only healthy adolescents were selected on the basis of teachers of their respective school's appraisal. For the true representation of the subjects the scholar selected them only from the schools of State Government and Private Schools, since students of original natives of that particular area whose parents had been spanning the entire strata in terms of economic consideration belong to those schools. The subjects belonged to different socio-economic status.

The Archeological survey of India divided the country into six divisions viz. West, East, North, South, Central and the North East zones. In this study the scholar confined the study only into the central zone. Then with the help of experts the central zone was further sub divided into five parts using Bonne's Projection method (Sarkar, 2006) those were East, West, North, South and Central. The Central Zone of India is comprised of Madhya Pradesh and Chhattisgarh states. In this study the scholar confined the study only into the central part of the central zone of India.

#### *1.3 Procedure*

Indirect measurement of maximal aerobic power was applied by using Astrand and Astrand Nomogram. Indirect measurement of maximal aerobic power was conducted because of reliability and administrative feasibility on a large number. To obtain required data for the study a step up test was adopted to assess VO<sub>2</sub> max of adolescent boys and girls by Astrand and Astrand Nomogram. For the step up test the subjects were asked to step all the way up on

the bench each time with the body erect. The stepping process was performed in four counts as: The stronger foot placed on bench; other foot placed on the bench; stronger foot placed on floor; other foot placed on floor. Soon after the cessation of 5 min. exercise on the bench, heart rate was recorded from 0 to 10 seconds, which was further converted to 60 seconds in terms of number of beats/min. Maximal Aerobic Power ( $V_{O_2}$  max) was measured in  $ml.kg^{-1}.min^{-1}$  using Astrand and Astrand Nomogram.

#### *1.4 Pilot Study*

One pilot study was conducted to assess the optimum workload (number of steps per minute) which brought the heart rate of the subjects approximately between 125 to 170 beats/minute after 5 minutes of step ups exercise on specific high benches. The height of the benches were for boys 14” for 12-14 years of age; 16” for 14-18 years of age and for girls 13” for 12-14 years of ages and 14” for 14-18 years of ages. It was found the boys of 12-14 years with 36 steps and of 14-18 years with 32 steps achieved the target heart rate. Further the girls of 12-14 years with 34 steps and of 14-16 years with 34 steps and 16-18 years with 30 steps achieved the target heart rate

### **Results**

The results found after analyzing the data have been presented in the following tables.

**Table-1: Mean and Standard Deviation of Different age group Boys and Girls in Relation to Maximal Aerobic Power**

Age category	GENDER	Mean (ml/kg/min)	S.D.
12 to below 14 Years	Boys	18.07	1.86
	Girls	17.39	2.14
14 to below 16 Years	Boys	26.21	2.68
	Girls	25.17	2.73
16 to below 18 Years	Boys	37.15	3.54
	Girls	35.83	2.78

The average values of Maximal aerobic power of Boys: 12 to below 14 Years ( $18.07 \pm 1.86$  ml/kg/min), 14 to below 16 Years ( $26.21 \pm 2.68$  ml/kg/min) and 16 to below 18 Years ( $37.15 \pm 3.54$  ml/kg/min) respectively. The average values of Maximal aerobic power of Girls: 12 to below 14 Years ( $17.39 \pm 2.14$  ml/kg/min), 14 to below 16 Years ( $25.17 \pm 2.73$  ml/kg/min) and 16 to below 18 Years ( $35.83 \pm 2.78$  ml/kg/min) respectively.

**Table-2: Mean comparison of maximal aerobic power between boys and girls (12 to below 14 years) of the central part of central zone of India**

Adolescent Boys	Adolescent Girls	Mean Difference	Std. Error Difference	df	t
18.07	17.39	0.68	0.154	668	4.39*

\*Significant at 0.05 level of confidence

$$t_{.05}(668) = 1.96$$

The above table reveals that significant mean differences was found between Adolescent boys and adolescent girls in relation to Maximal aerobic power as the calculated value of 't' = 4.39 is greater than the tabulated  $t_{.05}(668) = 1.96$ .

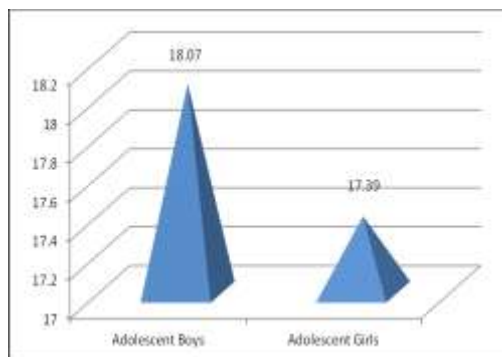


Fig. 1 Graphical representation of maximal aerobic power between boys and girls (12 to below 14 years) of the central part of central zone of India

**Table-3: Mean comparison of maximal aerobic power between boys and girls (14 to below 16 years) of the central part of central zone of India**

Adolescent Boys	Adolescent Girls	Mean Difference	Std. Error Difference	df	t
26.21	25.17	1.04	0.209	668	4.98*

\*Significant at 0.05 level of confidence,

$$t_{.05}(668) = 1.96$$

The above table reveals that significant mean differences was found between Adolescent boys and adolescent girls in relation to Maximal aerobic power as the calculated value of 't' = 4.98 is greater than the tabulated  $t_{0.05} (668) = 1.96$ .

