Original Article

Evaluation of Cardiorespiratory Fitness and Core Endurance Among Young Adults of Rawalpindi & Islamabad

Zoha Sabir ,[1] Mayya Firdous ,[2] Hania Tariq ,[3] Maria Hussain ,[4] Rafia Khawar, [5] Visha Waheed [6]

Abstract

Objective: The objective of this study is to evaluate the core endurance and cardiorespiratory fitness among the young adults of Rawalpindi and Islamabad.

Study Design: : A descriptive cross-sectional study was conducted.

Place and duration of study: The study design of this study was descriptive cross sectional which was done in community of Rawalpindi & Islamabad from February 2024 to January 2025.

Material and Methods: The study design of this study was descriptive cross sectional which was done in community of Rawalpindi & Islamabad from February 2024 to January 2025. Non probability purposive sampling technique was done on young adults of age 20-35 years. Core endurance was evaluated using Mc Gills test while cardiorespiratory fitness was determined through YMCA 3 minute step test and physical activity levels via IPAQ. SPSS v.21 was used data analysis. Mean±SD was used to express the quantitative variables while to compare the groups Kruskal Wallis test was applied.

Results: The study recruited 450 young adults which were equally distributed (n=150) among three activity levels (mild, moderate and vigorous). The score (19.53 ± 1.95) of Trunk Flexor Endurance Test was less in the mild physical activity category, contrary to the vigorous physical activity category which demonstrated the greatest score of (30.21 ± 1.69). Correspondingly, mild physical activity group had lowest value (8.25 ± 1.29) and vigorous physical activity group had a peak value (19.13 ± 1.72). Similar trend was seen in mild physical activity group with regard to the Left Sided Trunk Lateral Endurance Test which experienced the lowest score (8.17 ± 1.39) than vigorous physical activity group having the highest one (18.85 ± 1.77). The mild group attain the low value (4.53 ± 1.13) for Test of Trunk Extensor Endurance while the highest score (15.05 ± 1.44) was exhibited by vigorous physical activity group. The trend present in the mild physical activity group with regard to VO2max was lowest (46.23 ± 6.55) and in the vigorous physical activity group it was highest (74.23 ± 3.73). Moreover, the heart rate found to be highest (139.96 ± 3.09) in the mild physical activity group whereas the lowest heart rate (119.53 ± 5.05) was present in the moderate physical activity category

Conclusion: The study concluded that the physical activity impact on young adults demonstrated that individuals involved in vigorous activity have improved cardiorespiratory fitness along with good core endurance than those involved in mild activity and moderate activity category

Keywords: Core endurance, cardiorespiratory fitness, Physical activity

1. Introduction

Physical activity (PA) refers to any kind of movement produced by skeletal muscles resulting in the exertion of force. It differs among young adults. [1]

Numerous other factors including sedentary behavior which is specified by prolonged sitting inversely corresponds with participation in PA. It consecutively can also affect the core endurance and CRF. [2] The ability of the trunk muscles is indicated by the core endurance bringing about and maintaining force that is supported by the diaphragm, gluteal, paraspinal, hip girdle, pelvic floor, and abdominal muscles. [3] Certain characteristics such as spinal alignment, neural control, exercise intensity, training, and existing lower back pain put a major impact on core strength and endurance. Spine can be safeguarded from extreme loads and enables force transfer between the upper and lower body by the collaboration of core muscles which is significant for spinal stability. [4] Medium to high

Demonstrator,Foundation University College of Physiotherapy ,[1,] Student, Foundation University College of Physiotherapy [2,3,4,5]
Correspondence: Mayya Firdous,Student , Foundation University College of Physiotherapy **Email:** mayyah.firdaus@gmail.com

intensity dynamic large muscle exercises performed for extended periods essential for physical well-being of the body is referred as Cardio respiratory fitness (CRF). [5] VO2 max, the maximum oxygen consumption is a principally accepted measure of CRF providing approximate value of heart and lung capacity for observing daily physical exertion. [6]

Endurance training strengthens VO2 max which is an important factor VO2 max strengthened by endurance training enhances endurance performance and requires a constant or decreased maximal heart rate. VO2 max increases as stroke volume rises due to higher preload and lower afterload together with an increase in the systemic arteriovenous oxygen difference. [7]

