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| Research Article |

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Examining the Impact of Urban and Rural Environments on the Connection Between Cardiovascular Endurance and Body Mass Index in Female University Athletes

Fozia Tabassum Cheema & Dr. Mohibullah Khan Marwat

ABSTRACT

Objective: The primary aim of this study was to investigate the impact of urban and rural localities on the cardiovascular endurance of female university athletes in relation to Body Mass Index (BMI). **Methods:** A diverse sample of 136 players from various sports, with a mean age of 20.37±2.10 years, was included to represent different body types and communities. The participants' cardiovascular endurance was assessed using the Harvard Step Test, while BMI was determined by measuring their height and weight. Descriptive statistics, including the Kolmogorov-Smirnov and Shapiro-Wilk tests, as well as Spearman's correlation, a trend line, and an independent samples t-test, were conducted for data analysis, with a significance level set at 5%. **Results:** The findings revealed that the average BMI for the entire sample was 19.93±3.31 kg/m², and the average fitness index was 66.45±8.73, indicating an average level of fitness. Additionally, it was concluded that only a small proportion (3.7%) of female university players achieved a good level of fitness. The correlation coefficients indicated a weak and insignificant negative correlation ($r = -0.061$, $p>0.05$) between cardiovascular endurance and BMI. The results also demonstrated that the locality had a significant effect on both BMI ($t = 2.164$, $p < 0.05$) and cardiovascular endurance ($t = -2.397$, $p < 0.05$) among female university players. Moreover, it was observed that university athletes from rural areas exhibited higher fitness levels and lower BMI compared to players from urban areas. **Conclusion:** The study found that BMI had no significant association with cardiovascular endurance, but it was observed that locality had a significant impact on both BMI and cardiovascular endurance.

Key Words: Cardiovascular, Endurance, Fitness Index, BMI, University Athletes

Introduction

Physical fitness and overall health are of paramount importance, especially among young individuals engaged in regular physical activity. One crucial aspect of physical fitness is cardiovascular endurance, which refers to the ability of the cardiovascular system to deliver oxygen and nutrients efficiently during prolonged exercise. Another significant health indicator is the body mass index (BMI), a measurement that relates weight to height and serves as an indicator of body composition (Syamsuryadin et al., 2022).

Understanding the relationship between cardiovascular endurance and BMI is essential in promoting optimal health and performance among female university athletes. However, the influence of environmental factors, particularly the urban and rural localities in which athletes reside, on this relationship remains relatively unexplored. Investigating this relationship in different environmental contexts can provide valuable insights into the interplay between physical fitness and geographic settings (Jafari et al., 2019).

The association between body mass index (BMI) and cardiovascular endurance was investigated (Taati et al. (2021) in female students from an Iranian university, with BMI determined using

height and weight measurements, and cardiovascular endurance assessed through the 12-minute Cooper test. A significant negative correlation ($r = -0.325$, $p = 0.001$) indicated that higher BMI values were linked to lower cardiovascular endurance levels. The study highlights the importance of maintaining a healthy BMI for optimal cardiovascular endurance in female students, emphasizing BMI as a significant factor influencing this aspect of physical fitness. They contribute to understanding the negative relationship between BMI and cardiovascular endurance, offering potential avenues for interventions aimed at improving cardiovascular health in female students.

The connections between body composition and cardiovascular endurance in female team sport athletes, such as basketball, soccer, and volleyball players were conducted (Vehrs et al. (2021). The research revealed that participants with higher levels of lean body mass exhibited superior cardiovascular endurance when compared to those with higher levels of fat mass. Although the study did not exclusively concentrate on female athletes, the findings imply that body composition, encompassing lean body mass, can influence cardiovascular endurance in team sport athletes, including females. Nevertheless, further research is necessary to gain a comprehensive understanding of the relationship between body composition and cardiovascular endurance specifically in female athletes.

