

Research and Reviews: Journal of Medical and Health Sciences

Physical Fitness in South Indian Adolescents by $VO_{2\max}$

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Research Article

Received: 23/05/2013

Revised: 03/06/2013

Accepted: 25/06/2013

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Keywords: Physical fitness, $VO_{2\max}$, BMI,
Waist circumference

ABSTRACT

In this study the physical fitness of 100 healthy adolescents (50 boys/50 girls) aged 12–16 yrs were assessed for physical fitness by measuring $VO_{2\max}$ using the treadmill and related with BMI, heart rate and waist circumference. 27% of adolescents had achieved an average to good $VO_{2\max}$ and 73% low – fair $VO_{2\max}$. The boys had attained better $VO_{2\max}$ than girls. The $VO_{2\max}$ in boys and girls increased from a BMI of 15–16kg/m² to reach a peak at 17–19kg/m² and 18–19 kg/m² respectively and thereafter showed a decline. A linear relationship between $VO_{2\max}$ and peak heart rate was maintained in both. The $VO_{2\max}$ was reached at a waist circumference of 60–65cm and 65–70cm in boys and girls respectively and thereafter decreased. This study shows that physical fitness of South Indian adolescents was less and a normal BMI and waist circumference are necessary for achieving a good $VO_{2\max}$.

INTRODUCTION

Maximal oxygen consumption ($VO_{2\max}$) is the most important indicator of physical fitness and is positively correlated with cardiovascular health [1,2].

Several studies have been done in the developed countries to assess the physical fitness of adolescents [3,4,5,6]. In India very few studies have been done to determine the $VO_{2\max}$ in adolescents [7,8]. In both the developed and developing countries the physical fitness of adolescents has been declining over the past 20 years [9,10]. Therefore this study was undertaken to assess the physical fitness level of south Indian adolescents through measurement of $VO_{2\max}$ and its relationship with physiological variables such as BMI, heart rate and waist circumference.

METHODOLOGY

100 healthy adolescents (50 girls and 50 boys) in the age group of 12–16 years were assessed for physical fitness by measuring $VO_{2\max}$.

The school authorities and parents provided permission to conduct the study after being thoroughly informed about the purpose and the protocols of the study. The study subjects were evaluated for body weight, height and waist circumference. All measures were done while subjects wore light clothes without shoes. BMI (kg/mt²) was calculated.

The subjects were informed that they would be exercising for 10 – 15 minutes. They were told that the test would be terminated if they experienced chest discomfort, dizziness, nausea, severe shortness of breath, extreme leg fatigue and were instructed to signal if they experienced any of these symptoms. The subject's heart rate and was recorded at rest. The treadmill was then started at a relatively slow warm up speed. The treadmill speed and its slope or inclination was increased every 3 minutes according to the Bruce protocol [13].

Three of the ECG leads were constantly displayed on the treadmill monitor when the subjects were exercising. The treadmill was stopped when the subject was unable to exercise or if he or she developed chest discomfort, shortness of breath and dizziness. The total time exercised by the subject was noted. The $VO_{2\text{ max}}$ was calculated using the regression formula

$$VO_{2\text{ max}} (\text{ml} / \text{kg} / \text{minute}) = 3.26 \times (\text{minutes}) + 6.14$$

Depending on the $VO_{2\text{ max}}$ values the subjects were classified as very low, low fair, average, good, very high [11].

The data was analysed using the Statistical software namely SPSS 11.0 and Systat 8.0. Chi-square test has been used to find the significant difference of percentage of Average to good

$VO_{2\text{ max}}$ between boys and girls. Analysis of variance has been used to find the significance of $VO_{2\text{ max}}$ in relation to BMI, peak heart rate and waist circumference.

RESULTS

Figure 1 shows the overall distribution of $VO_{2\text{ max}}$. Among the 100 subjects 27% had achieved an average to good $VO_{2\text{ max}}$ (44– 49 ml/kg/min) and 73% a low – fair $VO_{2\text{ max}}$ (34 –39 ml/kg/min). 66% of boys had low-fair $VO_{2\text{ max}}$ values 34% had attained average-good $VO_{2\text{ max}}$. In girls 80% had achieved low-fair and remaining 20% average – good $VO_{2\text{ max}}$. The $VO_{2\text{ max}}$ for boys was higher when compared to girls with same BMI . Table 1 shows the association of BMI with $VO_{2\text{ max}}$ in boys and girls. The $VO_{2\text{ max}}$ in boys and girls increased from a BMI of 15–16kg/m² to reach a peak at 17–19kg/m² and 18–19 kg/m² respectively and thereafter showed a decline. Table 2 shows the association of Peak heart rate with $VO_{2\text{ max}}$ in boys and girls The $VO_{2\text{ max}}$ of both boys and girls has been achieved at a peak heart rate of 170–180 beats per minute. Table 3 shows the association of Waist circumference with $VO_{2\text{ max}}$ in boys and girls. In boys $VO_{2\text{ max}}$ was reached at a waist circumference of 60–65cm and in girls at 65–70cm and after that there was a decrease in both.