The diaphragm plays a significant role in respiration and core stability. Core endurance and stability during movements is built up by training the diaphragm. It also enhances respiratory function which is necessary for aerobic activities and cardiovascular fitness (CRF). Overall fitness can be improved focusing on both core strength and cardiovascular training by participating in a training regimen. [8]

A cross sectional study in healthy adults was conducted by Okada et al. (2011) which founds a connection among trunk stability, biomechanical movement and performance. Only weak to moderate connections among functional assessment and trunk stability in healthy adults was gathered by the study. [9]

In a onetime reflection, the relationship between trunk stability and physical exertion was intended by Dr Prachi kapdule et al. (2019). The recruitment involved 110 young adults in total among which 67 were females and 43 were males. A positive association between trunk stability and physical exertion levels is shown in individuals who participate in more physical activity and those with increased levels of trunk stability as proposed by the results. [10]

A Prioreschi et al. (2017) performed an observational study which evaluates cardio respiratory fitness levels and its association with the body composition and physical activity in young South African adults. In accordance to the results ($p < 0.001$), a comparison was made between the females and males which shows greater generality of overweight and obesity observed in females contrast to males. Furthermore, males who are generally more involved in medium to high intensity physical activity verified remarkably elevated VO2 max in comparison to females. The study brings forward a positive correlation between MVPA and VO2 max ($P > 0.001$). In contrast, sedentary time showed no correlation with VO2max while BMI demonstrated a converse relationship. [11]

The connection of physical exertion and sedentary behavior on cardio respiratory fitness in healthy adults-adolescents was found in a cross sectional study carried out by Rute Santos et al. (2014). Categorization of participants was done as low active/low sedentary and those as high active/low sedentary. Those classified as low active/low sedentary, exhibits superior chances of having fitness in contrast to those in low active/high sedentary group. Factors such as sedentary behavior and physical activity regulates Cardio respiratory fitness as indicated by the study. A negative correlation was observed between sedentary behavior and CRF. [12]

An interventional study proposed by Alireza Shamsoddini et al. (2018) examined CVS risk factor in elderly and cardio respiratory fitness. The study established the impact of Thera band strength training exercises and core stability on cardio respiratory fitness. Significant improvement in FBS and lipid profiles was revealed following the intervention. Additionally, progression was noticed in BMI, blood pressure and VO2 max post exercise. No notable differentiation was found in blood pressure, BMI, lipid profile and VO2 max. However, considerable depletion in the group that took part in Theraband resistance training was displayed by FBS only. There was a positive impact of Theraband strength training and core stability on cardiovascular risk factor and cardio respiratory fitness among elder people. The outcome shows reduced BP, cholesterol levels and BMI along with advancement in VO2 max and exercise tolerance. [13]

2. Materials & Methods

The study was structured as descriptive cross-sectional observational study. The research was completed in one year after approval from ERC, from February 2024 to January 2025. The data was gathered from the

community of Rawalpindi and Islamabad. Non-probability Purposive sampling was chosen as a sampling technique. As indicated by Worldometer, the combined population of Rawalpindi and Islamabad is reported to be 2,344,701 in the year 2023. A sample count of 385 was computed using OpenEpi, at 95% confidence interval with a 5% margin of error, and having a response distribution of 50%. Participants of age range 20-35years, both genders; female and male, and BMI 18.5-24.9 were included. Participants were excluded on the basis of Physical Activity Readiness Questionnaire (PAR-Q) and any participant having a history or a current diagnosis of the following pathologies were excluded from the study; cardiovascular, respiratory, neurological, musculoskeletal, pregnancy, and BMI more than 24.9.

Following the initial demographic survey, participant body weight and height were assessed to determine their Body Mass Index (BMI). Weight was measured in kilograms using a standard digital scale, with participants standing barefoot. Height was measured in inches with participants standing against a wall in the anatomical position. These height measurements were later converted to meters. BMI was then calculated for each participant using the standard Quetelet index protocol: BMI = weight (kg) / height (m^2).

The PAR-Q is a seven-step questionnaire that was administered to identify risk factors during moderate physical activity and evaluate family medical history and disease severity.