The relationship between BMI and cardiorespiratory fitness in adolescent girls has been examined among 278 female students with an average age of 14.7 years. The researchers measured BMI, and cardiorespiratory fitness using a 20-meter shuttle run test, and assessed additional variables like blood pressure and body fat percentage. The findings of the study demonstrated a negative association between BMI and cardiorespiratory fitness in adolescent girls. This means that girls with higher BMI values exhibited lower levels of cardiorespiratory fitness. Furthermore, the researchers discovered that girls with higher BMI had significantly higher body fat percentages and blood pressure (McArdle et al., 2014).

The association between body composition, BMI, and cardiorespiratory fitness in professional soccer players has also been explored (Garrido-Méndez et al., 2020) in male soccer players with an average age of 24.1 years. BMI, body fat percentage, and maximal oxygen uptake (VO2 max) were measured to assess body composition and cardiovascular endurance. It indicated a negative correlation between BMI and VO2 max, implying that players with higher BMI values demonstrated lower levels of cardiorespiratory fitness. Additionally, body fat percentage was negatively correlated with VO2 max, while lean body mass exhibited a positive correlation with VO2 max. These outcomes underscore the significance of maintaining a healthy BMI and body composition for achieving and sustaining optimal cardiovascular endurance, even among highly trained athletes.

The implications of the study extend beyond soccer, suggesting that athletes in other sports should also prioritize maintaining good cardiovascular endurance to enhance overall athletic performance. These findings highlight the importance of a comprehensive approach to physical fitness, encompassing BMI, body composition, and cardiorespiratory fitness (Lee et al., 2019).

The studies cited above provide insights into the relationship between BMI and physical performance, and suggested the need for appropriate weight management strategies in sports performance. These emphasize the significance of maintaining a healthy BMI to promote optimal cardiorespiratory fitness among adolescent girls. These findings underscore the importance of instilling healthy habits, such as engaging in regular exercise and maintaining a balanced diet, from a young age to foster cardiovascular health throughout the lifespan (Al-Hazzaa et al., 2021). This study aims to examine the impact of urban and rural environments on the connection between cardiovascular endurance and BMI in female university athletes. By considering the influence of localities, we can better understand how environmental factors may interact with physiological and anthropometric characteristics in shaping athletes' overall health and performance.

To ensure the scientific rigor of this study, relevant literature and previous research will be extensively reviewed. Previous studies exploring the relationship between cardiovascular endurance, BMI, and geographic factors will be examined and cited throughout this research. This approach will allow for a comprehensive understanding of the existing knowledge and enable the identification of potential research gaps.

The findings of this study may have practical implications for the development of targeted interventions and training programs for female university athletes based on their geographic location. By recognizing the impact of environmental factors on cardiovascular endurance and BMI, sports scientists, coaches, and health professionals can tailor strategies to optimize athletes' health, performance, and overall well-being.

The hypothesis put forward suggests that there is no significant association between the fitness index and BMI. Furthermore, it proposes that the urban or rural locality does not have a significant impact on the BMI and Fitness Index of female players enrolled in Lahore College for Women University, Kinnaird College University for Women, and Home Economics College in Lahore, Pakistan.

Methods

Research design and sample:

The present study examined female university players from Lahore College for Women University (LCWU), Home Economics College in Lahore, and Kinnaird College for Women University in Lahore. A total of 136 players from various games, aged between 16 and 28 years, were included, representing diverse body types and communities (Urban & Rural). Participants with a medical history of critical diseases, recent surgeries, and specific conditions such as neurological disorders, head injuries, and diabetes were excluded from the study.

Procedure:

The research protocol for this study was approved by the ethics and research committee of the University of Lahore, Pakistan. The participants were provided with a comprehensive explanation regarding the nature and objectives of the study. Cardiovascular endurance was assessed using the Harvard Step Test, while BMI was determined by measuring the height and weight of the participants.

