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Impact of physical activity on body composition and physical fitness: A comparative study on university athletes and non-athletes

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ABSTRACT

The physical activity levels of university students are decreasing daily due to academic burden and society's modernisation. This study aimed to investigate the correlation between physical activity, body composition, and physical fitness among university students. The research was carried out in 2024 with a sample totalling *N* = 354 students, *n* = 286 (80.8% male), aged 19–27, and *n* = 68 (19.2% female), aged 19 to 27 (22.84 ± 2.60 in total). The International Physical Activity Questionnaire was used to quantify physical activity levels. Furthermore, the IN-F500 body composition analyser was used to determine body composition. The Hand Grip Test (muscular strength), the Push Up Test (muscular endurance), the Sit and Reach Test (flexibility), and the Harvard Step Test (cardiorespiratory fitness) were utilised to assess physical fitness. Male athletes exhibited higher levels of physical activity, possessed a lower fat mass%, and had superior physical fitness. Overall, fat mass% showed statistically significant inverse correlations, whereas skeletal muscle mass%, moderate physical activity, and vigorous physical activity showed positive correlations with physical fitness. No significant correlations were found between low physical activity and physical fitness. This study suggested that universities to include high-intensity physical activity including muscular fitness, speed, and agility in to fitness programs.

KEYWORDS: physical activity; body composition; physical fitness; athletes vs. non-athletes; university students.

INTRODUCTION

A fit physique is an indication of an active and healthy lifestyle. Following college, lifestyle changes include separation from the family core, becoming more independent, engaging in less physical activity, and increased social interaction with friends (López-Sánchez et al., 2019). The adverse effects of decreased physical activity are evident among students, as it may lead to reduced physical fitness. One of the main obstacles affecting students' physical activity is the limited free time caused by the academic schedule and commitments in social and family lives (Kljajević et al., 2021). Therefore, insufficient physical activity may increase the likelihood of obesity and cardiovascular problems (Sacheck et al., 2010). Reduced levels of physical activity and worse physical fitness can lead to an increase in weight. Furthermore, apart from obesity, there is a likelihood of other illnesses, particularly those that often afflict individuals in their middle-aged and older years, manifesting as well (Saberi & Mohammadi, 2016). Inadequate physical fitness throughout adolescence poses a significant risk to the immediate and long-term health of young individuals and children (Azim et al., 2024). Again, a study reveals that a connection between physical fitness in youth and physical activity level is generally favourable (Lohman et al., 2008). It has been demonstrated that over 35% of cases of type 2 diabetes and cardiovascular diseases are caused by physical inactivity (Liu et al., 2023).

Self-reported physical activity questionnaires are widely used to assess physical activity due to their popularity,

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simplicity, and cost-effectiveness, especially in epidemiological research. The International Physical Activity Questionnaire (IPAQ) is a globally applicable tool used to measure levels of physical activity (Sebastião et al., 2012). IPAQ accurately measures moderate to vigorous physical activity (MVPA), but has difficulty measuring low-intensity activities or sedentary behaviour, which are becoming increasingly important in modern physical activity studies (Duncan et al., 2019). In terms of physical activity, it refers to any movement generated by muscular contraction, while physical fitness extends to a comprehensive spectrum of physiological and psychological attributes (Tabassum & Azim, 2024; Zaqout et al., 2016). More specifically, physical fitness spans performance-related fitness, which includes the specific aspects of fitness required for optimum performance in a job, sports, dance and health-related fitness (Lobo et al., 2024), which focuses on the capacity to carry out everyday activities (Milanese et al., 2020). Health-related fitness includes muscular strength, endurance, flexibility, and cardiorespiratory fitness (Artero et al., 2011). The overall variation in body composition is strongly correlated with a person's physical fitness level and may serve as a significant indicator of fitness state (Joensuu et al., 2021). Although laboratory-based methods may effectively assess physical fitness, owing to high costs, equipment logistics, personnel qualifications, and time restrictions, such laboratories are impractical for population-based investigations (Paineau et al., 2008). Following the completion of all obstacles, we employed laboratory-based physical fitness assessments: body composition was evaluated with a body composition analyser utilising the BIA approach (Azim et al., 2025), muscular strength was measured with a hand dynamometer, muscular endurance was assessed by push-ups, and flexibility was determined via the sit-and-reach test (Hung et al., 2022).