Physical activity was assessed by the self-administered short version of IPAQ, covering the previous 7 days. Results were reported in categories such as mild, moderate and vigorous based upon activity level or in MET minutes a week as a continuous parameter. MET minutes represent the amount of energy expended performing a physical activity. To get a score from the IPAQ of MET minutes a week, take into consideration a walking to be 3.3 METS for mild, moderate physical activity to be 4 METS and vigorous physical activity to be 8 METS. Results will be reported in different ways; (I) HIGH Level- Vigorous intensity activity on at least 3 days achieving a minimum total physical activity of at least 1500 MET minutes a week OR 7 or more days of any combination of walking, moderate intensity or vigorous intensity activities achieving a minimum total physical activity of at least 3000MET minutes a week. II) MODERATAE Level- 3 or more days of high intensity activity and/or walking of at least 30minutes daily achieving a minimum total physical activity of at least 600MET minutes a week. III) LOW Level- individual is not fulfilling any requirement of either MODERATE or HIGH levels of physical activity.

The McGill test was employed to evaluate core muscle endurance, encompassing assessments of trunk flexors (maintaining a sit-up position with the back inclined at 60° from the floor), trunk extensors (adopting a prone position with upper limbs positioned above the Anterior Iliac Spines (ASIS) while hanging off the table), and lateral trunk musculature (assuming a left or right side-lying position on the floor with a 90° bent elbow and alignment under the shoulder, with the pelvis raised). Participants were instructed to sustain each isometric posture for as long as possible, as directed by the examiner, and performed the test only once. The duration each participant maintained the correct position for each posture was recorded, and the cumulative results from the four subtests were aggregated to derive an overall score.

The Three minute step test was employed to assess cardiorespiratory or aerobic fitness. In sync with the beat, participant step up on the bench (1st beat), then followed by the second foot (2nd beat), subsequently step down with one foot (3rd beat), and lastly step down with the other foot (4th beat). The participant practice stepping to the 12 inch bench, with a stepping rate of 24 steps per minute for 3 minutes. After completion of the test, participant heart rate was counted within 5 seconds and continue for one minute using pulse oximeter.

VO2max was then calculated by the following prediction equation: Males: VO2max= 111.33-0.42 H, Females: VO2max= 65.81-0.1847 H, where H = Heart rate (in beats/min) after completion of test. Data of 450 participants were analyzed using SPSS version 21.

3. Results

5.1 IPAQ CATEGORIZATION:

In consistent with the IPAQ: mild, moderate, and vigorous a total of 450 participants were included in the study which was further classified within the three categories on the basis of their physical activity levels. There were equal number of participants in each of the group, with 150 individuals in each activity level.

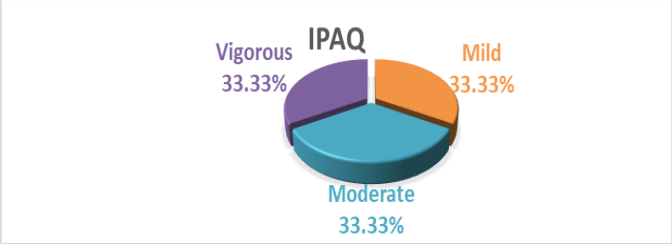

Figure 1 IPAQ Categorization

5.2 DESCRIPTIVE STATSTICS:

5.2.1 Age Distribution:

In contrary to mean age of moderate physical activity group which was 29.37 ± 3.03 years, mean age of mild physical activity group was 28.27 ± 3.86 years. However, mean age of 25.41 ± 4.65 years was exhibited by the participants of vigorous physical activity group.

IPAQ	Age Years (Mean±S.D)
Mild	**28.27±3.86**
Moderate	**29.37±3.03**
Vigorous	**25.41±4.65**

Table 1 Mean of Participants According to Age

5.2.2 Gender Distribution:

Total number of participants included in the study were 319 males and 131 females. In accordance with physical activity categories the gender distribution is shown in the table below.

IPAQ	Gender	Frequency (%)
Mild	**Male**	**74 (49.3)**
	Female	**76 (50.7)**
	Total	**150 (100)**
Moderate	**Male**	**95 (63.3)**
	Female	**55 (36.7)**
	Total	**150 (100)**
Vigorous	**Male**	**150 (100)**

Table 2 Percentage of Participants in Gender Categorization

5.2.3 BMI Distribution:

Across numerous activity levels the distribution of BMI categories are demonstrated in table. In mild activity category 149 participants was being in the normal BMI range, while 1 of the individual was overweight. In moderate and vigorous activity groups, all participants had BMIs which falls in between the normal range.