Measurement of Fitness Index (FI):

For observation of the cardiovascular endurance fitness of the players, Harvard Step Test (Sharma et al., 2021) was carried out for each player. The participants were asked to step up and down on the step for 5 minutes, maintaining a pace of 30 steps per minute on average. At the end of the 5 minutes steps, the participants were asked to sit immediately. After 1 minute of rest player's heart rate was measured per 30 sec. After 30-sec rest player's heart rate was measured per 30 sec again (2^{nd} time). After 30-sec the player's heart rate was measured per 30 sec again (3^{rd} time). The fitness index (FI) and status were considered as FI below 55: Poor, FI from 55 to 80: Average, FI above 80: Good (Eq. 1).

$$FI = \frac{(\boldsymbol{Duration\ of\ Exercis\ in\ Seconds} * \mathbf{100})}{(\mathbf{2} * \boldsymbol{Sum\ of\ Pulses\ in\ Recovery\ Time})} \ldots\ldots\ldots\ldots\ldots\ldots \boldsymbol{Eq.1}$$

Assessment of BMI:

The evaluation of Body Mass Index (BMI) is frequently used as a method to assess body composition, specifically in relation to excessive adiposity and higher body weight (Ángel Latorre-Roman, 2018; Nene et al., 2011). The participant's height was measured using a measuring tape, with the measurement recorded to the closest centimeter. Weight was measured utilizing standard portable weighing equipment, with the participant barefoot and wearing lightweight clothing, and the measurement was recorded to the closest kilogram. The BMI was computed using the provided formula (Eq. 2).

$$\boldsymbol{BMI = Weight\ (kg)/Height\ (m\text{^}2)} \ldots\ldots\ldots\ldots\ldots\ldots \boldsymbol{Eq.2}$$

Statistical Analysis:

Descriptive statistics were employed to summarize the demographic characteristics of the participants. To investigate the association between Cardiovascular Endurance (Fitness Index) and Body Mass Index (BMI), Spearman's correlation analysis was utilized. Additionally, a regression line was applied to examine the impact of BMI on Fitness Index. The effects of locality on BMI and Fitness Index were examined using independent samples t-test. Statistical analysis was performed using SPSS ver. 21.0. A significance level of $p < 0.05$ was set to determine statistical significance.

Result

Table 1: Descriptive Statistics of the 136 Participants.

Items	Categories	n	Mean	SD
Urban	Age (years)	86	20.62	2.27
	Height (m)	86	1.57	0.07
	Weight (kg)	86	50.86	6.66

	BMI (kg/m^2)	86	20.95	2.37
	Fitness Index	86	65.10	9.02
Rural	Age (years)	50	19.94	1.73
	Height (m)	50	1.58	0.09
	Weight (kg)	50	49.40	7.34
	BMI (kg/m^2)	50	19.89	3.22
	Fitness Index	50	68.76	7.75
Total	Age (years)	136	20.58	2.67
	Height (m)	136	1.57	0.08
	Weight (kg)	136	50.32	6.93
	BMI (kg/m^2)	136	19.93	3.31
	Fitness Index	136	66.45	8.73
	BMI Index			
Fitness Index	Under Weight	25	71.48	5.65
	Normal	105	64.90	8.77
	Over Weight	4	74.75	5.97
	Obesity	2	68.00	15.56

The study comprised a sample of 136 female players, with a mean age of 20.37 and a standard deviation (SD) of 2.10 years. The sample included 86 Urban players (Age: 20.62±2.27 years) and 50 Rural players (Age: 19.94±1.73 years). According to Table 1, the average Body Mass Index (BMI) for the entire sample was 19.93±3.31 kg/m^2, while the average fitness index was 66.45±8.73. It was observed that Urban players had higher BMI values compared to Rural players. Additionally, the overall fitness index of all participants was at an average level, with Rural players (68.76±7.75) exhibiting higher fitness levels than Urban players (65.10±9.02).

Table 2: Frequency Distribution of the Fitness Level.