Figure1: Overall distribution of $VO_{2\text{ max}}$

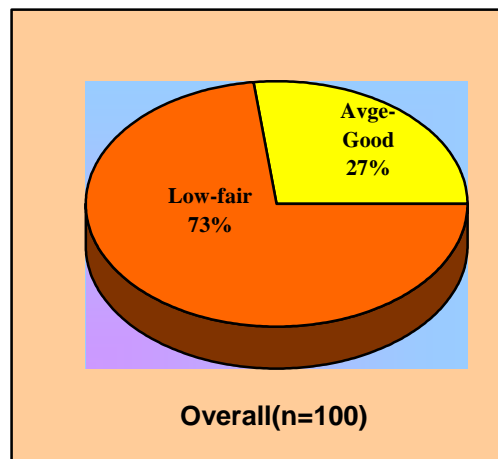


Table 1: Association of BMI with $VO_{2\text{ max}}$ in boys and girls

BMI (Kg/m ²)	$VO_{2\text{ max}}$ in Boys		$VO_{2\text{ max}}$ in Girls	
	Range	Mean ± SD	Range	Mean ± SD
14-15	20.01 – 45.80	30.56±11.02	20.07 – 26.09	25.53 ± 2.73
15-16	15.92 – 47.00	26.66 ± 10.14	17.45 – 36.58	26.46 ± 7.29
16-17	16.50 – 45.40	32.91 ± 11.38	14.48 – 43.00	25.79 ± 8.98
17-18	26.97 – 55.40	35.77 ± 10.68	17.12 – 40.37	26.28 ± 8.15
18-19	25.70 – 50.34	35.47 ± 8.04	24.16 – 50.00	33.09 ±
19-20	17.74 –29.93	24.95 ± 5.03	29.10 – 32.35	

Table 2: Association of Peak heart rate with Vo₂max in boys and girls

Peak heart rate (beats/min)	Vo ₂ max in Boys		Vo ₂ max in Girls	
	Range	Mean ± SD	Range	Mean ± SD
≤110	19.92 –30.10	23.93 ± 4.92	17.12–26.09	21.61 ± 6.34
110–120	27.26 –35.96	31.05 ± 4.46	14.48–27.03	20.63 ± 5.83
120–130	15.92 –29.64	23.14 ± 4.89	17.12–27.60	20.35 ± 5.49
130–140	16.56 –35.90	28.55 ± 6.61	17.48–29.28	23.16 ± 4.58
140–150	16.86 –39.29	30.61 ± 7.15	16.80–35.70	24.64 ± 5.53
150–160	16.60 –42.90	33.42 ± 11.55	20.25–30.39	25.68 ± 5.11
160–170	17.15 –50.34	34.16 ± 13.72	19.73–36.58	30.15 ± 5.84
170–180	42.75 –55.40	47.26 ± 4.79	35.96–50.00	40.87 ± 5.14
≥ 180	17.74 –47.00	32.62 ± 13.55	27.23–35.80	32.72 ± 3.97

Table 3: Association of Waist circumference with Vo₂max in boys and girls

Waist circumference (cm)	Vo ₂ max in Boys		Vo ₂ max in Girls	
	Range	Mean ± SD	Range	Mean ± SD
Upto 60	20.01–45.40	30.84±9.50	17.12–43.00	23.59±7.81
60.1–65.0	16.50–55.40	33.75±10.14	14.48–40.37	25.14±6.62
65.1–70.0	15.92–46.90	29.09±10.48	19.76–50.00	33.36±6.78
70.1–75.0	15.92–47.00	29.37±10.38	16.80–29.64	22.26±5.18

DISCUSSION

In the present study among the 100 subjects 27% had achieved an average – good Vo₂max and 73% had a low – fair Vo₂max. This clearly indicates that the physical fitness of adolescents was decreasing. Several studies have shown that there were gender differences in aerobic capacity. In this study the percentage of girls who had attained an average – good Vo₂max was lower when compared to boys. This was probably due to higher BMI of girls who have relatively more body fat than boys.

The boys had achieved Vo₂max at a BMI of 17–19kg/m² and girls at a BMI of 18–19kg/m² after which there was a decline in both. Therefore this study shows that a normal BMI is required for good cardio respiratory fitness and also as the BMI increases beyond a certain level the Vo₂max decreases. Several studies have proved the inverse relationship between BMI and Vo₂max and have found that excess body fat impairs cardio respiratory functions and reduces mechanical efficiency for a given work load [5,7].