IPAQ	BMI (kg/m2)	Frequency (%)
Mild	**Normal (18.5-24.9)**	**149 (99.3)**
	Overweight (25-29.9)	**1 (0.7)**
Moderate	**Normal (18.5-24.9)**	**150 (100)**
Vigorous	**Normal (18.5-24.9)**	**150 (100)**

Table 3 Percentage of Participants in BMI Categories

5.2.4 Heart Rate Distribution:

The heart rate distribution in the three different activity Levels are illustrated in table below

IPAQ	Heart Rate bpm (Mean±S.D)
Mild	**139.96±3.09**
Moderate	**119.93±5.05**
Vigorous	**88.32±8.89**

Table 4 Mean of Participants Heart Rate

The heart rate distribution in the three different activity levels is illustrated above

5.3 INFERENTIAL STATISTICS:

5.3.1 Graphical Representation of Core Endurance & Cardiorespiratory Fitness:

The median of core endurance components and cardiorespiratory fitness is represented in the graph below. Mild activity group had the least values of components of core endurance whereas high values of median was present in vigorous activity group. Similarly the mild activity group had poor cardiorespiratory fitness than vigorous activity group which showed greater values.

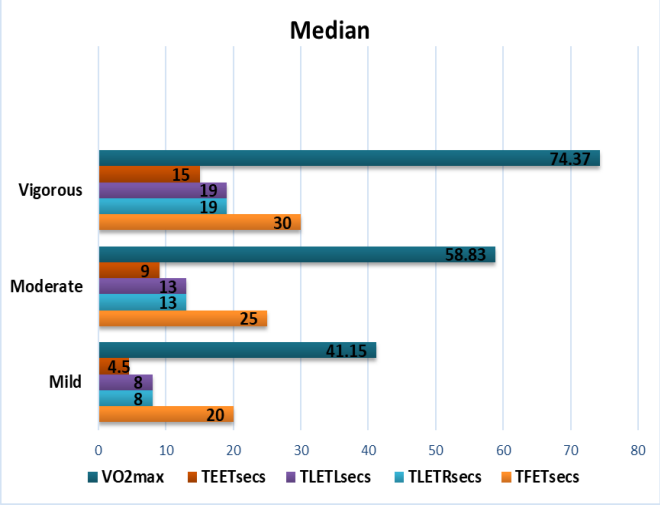

Figure 2 Median for Core Endurance & Cardiorespiratory Fitness

5.3.2 Checking the Normality of Data:

The normality of data was tested by Kolmogorov-Smirnov test due to the assumption that sample size was more than 50. All the variables of this study that includes; Trunk Flexor Endurance Test, Right sided Trunk Lateral Endurance Test, Left sided Trunk Lateral Endurance Test, Trunk Extensor Endurance Test, and VO2max were significant statistically i.e. ($p<0.05$) among all the activity levels.

IPAQ	Variables	p-Value
Mild	**TFETsecs**	**0.000**
	TLETRsecs	**0.000**
	TLETLsecs	**0.000**
	TEETsecs	**0.000**
	VO2max	**0.000**
Moderate	**TFETsecs**	**0.000**
	TLETRsecs	**0.000**
	TLETLsecs	**0.000**
	TEETsecs	**0.000**
	VO2max	**0.000**
Vigorous	**TFETsecs**	**0.000**
	TLETRsecs	**0.000**
	TLETLsecs	**0.000**
	TEETsecs	**0.000**
	VO2max	**0.002**

TFET: Trunk Flexor Endurance Test, TLETR: Trunk Lateral Endurance Test (Right), TLETL: Trunk Lateral Endurance Test (Left), TEET: Trunk Extensor Endurance Test

Table 5: Normality of Data

5.3.3 Group Distribution of Core Endurance and Cardiorespiratory Fitness

As the data was not normally distributed so Kruskal Wallis Test was employed to compare the medians among the groups. The table shows the median value with Inter Quartile Range for Trunk Flexor Endurance Test, Trunk Lateral Endurance Test (Right side), Trunk Lateral Endurance Test (Left side), Trunk Extensor Endurance Test and VO2max across three physical activity categories.