The current study assessed the primary health-related anthropometric parameters of university athlete and non-athlete students (Lacome et al., 2014) to determine their association with gender-specific physical activity and physical fitness (Souza et al., 2023).

METHODS

Participants

The study was performed between October 2023 and January 2024. The sample included $N = 354$ university students, consisting of $n = 122$ male athletes, $n = 27$ female athletes, $n = 164$ male non-athletes, and $n = 41$ female non-athletes. The participants were between 19 and 27 years old, with an average age of (22.84 ± 2.60) years. Participants were selected from several academic programs across the University of Rajshahi in Bangladesh, of whom 80.8% were male, and 19.2% were female.

The research was carried out in compliance with the University of Rajshahi and received approval from the Institutional Animal, Medical Ethics, Biosafety, and Biosecurity Committee [336(15)/320/IAMEBBC/IBSc]. The procedures adhered to the ethical standards of the institutions regarding human experimentation. All participants were provided with both verbal and written information about the study's purpose and procedures, and then voluntarily signed an informed consent document before commencing the research. Participation was voluntary and could stop at any time.

Procedures

Physical activity

In its complete version, the International Physical Activity Questionnaire (IPAQ) assessed physical activity over seven days with 27 items (Ács et al., 2020). The IPAQ stands out as the most widely utilised and validated questionnaire for assessing physical activity on a global scale (Sember et al., 2020). Participants must report the frequency (days per week) and duration (hours and minutes) of vigorous, moderate, and light physical activity in the week preceding (Van Holle et al., 2015). Low physical activity (LPA), moderate physical activity (MPA), and vigorous physical activity (VPA) levels are classified (Craig et al., 2003). These categories are based on weekly cumulative metabolic equivalents (METs) for low, moderate, and vigorous physical activity. The METs for each intensity level are determined by multiplying the MET value (3.3 for low, 4.0 for moderate, and 8.0 for vigorous) by the total number of minutes per week spent on each type of physical activity (Forde, n.d.). The total physical activity (TPA) is obtained by adding the METs for low, moderate, and vigorous physical activity (Garashi et al., 2020). The questionnaires were translated from English to Bengali by two native Bangladeshi speakers and back to English by two native English speakers.

Body composition

The IN-F500 body composition analyser (INBCA Medical Corp., Shenzhen, China) (Hossain et al., 2024) was utilised to determine body composition bioelectrical impedance analysis (BIA). In the same machine, the participants' height (H), weight (W), and body mass index (BMI) were

assessed. Three limitations were identified: 1) a maximum weight capacity of 500 kg; 2) a precision of 0.01 kg; and 3) a maximum height capacity of 250 cm with a precision of 0.5 cm. The Bioelectrical impedance analysis (BIA) was used to assess body fat mass (BFM), non-fat mass (NFM), muscle mass (MM), skeletal mass (SM), and total body water (TBW) (Kyle et al., 2004a). To participate in the body composition measurement the following conditions had to be met: students were instructed to fast for a minimum of five hours (participants were instructed to fast for at least five hours and avoid heavy meals, although light snacks were permitted), abstain from VPA for the previous twelve hours, wear lightweight clothing, refrain from consuming alcoholic or caffeine-containing beverages for the twelve hours prior to the examination, and passed urine 30 minutes ago during test session (Kyle et al., 2004b).

Muscular strength

Upper-limb isometric strength was measured using a hand dynamometer with an adjustable grip, Smedlay's Dynamometer, manufactured by TTM in Tokyo, Japan. The participants were required to maintain a conventional bipedal stance, with their arms fully extended and holding the dynamometer. The dynamometer was calibrated according to the participant's gender and hand size (Norman et al., 2011). The muscular grip strength test was done three times. Analyses used the mean of the three measurements (Du et al., 2024). Higher hand grip (HG) scores indicate excellent performance (Amaral et al., 2019).

