Assessment of cardiorespiratory fitness by the Ruffier Dickson test and its correlation with lifestyle related factors: A cross sectional study among Pakistani youth
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Abstract
Objective: To evaluate the correlation of physical activity, screen time and anthropometric parameters with cardiorespiratory fitness using the Ruffier Dickson test.
Method: The cross-sectional study was conducted at the Riphah International University, Islamabad, Pakistan, from October 2021 to May 2022, and comprised healthy undergraduate medical students of either gender aged 18-23 years. Anthropometric parameters were measured and standardised assessment tools were used to assess screen time and physical activity. Cardiorespiratory fitness was assessed using Ruffier Dickson test. Data was analysed using SPSS 26.
Results: Of the 300 subjects, 186(62%) were females and 114(38%) were males. Body mass index, body weight, resting heart rate, height and the level of physical activity were significantly associated with cardiorespiratory fitness (p<0.05).
Conclusion: Physical activity, body weight and body mass index could independently predict cardiorespiratory fitness.

Subjects and Methods
The cross-sectional study was conducted at the Riphah International University, Islamabad, Pakistan, from October 2021 to May 2022. After approval from the institutional ethics review committee, the sample size was calculated using Raosoft calculator with 95% confidence level, 5% margin of error and 50% response distribution. The sample was raised using non-probability convenience.
sampling technique. Those included were undergraduate students of either gender aged 18-23 years. Those excluded were known cases of physical or mental disabilities and students with a history of major surgery or medications.

According to the American College of Sports Medicine guidelines for exercise testing, the students were asked to fill Physical Activity Readiness Questionnaire (PAR-Q+) proforma before initiating the test.12 Those who answered NO to all the 7 questions were enrolled. After taking informed consent.

Height (m) was measured without shoes using a wall-mounted stadiometer, and body weight was measured to the nearest 0.1kg using a digital scale, with the participants wearing light clothing and no shoes. BMI was calculated by dividing the body weight (kg) with height (m²). Physical Activity Vital Sign (PAVS) is a tool created to quickly measure quantified self-reported physical activity level.13

PAVS equation=(days/week with physical activity) x (minutes of physical activity/day)=min of physical activity/wk.

Regarding screen time assessment, the participants were asked to estimate total time spent in hours using television, computer and smartphone. Screen time may show variations throughout the day and week, so the questionnaire further inquired about screen use on a typical college and weekend day.14 VO₂max is considered the gold standard for assessing CRF.15

The RDT was performed at the end of the questionnaire, thus giving them time to rest for more than 5 min. A demo was shown before starting. The participants were instructed to complete 30 squats in 45 min. At the end of the test, HR of the participants was measured. VO₂max was estimated using the following equation:

\[
\text{VO}_2\text{max}= 3.0143+1.1585 \times \text{sex} -0.0268 \times (\text{HR1/height}) + 118.7611 \times [(\text{HR2} - \text{HR3})/ \text{age}^3].
\]

The normative value of VO₂max was taken as reference value corresponding to age 20-29 years both in males and females. CRF criterion-reference for males (poor: ≤24.9, fair: 25-33.9, average: 34-43.9, good: 44-52.9 and excellent: ≥53) and females (poor: ≤23.9, fair: 24-30.9, average: 31-38.9, good: 44-52.9 and excellent: ≥49) was determined based on the tertiles of CRF and expressed as millilitres per kilogram body mass per minute.9

Data was analysed using SPSS 26. Continuous data was presented as mean and standard deviation. The strength of the association between estimated VO₂max and variables was assessed by Pearson correlations coefficient test (r). The study data passed the normality test and was found to have no outliers. Multiple linear regression was performed to determine the independent contributions of variables on predicting CRF. Chi-square test was used for categorical variables. Statistical significance was set at p<0.05.

Results

Of the 300 subjects, 186(62%) were females and 114(38%) were males. The overall mean age was 19.56±1.5 years and mean BMI was 23.92±3.7 kg/m². Mean value of VO₂max for male subjects was higher than female subjects (Table-1).

There was a strong negative correlation between VO₂max and body weight (r=-0.54 females, r=-0.68 males). VO₂max showed positive relationship with physical activity, and negative relationship with BMI, HR1, HR2 and HR3, while the association of CRF with height in males was stronger than females (Table-2). Age and screen time showed no significant correlation (Table-1). Age and physical activity showed positive correlation with VO₂max. Estimation of VO₂max using PAVS equation gave a p<0.01.

Table-1: Participants' characteristics.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total Mean±SD</th>
<th>Females Mean±SD</th>
<th>Males Mean±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=300</td>
<td>n=186</td>
<td>n=114</td>
</tr>
<tr>
<td>Mean Age (years)</td>
<td>19.56±1.5</td>
<td>19.74±1.69</td>
<td>19.26±1.36</td>
</tr>
<tr>
<td>Mean Body Weight (kg)</td>
<td>62.54±8.3</td>
<td>59.90±7.6</td>
<td>66.84±7.7</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.66±0.1</td>
<td>1.62±0.08</td>
<td>1.74±0.08</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>23.92±3.7</td>
<td>23.83±3.9</td>
<td>24.03±3.6</td>
</tr>
<tr>
<td>Screen time (hours/day)</td>
<td>3.10±1.0</td>
<td>3.22±0.99</td>
<td>2.8±1.1</td>
</tr>
<tr>
<td>Physical activity (min/week)</td>
<td>424.8±252</td>
<td>353.4±204</td>
<td>540±276</td>
</tr>
<tr>
<td>HR1 (beats/min)</td>
<td>74.6±12.3</td>
<td>73.8±10.8</td>
<td>75.42±14.8</td>
</tr>
<tr>
<td>HR2 (beats/min)</td>
<td>134.1±17.1</td>
<td>135.5±14.9</td>
<td>131.7±20.5</td>
</tr>
<tr>
<td>HR3 (beats/min)</td>
<td>95.1±21.3</td>
<td>96.32±21.4</td>
<td>93.21±21.6</td>
</tr>
<tr>
<td>Estimated VO₂max (L/min)</td>
<td>2.38±1.1</td>
<td>1.78±0.57</td>
<td>3.35±1.1</td>
</tr>
<tr>
<td>Estimated VO₂max (ml/kg/min)</td>
<td>39.3±12.4</td>
<td>36.05±10.0</td>
<td>44.60±14.2</td>
</tr>
</tbody>
</table>