IPAQ	TFETsecs	TLETR secs	TLE TL secs	TEET secs	VO2max
		Median (IQR)			
Mild	20.00 (1)	8.00 (2)	8.00 (2.25)	4.50 (1.5)	41.15 (12.58)
Moderate	25.00 (2)	13.00 (2)	13.00 (3)	9.00 (3)	58.83 (18.04)
Vigorous	30.00 (2)	19.00 (2)	19.00 (2)	15.00 (2)	74.37 (6.72)

Table 6 Core Endurance and Cardiorespiratory Fitness per IPAQ

4. Discussion

The young adults of age group 20-35 years having BMI that lies in a normal range were categorized into activity levels of IPAQ to evaluate the cardiorespiratory fitness and core endurance. The findings demonstrated that there was significant difference statistically for the core endurance, heart rate and gold standard of cardiorespiratory fitness i.e. VO2max across different IPAQ activity groups. Individuals of vigorous activity group showed higher VO2 max values demonstrating improved CRF in contrast to the mild activity level. This finding is consistent with the earlier study done by Dyrstad et al. (2015) found that individuals performing vigorous physical activity exhibit higher values of VO2 max contrary to individuals of mild or moderate activity level. [15] In addition to this, another study done by Sajjad et al. (2020) highlighted that higher activity levels correlates with increased CRF. [16] Moreover another study done by Hudain et al. (2023) further corroborated our results and found that increased physical activity in athletes positively correlated with the higher values of VO2 max. This underscores the significance of vigorous physical activity with improved aerobic capacity.

[13] Beside this, research done by Sonia et al. (2017) concluded that CRF among the physiotherapy students was average, which positive correlation between VO2 max and the physical fitness index underscoring the need for increased physical activity to improve the fitness levels. [14]

The observation that the higher heart rates present in mild activity group whereas the vigorous physical activity category in harmony with the physical responses that were established. Regular vigorous physical activity enhance the efficiency of the cardiovascular system that results in often low resting heart rates and submaximal exercise heart rates. The American College of Sports Medicine (ACSM) guidelines supports it, which proposed that people having low heartbeat rates have increased CRF values at various exercise intensities. [17] The results also indicated that core endurance was higher in the vigorous activity group than in mild group. This outcome is consistent with the study of Akduman et al. (2019) that shows higher physical activity levels correlates positively with better core endurance in young adults. The study concluded that core muscle strength and endurance can be enhanced by regular physical activity at high intensity. [18] Furthermore, Santos et al. (2020) explored that individuals with better core endurance results from higher activity levels, performing better in athletic and functional tasks. [3] Moreover, research done by Lu et al. (2019) observed that individuals with intellectual disabilities, also showed overall poor core endurance with low activity level. [19] Beside this, another study by Koju et al. (2017) concluded that medical students performing moderate physical activity have significant improvements in core endurance, although these

improvements were markedly less than those engaged in vigorous physical activity. [20]

Interestingly, the results showed that trunk flexor endurance was generally good across all activity levels. This collaborates with research done by Bayraktar et al. (2019), who concluded that trunk flexor endurance is well-developed even in individuals who engage in mild physical activity due to the natural engagement of the abdominal muscles in everyday movements and low-intensity exercises. But the study highlights that there is no such significant relationship between improved core endurance with increased physical activity. This result could be due to small sample size of 51 participants. [21]

However, our findings suggested that trunk extensor endurance was poor across all activity levels and is notable. This corresponds to the study of Esfahani et al. (2020) demonstrated that sitting posture, lower physical fitness levels, and shorter durations of sitting at home, rather than prolonged sitting at work, may be associated with poor endurance of extensor muscle in individuals having chronic low back pain but nonspecific. [22] In addition to this another study by Chan (2019) reported that trunk flexor endurance was well developed in male intercollegiate rowers.

Conclusion:

The study concluded that the impact of physical activity on young adults demonstrated that individuals involved in vigorous activity have improved cardiorespiratory fitness along with good core endurance than those involved in mild activity and moderate activity category.

Future Recommendations

Raising awareness about migraine among students and staff is essential. Targeted support such as physiotherapy, psychological counseling, and appropriate medical treatment can help reduce migraine-related disability. Strengthening wellness and mental health services within university health systems may further improve students' quality of life.

Disclosure /Conflict of interest:

Authors declare no conflict of interest.

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