Muscular endurance

Push-up (PU) measures muscular endurance (Hassan, 2018). The male participants performed regular push-ups. While females completely extend their arms, maintaining their knees and back straight. The back should remain aligned with the head during the exam. The participant lowers their body via hands until the upper arm and forearm angles approach 90◦, then returns to the starting position. Repeat this pattern as many times as possible in a 10s rhythm (Sinđić et al., 2021). The Push-up (PU) test was conducted in two trials, and the average result was used.

Flexibility

The sit-and-reach test (SRT) was used to assess lower back flexibility (Ayala et al., 2012). Participants sat on the sit-and-reach box, barefoot, and stretched their legs out in front. They then slowly reached forward as far as possible (Liu et al., 2022). The best score was registered from the two implementations.

Cardiorespiratory fitness

The Harvard step test (HST) was used to assess cardiorespiratory fitness. The participants were instructed to walk 30 steps per minute up and down the bench for five minutes, or until they were unable to maintain this pace. The bench height was set at 20 inches (45 cm) for males and 18 inches (40 cm) for females (Khurde et al., 2021). Participants began with one foot (right or left) and utilised the same foot as the "step-up" foot throughout the procedure with metronome-controlled stepping. After five minutes of rest, pulse rates were measured at three intervals of 30 seconds from 1 to 1½, 2 to 2½, and 3 to 3½ minutes after the session. Cardiorespiratory fitness was assessed using the Cardiorespiratory Fitness Index, calculated according to Equation (1) (Kim et al., 2022)

$$\text{Cardiorespiratory Fitness Index} = \frac{Time\ of\ Test(sec.) \times 100}{2 \times sum\ of\ three\ pulse\ count} \quad (1)$$

Statistical analysis

The statistical analyses were conducted using IBM SPSS Statistics (Version 25.0). The data were reported as means (standard deviation) and medians (interquartile range) for both the whole sample and the four distinct groups in which individuals were classified:male athletes, female athletes, male nonathletes, and female nonathletes. The Kolmogorov-Smirnov test was used to assess normality, while Levene's test was used to assess homogeneity. Between-group differences were assessed using independent Student's t-tests for normally distributed variables, and Mann-Whitney U tests for non-normally distributed variables. Statistically significant differences were deemed to exist when the p-value was less than or equal to 0.05. Additionally, the researchers conducted specific regressions on fitness tests, anthropometrics, body composition, and physical activity. All the fitness tests were treated as dependent variables, while the independent variables included BMI, BFM%, SM%, MPA, and VPA. A significance level of less than 0.05 was necessary to incorporate a new variable into every prediction model. The adjusted R^2 was used to assess the overall predictive power.

RESULTS

Table 1 outlines the characteristics of participants in this study and indicates a significant difference in total physical activity (< .0001) between the BMI and sport cohorts.

Anthropometrics, body composition, physical activity, and physical fitness of participants are presented in Table 2 by gender. NFM%, MM%, SM%, TBW%, and BMI were substantially higher in men than in women (p < .001).

Conversely, BFM% was higher in females than in males (p < .001). In the same way, the results of the physical activity and fitness tests showed that males performed substantially better than females on the LPA, MPA, VPA, HG, PU, SRT, HST (p < .001), and TPA (p < .01) (Table 2).

Table 3 presents the results of the study, specifically focusing on anthropometric measurements, body composition, physical activity, and physical fitness. The outcomes are organised into four categories: male athletes, female athletes, male non-athletes, and female non-athletes. The findings indicated substantial differences in BFM%, NFM%, MM%, and SM% among the four categories.

Male athletes had significantly higher scores than male non-athletes in LPA, MPA, VPA, TPA, HG, PU, SRT, and HST (p < .001) (Table 3). Female athletes exhibited significantly higher levels of LPA, MPA, VPA, TPA, HG, PU, SRT, and HST (p < .001) compared to female non-athletes. Male non-athletes had significantly higher levels compared to female non-athletes (p < .001 for LPA, VPA, HG, PU, SRT, and HST; p < .05 for TPA). The male athlete exhibited significantly higher levels of LPA, VPA, TPA, HG, PU, SRT, and HST (p < .001) compared to the female athlete (Table 3).