BMI: body mass index, SD: Standard deviation, HR1: Resting heart rate, HR2: Maximum heart rate after squatting, HR3 = Recovery heart rate after 1 min, Estimated VO₂max: Maximal oxygen consumption.

Table-2: Correlation of cardiorespiratory fitness (CRF) (VO₂max ml/kg/min) with participant characteristics.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Females</th>
<th>Males</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=186</td>
<td>n=114</td>
</tr>
<tr>
<td>Age (years)</td>
<td>-0.04</td>
<td>-0.16</td>
</tr>
<tr>
<td>Height (m)</td>
<td>0.29</td>
<td>0.75</td>
</tr>
<tr>
<td>Body Weight (kg)</td>
<td>-0.54</td>
<td>-0.68</td>
</tr>
<tr>
<td>Physical activity (min/week)</td>
<td>0.74</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Screen time (hours/day)</td>
<td>-0.25</td>
<td>0.16</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>-0.73</td>
<td>-0.95</td>
</tr>
<tr>
<td>HR1 (beats/min)</td>
<td>-0.82</td>
<td>-0.75</td>
</tr>
<tr>
<td>HR2 (beats/min)</td>
<td>-0.75</td>
<td>-0.87</td>
</tr>
<tr>
<td>HR3 (beats/min)</td>
<td>-0.76</td>
<td>-0.85</td>
</tr>
</tbody>
</table>

BMI: Body mass index, HR1: Resting heart rate, HR2: Maximum heart rate after squatting, HR3: Recovery heart rate after 1 min.
significant association ($p>0.05$).

CRF was independent and positively associated with physical activity ($p<0.001$). There was significant inverse association of CRF with BMI, body weight and HR1 (Table 3). The model accounted for 87% of the variance of CRF.

Males in excellent CRF category were more physically active compared to those in poor, fair, average and good CRF categories, and significantly more males than females were in the average/excellent CRF category (Figure).

**Discussion**

RDT is an inexpensive valid method to assess CRF as a part of preventive medicine. The current study showed that physical activity was significantly correlated with VO$_{2\text{max}}$ using the RDT. The findings are in line with previous studies.$^{16}$

A Pakistani study reported that CRF capability and body composition of youth population can be strengthened by improving their routine physical exercise.$^{17}$ According to the current results, females were less physically active and spent more time watching TV or using computers than the male medical students. As a result, female participants had below-average CRF compared to males. Another possible explanation for females could be lack of time and completing priorities towards aerobic activities.$^{18}$ Another study mentioned barriers to physical activity, such as safety issues, limited indoor space for exercise and lack of affordable physical activity facilities and programmes for Pakistani females.$^{19}$ Therefore, understanding and addressing social and contextual influences on regular physical activity is essential to establish affordable programmes and facilities.

In medical colleges, students are at higher risk of getting obese due to physical inactivity and sedentary lifestyle. Obesity is responsible for decrease in lung compliance and stiffening of the respiratory muscles which may lead to increased risk of cardiovascular disease mortality.$^{20}$ The current findings demonstrated that the VO$_{2\text{max}}$ estimated by RDT was inversely correlated although significantly related with body weight and BMI. These findings are in line with earlier reports.$^{8}$ A recent study suggested that body fat mass and BMI value could be helpful in achieving optimum physical fitness. In addition, poor performance during RDT evaluation predicts that overweight adolescents showed significantly decreased VO$_{2\text{max}}$ due to increased oxygen demand to move excess body weight.$^{21}$ Excess adiposity may result in a state of cardiopulmonary deconditioning associated with greater cardiac load and functional impairment, which was also reported earlier.$^{22}$

HR parameters were inversely correlated with the estimated VO$_{2\text{max}}$. However, in multivariate model, only HR1 proved to be a significant predictor of the estimated VO$_{2\text{max}}$. The participants with lower HR1 had significantly higher CRF due to low sympathetic activity.$^{23}$ Therefore, it is suggested that change in HR1 may be used to accurately detect changes in CRF over time. The strength of correlation between CRF and HR features found in the current study was comparable to previous studies.$^{10}$

The current study has its limitations as it had a cross-sectional design with a relatively small sample size to allow generalisation. Also, only apparently healthy young adults without any medications or current disease history were included. Besides, the study participants were young adults aged 18-23 years. Further studies are required for better understanding of relation between different age groups with a wide range of BMI affecting CRF.

**Conclusion**

RDT could be used in clinical settings as it a rapid and inexpensive method. Physical activity, body weight and BMI had an influence on CRF. As such, appropriate...
Assessment of cardiorespiratory fitness by the Ruffier Dickson test and its correlation with improvement in physical fitness programmes regarding physical exercise and healthy lifestyle should be incorporated in daily routine, which can greatly improve the quality of students’ life and slow down the aging process.

Disclaimer: None.

Conflict of Interest: None.

Source of Funding: None.

References