The heart rate /oxygen uptake relationship is linear within an individual during dynamic exercise. In this study the linear relationship between heart rate and Vo₂max was maintained and they have achieved a peak heart rate at 170–180 bpm. The boys and girls have attained Vo₂max well below their maximum heart rate (220 bpm) indicating that they have good cardio-respiratory fitness (CRF).

Research has shown that men and women with high cardio-respiratory fitness had lower levels of total fat and abdominal fat for a given BMI compared with men and women with low CRF. In this study it was observed that the Vo₂max decreased above a waist circumference of 70 cm in both boys and girls indicating that increase in the amount of fat decreased the performance. The only difference is that in girls the decline was steep whereas in boys it had attained a plateau. This difference could be due to the higher accumulation of body fat in girls than in boys [16].

Limitations of the Study

The sample size of this study was probably not large and the limitation of sample size was due to the short duration of the study. Studies with more sample size and other variables influencing the Vo₂max such as nutrition, socio economic status if included in the study design could have probably given accurate results.

CONCLUSION

This study clearly showed that the physical fitness of south Indian adolescents was less and that a normal BMI and waist circumference are essential for achieving a good Vo₂max.

The cause of this decrease could be due to unhealthy eating patterns, sedentary life style and decreased physical activity levels. Therefore physical education programmes can be introduced at the school level and these activities can be made compulsory and a part of academics. These programmes will definitely improve the physical fitness of South Indian adolescents.

REFERENCES

1. Pate RR, Marsha Dowda M, Ross J G. Association between physical activity fitness in American Children. *American J Dis Child*. 1990; 144; 1123-1129.
2. Shephard R J, Allen C, Davies C T, Hedman R, Kaneko M. The maximal oxygen intake an international Standard of Cardio respiratory fitness. *Bull World Health Org*. 1968;38; 757 – 764.
3. Joseph L Andreacci, Robert J Robertson, John J Dube, Deborah J Arvn, Curt B Dixon, Silva A. Arslanian. Comparison of maximal oxygen consumption between obese black and white adolescents. *Pediatric Res*. 2005; 58: 478 – 482.
4. Georgious Lapoussis, Konstantinos Lapardi, Elisavet Petsvoic, Savas Tokmakidis, Varsilis Mougious, Vasilis Makrigiannis et al. The Influence of aerobic capacity in blood pressure in School children aged 12 – 16 years. *J Inquiries Sort Physical Edu*. 2005;3:113 – 122.
5. Sulayma AL Barwani, Mohammed Al Abri, Khanuis Al Hashmi, Masoud Al Shukeiry, Khurram Tahlilker, Thuraya Al Zuheibi et al. Assessment of aerobic fitness and its correlates in Omani adolescents using the 20-metre shuttle run test. *SQU J Sci Res*. 2001; 3: 77-80.
6. GB. Spurr, JC Reina. Maximum oxygen consumption in marginally malnourished Colombian boys and girls 6 – 16 years of age. *American J Human Biol*. 2005; 1:11 –19.
7. Satipati Chatterjee, Pratime Chatterjee and Amit Bandyopadhyay. Cardio respiratory fitness of obese boys. *Indian J Physiol Pharmacol*. 2005; 49 (3): 353 – 357.
8. S Chatterjee, P Chatterjee, PS Mukherjee, A Bandyopadhyay. Validity of Queens College Step test for use with young Indian men. *British J Sports Med*. 2004; 38: 289-291.
9. Obesity: preventing and managing the global epidemic. Report of a WHO consultation Geneva, World Health Organization 2000 (WHO Technical Report Series, No 894)
10. Andrew M Prentice. The emerging epidemic of obesity in developing countries. *Intl J Epidemiol*. 2006; 35 (1): 93-99
11. Laurence E. Morehouse. Laboratory manual Physiology of Exercise. The CV Mosby Company, 1972.
12. Bernard Rosner (2000), Fundamentals of Biostatistics, 5th Edition, Duxbury.
13. M. Venkataswamy Reddy. 2002, Statistics for Mental Health Care Research, NIMHANS publication, INDIA
14. Loftin M, Sothern M, VanVrancken C, O'Hanlon A, Udall J. Effect of obesity status on Heart rate peak in female youth. *Clin Pediatr (Phila)*. 2003;42(6): 505-10.
15. Armstrong N. et al. The peak oxygen uptake of British children with reference to age, sex and sexual maturity. *European J App Physiol*. 62:369-375, 1991.
16. Ross, R, Katzmarzyk PT. Cardio respiratory fitness is associated with diminished total and abdominal obesity independent of body mass index. *Intl J Obesity Related Metabol Dis*. 2003; 27,204-210