Table 4 presents the standardised regression coefficients β, which indicate the direction, significance, and comparable strength of the associations between BFM%, SM%, BMI, MPA, and VPA in males, females, and all participants. The regression model explained (R^2) 79.7, 78.4, and 81.7% of the variance in HG (muscular strength), 75.6, 71.6, and 78.8% of the variance in PU (muscular endurance), 72.6, 75.3, and 82.6% of the variance in SRT (flexibility), and 71.9, 82.4, and 81.9% of the variance in HST (cardiorespiratory fitness) for male, female, and all participants, respectively (Table 4).

Table 1. Characteristics of participants.

Variable	Frequencies (N)	Percentage (%)	TPA (MET-min a day) Median (IR)	p-value
Age				
> 20	88	24.86	2817.48 (1514.24)	.808
20–24	158	44.63	2933.55 (1495.33)	
< 24	108	30.51	2944.64 (1518.50)	
Education				
Honours 1st year	88	24.9	2817.47 (1514.23)	.908
Honours 2nd year	77	21.8	2956.07 (1508.52)	
Honours 3rd year	81	22.9	2912.13 (1491.75)	
Honours 4th year	34	9.6	2785.41 (1408.62)	
Masters	74	20.9	3017.79 (1570.20)	
BMI				
Underweight (BMI ≤ 18.4)	35	9.89	2423.63 (1478.89)	.0001*
Normal (BMI 18.5–25)	201	56.78	3617.41 (1421.65)	
Overweight (BMI ≥ 25.1)	118	33.33	1843.51 (808.98)	
Current living arrangement				
With family	59	16.67	2839.93 (1424.17)	.797
University dormitory	173	48.87	2962.69 (1531.56)	
Rented flat with friends	122	34.46	2863.60 (1510.58)	
Sports				
Football	66	18.64	4646.06 (380.23)	.0001*
Cricket	46	12.99	4515.76 (358.03)	
Athletics	11	3.11	4591.27 (355.44)	
Handball	21	5.93	4288.48 (381.73)	
Basketball	5	1.41	4699.80 (439.32)	
Not taking part in sports	205	57.91	1712.36 (624.39)	

BMI: body mass index; TPA: total physical activity. Data is presented as frequencies, percentage and median (interquartile range). *There are significant differences for p < .05 in non-parametric variables.

Regarding Muscular strength, HG level showed a strong positive association with SM% and VPA in all participants (p < .001) as presented in Table 4. Nonetheless, BFM% exhibited a negative association with all participants, as well as with females (p < .001) and males (p < .05). There is a positive association between MPA and HG in all participants (p < .001) and in males (p < .01). The BMI is positively associated with HG in all subjects and in male participants (p < .05) (Table 4).

Muscular endurance (PU) showed a significant positive association (p < .001) among all participants between PU, SM%, MPA, and VPA. There was a significant positive association (p < .001) between PU and SM%, VPA, and MPA (p < .01) in the male individuals (Table 4). In female PU, there was a positive association (p < .001) between SM% and VPA. However, BFM% and PU had inverse association (p < .001) across all participants, regardless of gender (Table 4).

Regarding Flexibility, all participants had a significant positive association between SRT, SM%, MPA, and VPA (p < .001) (Table 4). There was a significant positive association (p < .001) observed in male and female participants between SRT, SM%, and VPA (p < .001). However, in all participants and both genders, BFM% had a significant negative association with SRT (p < .001) (Table 4).

Concerning cardiorespiratory fitness, all participants demonstrated a significant positive association between HST, SM%, VPA (p < .001), and MPA (p < .05). Male subjects had a significant and positive association between HST, SM%, VPA (p < .001), and MPA (p < .01) (Table 4). In female participants, there was a significant, positive association among HST, SM%, and VPA (p < .001). However, BFM% had a significant negative association with HST (p < .001) in all participants and both genders (Table 4).