Locality	Fitness Level	Frequency	Percent	Cumulative Percent
Urban	Poor	10	11.6	11.6
	Average	72	83.7	95.3
	Good	4	4.7	100.0
Rural	Poor	2	4.0	4.0
	Average	47	94.0	98.0
	Good	1	2.0	100.0
Total	Poor	12	8.8	8.8
	Average	119	87.5	96.3
	Good	5	3.7	100.0

Table 2 presents the fitness levels of all participants based on their Fitness Index, categorized by their respective localities. The findings revealed that among urban participants, 83.7% had an average fitness level, while only 4.7% achieved a good fitness level. Similarly, among rural participants, 94% had an average fitness level, and only 2% reached a good level of fitness. Overall, 8.8% of the players had a poor fitness level, 87.5% had an average fitness level, and merely 3.7%

had a good fitness level. From this, it can be concluded that a relatively small proportion of female university players achieved a good level of fitness.

Table 3: Data Normality Tests.

Variables	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	P	Statistic	df	p
Fitness Index	0.108	136	0.000	0.945	136	0.000

The Kolmogorov-Smirnov and Shapiro-Wilk tests are statistical techniques used to evaluate the adherence of a dataset to a normal distribution. In Table 3, the statistical results of these tests are presented for the Fitness Index. The findings indicated that the distribution of the dependent variable, Fitness Index (FI), did not follow a normal distribution. Therefore, non-parametric, Spearman's correlation coefficients were calculated to examine the direction and strength of the relationship between Fitness Index and BMIs among female university players.

Table 4: Spearman's Correlation Coefficients between BMI & Fitness Index.

Locality	Variables	Fitness Index
Urban (n_1=86)	BMI	0.043
Rural (n_2=50)	BMI	-0.102
Total (n=136)	**BMI**	-0.061

The analysis of Spearman's Correlation Coefficients revealed an insignificant negative correlation (r = -0.061) between the Fitness Index and BMI. This association was found to be very weak, as indicated in Table 3. Specifically, the results demonstrated that the correlation between BMI and Fitness Index among Rural players was negative (r = -0.102), whereas it was positive correlation (r=0.043) for Urban players.

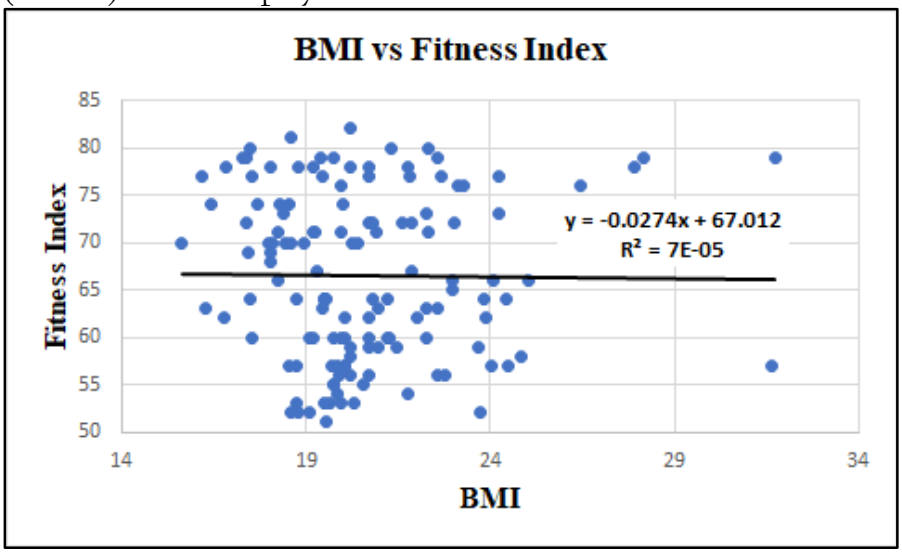

Figure 1: Relationship Chart between BMI & Fitness Index (n=136).

Figure 1 displays a scatter plot illustrating the relationship between BMI and Fitness Index. Additionally, a trend line (linear regression) was included, with an R^2 value of 0.00007. This indicates that only 0.007% of the variability in Fitness Index can be explained by BMI. Consequently, it was concluded that there was a weak and insignificant relationship between Cardiovascular Endurance and BMI among female athletes in the university setting.

Table 5: Independent Samples (t-Statistic) Test to Compare BMI & Fitness Index of Urban & Rural Community Players.

