Physical Fitness in South Indian Adolescents by Vo$_2$ max

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**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/m$^2$ to reach a peak at 17–19kg/m$^2$ and 18–19 kg/m$^2$ 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/m$^2$) 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 [11].
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 \( \text{VO}_2 \) \text{max} was calculated using the regression formula

\[
\text{VO}_2 \text{max} (\text{ml} / \text{kg} / \text{minute}) = 3.26 \times (\text{minutes}) + 6.14
\]

Depending on the \( \text{VO}_2 \text{max} \) 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 \( \text{VO}_2 \text{max} \) between boys and girls. Analysis of variance has been used to find the significance of \( \text{VO}_2 \text{max} \) in relation to BMI, peak heart rate and waist circumference.

**RESULTS**

Figure 1 shows the overall distribution of \( \text{VO}_2 \text{max} \). Among the 100 subjects 27% had achieved an average to good \( \text{VO}_2 \text{max} \) (44–49 ml/kg/min) and 73% a low–fair \( \text{VO}_2 \text{max} \) (34–39 ml/kg/min). 66% of boys had low–fair \( \text{VO}_2 \text{max} \) values 34% had attained average–good \( \text{VO}_2 \text{max} \). In girls 80% had achieved low–fair and remaining 20% average–good \( \text{VO}_2 \text{max} \). \( \text{VO}_2 \text{max} \) for boys was higher when compared to girls with same BMI. Table 1 shows the association of BMI with \( \text{VO}_2 \text{max} \) in boys and girls. The \( \text{VO}_2 \text{max} \) in boys and girls increased from a BMI of 15-16 kg/m\(^2\) to reach a peak at 17-19 kg/m\(^2\) and 18-19 kg/m\(^2\) respectively and thereafter showed a decline. Table 2 shows the association of Peak heart rate with \( \text{VO}_2 \text{max} \) in boys and girls. The \( \text{VO}_2 \text{max} \) 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 \( \text{VO}_2 \text{max} \) in boys and girls. In boys \( \text{VO}_2 \text{max} \) was reached at a waist circumference of 60-65 cm and in girls at 65-70 cm and after that there was a decrease in both.

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**Table 1: Association of BMI with \( \text{VO}_2 \text{max} \) in boys and girls**

<table>
<thead>
<tr>
<th>BMI (Kg/m(^2))</th>
<th>( \text{VO}_2 \text{max} ) in Boys</th>
<th>( \text{VO}_2 \text{max} ) in Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>Mean ± SD</td>
<td>Range</td>
</tr>
<tr>
<td>14-15</td>
<td>20.01 - 45.80</td>
<td>20.07 - 26.09</td>
</tr>
<tr>
<td>15-16</td>
<td>15.92 - 47.00</td>
<td>17.45 - 36.58</td>
</tr>
<tr>
<td>16-17</td>
<td>16.50 - 45.40</td>
<td>14.48 - 43.00</td>
</tr>
<tr>
<td>17-18</td>
<td>26.97 - 55.40</td>
<td>17.12 - 40.37</td>
</tr>
<tr>
<td>18-19</td>
<td>25.70 - 50.34</td>
<td>24.16 - 50.00</td>
</tr>
<tr>
<td>19-20</td>
<td>17.74 - 29.93</td>
<td>24.95 ± 5.03</td>
</tr>
</tbody>
</table>

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**Figure 1: Overall distribution of \( \text{VO}_2 \text{max} \)**

- Low-fair: 73%
- Average: 27%
- Overall (n=100)
In this study the linear relationship between heart rate and VO\(_{2}\text{max}\) was maintained and they have achieved a peak heart rate at 170–180 bpm. The boys and girls have attained VO\(_{2}\text{max}\) well below their maximum heart rate (220 bpm) indicating that they have good cardio-respiratory fitness and also as the BMI increases beyond a certain level the VO\(_{2}\text{max}\) decreases. Several studies have proved the inverse relationship between BMI and VO\(_{2}\text{max}\) 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 VO\(_{2}\text{max}\) was maintained and they have achieved a peak heart rate at 170–180 bpm. The boys and girls have attained VO\(_{2}\text{max}\) 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 VO\(_{2}\text{max}\) 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 VO\(_{2}\text{max}\) 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 VO\(_{2}\text{max}\).
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