In this study, a strong association was observed between physical activity (PA) and physical fitness (PF). The MVPA may enhance the boys' body composition, muscular strength, explosive strength, agility, and aerobic fitness, as well as girls' agility and balance, according to Hui Fang (Fang et al., 2017). In a survey, Raistenskis et al. (2016) found that 20.1% of youngsters are obese or overweight, which has led to inactivity and an unfit physique . Participants engaged in moderate-to-vigorous physical activity, which was 22.4 min less per day and walked 50.9 m less on average during a 6-min test than non-obese/overweight children. The same study showed that physical fitness parameters correlated with daily moderate-vigorous physical activity duration and with most of the children's anthropometric parameters (Raistenskis et al.,

Table 2. Anthropometrics, body composition, physical activity, and physical fitness of participants categorised by gender.

N (%)	All participants 354 (100%)	Male 286 (80.8%)	Female 68 (19.2%)	*p*-value
	Median (IR)	Median (IR)	Median (IR)	
Age (year)	23.00 (4.25)	23.00 (5.00)	22.50 (4.00)	.809
Height (cm)	164.10 (12.65)	165.30 (10.65)	155.75(6.00)	< .001 *
Weight (kg)	63.70 (16.60)	65.15(14.75)	49.85(11.00)	< .001 *
Non-fat mass%	78.92(9.63)	79.84(8.16)	73.30 (11.10)	< .001 *
Muscle mass %	75.23(8.62)	76.11(7.16)	68.48(10.89)	< .001 *
Total body water %	55.90 (4.20)	56.60 (3.70)	51.54(4.88)	< .001 *
Body mass index	23.45(5.28)	23.80 (4.73)	21.05(5.35)	< .001 *
Low physical activity	894.00 (56.25)	902.50 (47.25)	806.50 (111.25)	< .001 *
Vigorous physical activity	189.00 (1770.00)	193.00 (1775.75)	152.00 (1716.25)	< .001 *
Total physical activity	2272.50 (2744.50)	2384.00 (2737.00)	2030.00 (3007.25)	< .01 *
Push up	19.00 (12.00)	19.00 (12.25)	10.00 (12.75)	< .001 *
Sit and reach test	26.00 (14.25)	26.50 (13.00)	16.00 (16.75)	< .001 *
Harvard step test	68.00 (21.00)	69.00 (21.00)	53.00 (21.00)	< .001 *
	Mean (SD)	Mean (SD)	Mean (SD)	p-value
Body fat mass%	21.21(7.68)	19.69(6.72)	27.60 (8.19)	< .001 †
Skeletal mass%	40.63(4.62)	41.85(4.04)	35.49(3.16)	< .001 †
Moderate physical activity	1128.81(654.38)	1163.62(646.56)	982.44(671.53)	< .05 †
Hand grip	48.11(13.65)	50.00 (13.09)	40.16(13.20)	< .001†

The data is presented as the mean (standard deviation) and median (interquartile range). * There are significant differences for p < .05 in non-parametric variables. † There are significant differences for p ≤ 0.05 in parametric variables.

Table 3. Anthropometrics, body composition, physical activity, and physical fitness of participants categorized by athlete and non-athlete.