	Levene's Test for Equality of Variances		t-test for Equality of Means		
Variables	F	p	t	Df	p
BMI	2.531	.114	2.164	134	.032
Fitness Index	4.161	.043	-2.397	134	.018

To investigate the influence of urban and rural communities on the BMI and Fitness Index of female university players, an independent sample t-test was employed. The outcomes of this statistical analysis can be found in Table 5. This methodology allowed us to compare the means between the two distinct groups: urban and rural. The objective was to evaluate how urban and rural community settings impact the BMI and Fitness Index of female players enrolled in universities. The results, as shown in Table 5, revealed that the locality had a significant effect on both the BMI ($t = 2.164$, $p < 0.05$) and the Fitness Index ($t = -2.397$, $p < 0.05$) of university players. Furthermore, it was concluded that university athletes from rural areas exhibited higher fitness levels in comparison to players from urban areas.

Discussion

The aim of this study was to investigate the impact of urban and rural localities on the cardiovascular endurance of female university athletes in relation to their body mass index (BMI). The sample consisted of 136 female players, with an average age of 20.37±2.10 years. In this study, cardiovascular endurance (Fitness Index) was assessed using the Harvard Step test, while previous research by Taati et al. (2021) utilized the 12-minute Cooper test for female students from Iranian universities. The average BMI for the entire sample in this study was found to be 19.93±3.31 kg/m², whereas Taati et al. (2021) reported an average BMI of 23.36 kg/m².

Taati et al. (2021) reported a significant negative correlation ($r = -0.325$, $p = 0.001$), indicating that higher BMI values were associated with lower levels of cardiovascular endurance. This study underscores the importance of maintaining a healthy BMI for optimal cardiovascular endurance among female students, highlighting BMI as a significant factor influencing this aspect of physical fitness. However, the current study found a weak and insignificant negative correlation ($r = -0.061$, $p>0.05$) between cardiovascular endurance and BMI, suggesting that BMI was not a significant predictor of fitness level.

In a study by Vehrs et al. (2021), the relationship between body composition and cardiovascular endurance was examined in female team sport athletes, such as basketball, soccer, and volleyball players. They found that body composition, specifically lean body mass, can influence

cardiovascular endurance in team sport athletes. Conversely, the current study demonstrated a non-significant correlation between BMI and cardiovascular endurance.

McArdle et al. (2014) conducted a study to explore the relationship between BMI and cardiorespiratory fitness in adolescent girls. The research involved 278 female students with an average age of 14.7 years. BMI, cardiorespiratory fitness (measured using a 20-meter shuttle run test), and additional variables such as blood pressure and body fat percentage were assessed. Their findings revealed a negative association between BMI and cardiorespiratory fitness in adolescent girls, indicating that higher BMI values were associated with lower levels of cardiorespiratory fitness. The current study, utilizing the Harvard Step test to measure fitness level, validated these results by demonstrating a negative correlation between BMI and cardiovascular endurance.

The association between body composition, BMI, and cardiorespiratory fitness has also been investigated in professional male soccer players by Garrido-Méndez et al. (2020), with an average age of 24.1 years. Their study indicated a negative correlation between BMI and VO2 max, suggesting that players with higher BMI values exhibited lower levels of cardiorespiratory fitness. Similarly, the current study also revealed a negative association between BMI and cardiovascular endurance.

Conclusion

This study aimed to examine the impact of urban and rural localities on the cardiovascular endurance of female university athletes in relation to Body Mass Index (BMI). A diverse sample of 136 players (mean age: 20.37±2.10 years) representing various sports and body types was included. The average BMI was 19.93±3.31 kg/m², with an average fitness index of 66.45±8.73. Only 3.7% of the participants achieved a good fitness level. Weak and insignificant negative correlation was found between cardiovascular endurance and BMI. Locality had a significant effect on BMI and cardiovascular endurance, with rural athletes exhibiting higher fitness levels and lower BMI than urban athletes. It was concluded that BMI had a non-significant association with cardiovascular endurance while locality had a significant effect on BMI and cardiovascular endurance.

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