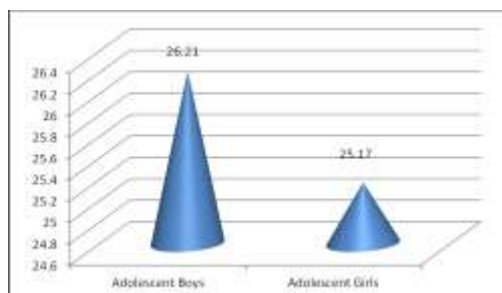


Fig. 2 Graphical representation of maximal aerobic power between boys and girls (14 to below 16 years) of the central part of central zone of India

**Table-4: Mean comparison of maximal aerobic power between boys and girls (16 to below 18 years) of the central part of central zone of India**

Adolescent Boys	Adolescent Girls	Mean Difference	Std. Error Difference	df	t
37.15	35.83	1.32	0.245	66	5.37
				8	*

\*Significant at 0.05 level of confidence

$$t_{0.05} (668) = 1.96$$

The above table reveals that significant mean differences was found between Adolescent boys and adolescent girls in relation to Maximal aerobic power as the calculated value of 't' = 5.37 is greater than the tabulated  $t_{0.05} (668) = 1.96$ .

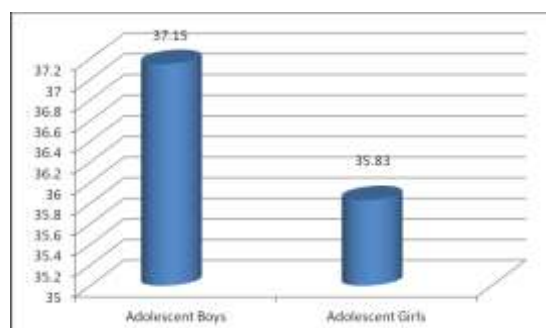


Fig. 3 Graphical representation of maximal aerobic power between boys and girls (16 to below 18 years) of the central part of central zone of India

### Discussion and Conclusions

The present study revealed that significant difference was found in case of adolescent boys and adolescent girls. The apparent gender difference in max  $VO_2$  has generally been ascribed



to difference in body composition and hemoglobin content. Untrained young adult women generally possess about 26% body fat where as the corresponding value for men averages 15%. The present study can be support by the findings of Andersen L. B., et.al (2005) in which they have stated that when comparing maximal oxygen uptake per kg lean body mass in the two sexes, the boys had 18.4% higher values than the girls, indicating that girls of this age have the lower fitness level. Moreover, Eiberg S., et.al (2005) has concluded that  $VO_2$  max is higher in boys than girls (+11%), even when related to body mass (+8%) and LBM (+2%). Most of the difference in  $VO_2$  max relative to body mass was explained by the larger percentage body fat in girls. When boys and girls with the same  $VO_2$  max were compared, it could be explained that boys show more interest in games and sports and other outdoor activities in general than girls. Boys even prefer to go to the play field after school and with the increase in age the boys' trend to take part in vigorous type of activities whereas girls engage themselves in household work or less strenuous activities. Thus it is concluded that adolescent girls possess lesser maximal aerobic power in comparison to adolescent boys.

### **Research Highlights**

- The  $VO_2$  max was measured using the indirect method by using the Astrand and Astrand Nomogram.
- Specific bench heights were used for the Step-up test.
- Only the Adolescents between the age group of 12 to below 18 years were considered for the study.
- The subjects were drawn from the central part of the Central zone of India. The entire population was stratified and clustered to reduce the heterogeneity of the population.

### **Limitation**

The diet, social and economic status of the subjects selected for the study was different and hence was treated as a limitation of the study. To minimize the effect of these factors the subjects were selected from the population using random technique which might have nullifying effect on these factors.

The study was limited to the indirect measurement of maximal aerobic power using Astrand and Astrand nomogram. To minimize the error the scholar got the proper training of measuring the pulse rate.

### **Recommendations**

Similar types of study may be conducted in the other part of India and further comparison can be done among the groups. A similar study could be conducted by selecting another indirect



experimental method and further validate that method scientifically. It is further recommended to formulate norms of cardiovascular efficiency based on direct or indirect experiments and the fitness of the youths should be assessed accordingly as because we still do not have standard norms based on Indian children.

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