N (%)	Male nonathlete	Female nonathlete	Male athlete	Female athlete	*p*-value
	164 (46.3%)	41 (11.6%)	122 (34.5%)	27 (7.4%)	
	Median (IR)	Median (IR)	Median (IR)	Median (IR)	
Age	23.00 (5.00)	23.00 (4.00)	23.00 (4.25)	22.00 (4.00)	
H	165.10 (11.83)	156.20 (7.60)	166.45 (9.23)	154.50 (5.20)	< .001 (ab, cd) *
W	67.65 (17.88)	53.20 (21.45)	63.75(10.58)	49.00 (6.50)	< .001 (ab, cd) * < .01 (ac) *
NFM%	77.05 (11.62)	68.90 (16.46)	81.18(5.17)	73.90 (6.54)	< .001 (ab, ac, cd) * < .05 (bd) *
MM%	73.84 (10.30)	64.94 (15.04)	77.44 (4.61)	69.30 (6.82)	< .001 (ab, ac, cd) * .05 (bd) *
TBW%	55.45 (4.70)	51.79 (6.80)	57.15 (2.23)	51.49 (3.50)	< .001 (ab, ac, cd) *
BMI	25.55 (7.30)	21.30 (8.55)	23.25(2.50)	20.40 (2.90)	< .01 (ab) * < .001 (ac, cd) *
LPA	885.00 (37.00)	770.00 (104.50)	933.00 (49.25)	880.00 (48.00)	< .001 (ab, ac, cd, bd) *
VPA	167.50 (30.50)	127.00 (35.50)	1950.50 (57.75)	1815.00 (1694.00)	< .001 (ab, ac, cd, bd) *
TPA	1816.00 (664.00)	1306.00 (932.50)	4531.50 (588.75)	4161.00 (2258.00)	< .05 (ab) * < .001 (ac, cd, bd) *
PU	16.00 (3.00)	9.00 (2.00)	29.00 (4.00)	22.00 (1.00)	< .001 (ab, ac, cd, bd) *
SRT	23.00 (6.75)	14.00 (3.00)	36.00 (5.00)	30.00 (2.00)	< .001 (ab, ac, cd, bd) *
HST	61.00 (9.00)	52.00 (2.00)	81.00 (5.25)	73.00 (3.00)	< .001 (ab, ac, cd, bd) *
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	p-value
BFM%	21.12 (8.01)	29.75 (9.31)	17.77 (3.67)	24.35 (4.60)	< .001 (ab, ac, cd) † < .01 (bd) †
SM%	41.02 (4.81)	33.47 (2.05)	42.98 (2.25)	38.57 (1.75)	< .001 (ab, ac, cd, bd) †
MPA	768.97 (498.68)	617.68 (570.63)	1694.12 (393.44)	1536.33 (364.30)	< .001 (ac, bd) †
HG	39.16 (3.48)	29.69 (2.52)	64.58 (3.66)	56.05 (1.98)	< .001 (ab, ac, cd, bd) †

a: male non-athlete; b: female non-athlete; c: male athlete; d: female athlete. The data is presented as the mean (standard deviation) and median (interquartile range). H: height (cm); W: weight (kg); NFM%: non-fat mass%; MM%: muscle mass%; TBW%: total body water %; BMI: body mass index; LPA: low physical activity; VPA: vigorous physical activity; TPA: total physical activity; PU: Push up; SRT: sit and reach; HST: harvard step test; BFM%: body fat mass%; SM%: skeletal mass %; MPA: moderate physical activity; HG: hand grip.*There are significant differences for $p < .05$ in non-parametric variables. † There are significant differences for $p \leq .05$ in parametric variables.

2016). As increased robust physical activity and high-intensity training improve fitness (Ortega et al., 2008), physical fitness assessment should be included in health monitoring systems from infancy to adolescence as a beneficial health marker. This fact has been shown as MVPA consistently correlates with fitness in youth, regardless of sedentary behaviour patterns. Moreover, limited and inconsistent relationships were reported for sedentary behaviours in research. Consequently, breaking up sedentary time in boys and non-prolonged sedentary bouts in females positively correlate with fitness, regardless of overall sedentary time or MVPA (Júdice et al., 2017). Children's and teenagers' physical fitness is positively affected by physical activity; to some extent, explosive muscle power is affected, while muscle endurance and strength are also strongly affected (Artero et al., 2010).

DISCUSSION

The primary outcome of this study indicated a strong inverse relationship between Body Mass Index (BMI) and Total Physical Activity (TPA) ($p < .001$). Students in the normal BMI range (18.5–25) exhibited the highest levels of physical activity, averaging 3617.41 MET-min/day, nearly double that of their overweight peers, who averaged 1843.51 MET-min/day. In our study, we also observed a significant disparity between students who participate in sports and those who do not. The TPA levels for basketball and football players exceeded 4600 MET-min/day. The fact that 57.91% of the sample did not engage in sports is troubling, particularly as it corresponds with the lowest median for overall physical activity recorded at 1712.36 MET-min/day.

The fat mass (FM)% exhibited a robust inverse association with the PF. The study also found a strong correlation between SM%, MPA, VPA and PF. The study observed a significant negative correlation between a higher FM% and physical fitness in all participants. Moreover, a positive correlation between higher SM% and physical fitness was observed across all participants. In a study, Szmodis et al. (2019) found that individuals with a lower FM% have a better PF. In both the age groups and all participants, there

Table 4. Associations of physical fitness components with anthropometry, body composition and physical activity.

	Male			Female			All participants		
	B (CI95%)	β	*p*-value	B (CI95%)	β	*p*-value	B (CI95%)	β	*p*-value
Dependent: Hand grip	R^2 =0.797			R^2 = 0.784			R^2 = 0.817		
BFM%	–0.22 (–0.42 to –0.02)	–0.11	< .05	–2.32 (–2.79 to –1.84)	–1.44	< .001	–0.30 (–0.46 to –0.15)	–0.17	< .001
SM%	0.78 (0.63 to 0.94)	0.24	< .001	3.66 (3.34 to 3.99)	0.88	< .001	0.84 (0.66 to 1.02)	0.28	< .001
BMI	0.35 (0.09 to 0.62)	0.11	< .05	2.66 (1.78 to 3.55)	0.87	.58	0.35 (0.15 to 0.55)	0.11	< .05
MPA	0.00 (0.00 to 0.00)	0.02	< .01	0.00 (0.00 to 0.00)	0.04	.67	0.00 (0.00 to 0.00)	0.06	< .001
VPA	0.01(0.01 to) 0.01	0.89	< .001	0.00 (0.00 to 0.00)	0.02	< .001	0.01 (0.01 to 0.01)	0.73	< .001
Dependent: Push up	R^2= 0.756			R^2 = 0.716			R^2 = 0.788		
BFM%	–0.92 (–1.29 to –0.55)	–0.83	< .001	–1.16 (–1.40 to –0.92)	–1.49	< .001	-0.29 (-0.37 to -0.21)	-0.30	< .001
SM%	0.39 (0.68 to 0.10)	0.21	< .01	1.70 (1.54 to 1.86)	0.84	< .001	0.56 (0.46 to 0.65)	0.35	< .001
BMI	0.58 (0.09 to 1.07)	0.33	.07	1.33 (0.89 to 1.76)	0.89	.34	0.35(0.24 to 0.45)	0.20	.08
MPA	0.00 (0.00 to 0.001)	0.14	< .001	0.00 (0.00 to 0.00)	0.07	.79	0.00 (0.00 to 0.00)	0.05	< .001
VPA	0.01 (0.01 to 0.01)	0.65	< .001	0.00 (0.00 to 0.00)	0.02	< .001	0.01 (0.01 to 0.01)	0.66	< .001
Dependent: Sit and reach test	R^2 = 0.726			R^2 = 0.753			R^2 = 0.826		
BFM%	–1.88 (–2.30 to –1.45)	–0.93	< .001	–1.48 (–1.81 to –1.15)	–1.45	< .001	–0.32 (–0.41 to –0.23)	–0.30	< .001
SM%	0.15 (-0.10 to 0.40)	0.07	< .001	2.21(1.99 to 2.44)	0.84	< .001	0.65 (0.54 to 0.75)	0.36	< .001
BMI	0.74 (0.42 to 1.06)	0.59	.23	1.67 (1.06 to 2.27)	0.86	.75	0.34 (0.22 to 0.46)	0.17	.41
MPA	0.00 (0.00 to 0.001)	0.03	.35	0.00 (0.00 to 0.00)	0.06	.42	0.00 (0.00 to 0.00)	0.07	< .001
VPA	0.01 (0.01 to 0.01)	0.65	< .001	0.00 (0.00 to 0.00)	0.02	< .001	0.01 (0.01 to 0.01)	0.62	< .001
Dependent: Harvard steptest	R^2=0.719			R^2 = 0.824			R^2 = 0.819		
BFM%	–0.42 (–0.61 to –0.22)	–0.26	< .001	–1.80 (–2.19 to –1.41)	–1.35	< .001	–0.31 (–0.42 to –0.19)	–0.21	< .001
SM%	0.83 (0.68 to 0.99)	0.31	< .001	2.97 (2.71 to 3.24)	0.86	< .001	0.94 (0.80 to 1.08)	0.38	< .001
BMI	0.42 (0.16 to 0.68)	0.16	.26	1.99 (1.26 to 2.72)	0.78	.98	0.20 (0.04 to 0.36)	0.08	.64
MPA	0.00 (0.00 to 0.00)	0.02	< .01	0.00 (0.00 to 0.00)	0.08	.25	0.00 (0.00 to 0.00)	0.05	< .05
VPA	0.01 (0.01 to 0.01)	0.80	< .001	0.00 (0.00 to 0.00)	0.00	< .001	0.01 (0.01 to 0.01)	0.64	< .001

BFM%: body fat mass%; SM%: skeletal mass %; BMI: body mass index; MPA: moderate physical activity; VPA: vigorous physical activity; TPA: total physical activity. Each association is accompanied by the unstandardized regression coefficient (B) along with its 95% confidence interval (CI), the standardized regression coefficient (β), and the *p*-value.

was a significant ($p < .05$) correlation between the FM% and PF assessments. Individuals with body fat percentages greater than 16–20% were less physically fit (Szmodis et al., 2019). Among football players, high FM% was associated with a negative effect on PF (Çelik et al., 2022). The prevalence of high FM% among non-athletes was similar to that observed in soccer players. Body fat percentage in soccer was inversely associated with local muscular endurance ($r = –0.39, p < .001$), maximum anaerobic power ($r = –0.20, p = .044$), and aerobic power ($r = –0.21, p = .029$) (Nikolaïdis, 2012). Another study suggested that FM% was inversely associated with the number of push-ups ($p < .001$) (a measure of endurance) and sit-ups ($p < .001$) (an indicator of flexibility) (Violanti et al., 2017).

According to Goon et al. (2013), the BFM% in girls (22.7 ± 5.7%, 95%CI = 22.3) was notably ($p = .001$) higher than that of boys (16.1 ± 7.7%, 95%CI = 16.8) (Goon et al., 2013). The children's excessive FM% negatively impacts their fitness and overall health (Goon et al., 2013). PF levels decreased as BF% increased (Dewi et al., 2021). The higher the motor skills, the lower the relative fat was in male prepubescents. The risk level cut-off point for males should be set at 20% relative body fat in order to be in a healthy biological state. The boys aged 9 to 13 scored much lower on the physical fitness test, which may also align with the suggested cut-off point (Szmodis et al., 2019). Physical fitness tests revealed that females often performed worse than males, with lower SM% and higher FM%. There was

a significant positive correlation between higher SM% and lower FM% and better performance in fitness tests (Lockie et al., 2021). Furthermore, a study conducted on soldiers found a moderate to strong correlation ($p < .001$) between the SM% and the physical fitness test (Aandstad, 2020). Young people's cardiorespiratory fitness and SM% were significantly correlated ($R^2 = 0.79$) (Wittekind et al., 2020). Reduced SM% and significant decreases over time are linked to a higher mortality risk and a lower state of PF (Metter et al., 2002).

Previous cross-sectional studies have reported significant associations between physical fitness and body composition, highlighting the importance of physical fitness early in life (Henriksson et al., 2016). However, in contrast to these findings, no significant association between BMI and physical fitness was observed in this present study.

Increasing physical activity is widely recommended as a key component for improving health outcomes and reducing the risk of multiple chronic disease and comorbidities and it may also improve mitochondrial content and function in skeletal muscle (Toledo et al., 2007). In the present study, physical activity was positively associated with physical fitness among university athletes and non-athletes. Previous study also supports that higher physical activity and lower sedentary behavior are associated with better muscular strength and power (Ramsey et al., 2021; Wu et al., 2021). Overall, these findings emphasize the importance of maintaining adequate physical activity and a healthy body composition to enhance physical fitness in young adults.

CONCLUSIONS

The study investigated disparities in PA levels between university athletes and non-athletes and examined the relationship between PA and other physical fitness factors. Athletes showed higher PA levels. PF correlated positively with both MPA and VPA. SM% was positively correlated with PF, while FM% was negatively correlated. No significant correlation was found between LPA and PF.

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CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Niloy Ahamed — Conceptualization; Methodology; Investigation; Data analysis; Writing – original draft. Ellie Abdi — Methodology; Validation; Writing – review & editing.Joseph T. Lobo — Supervision; Writing – review & editing.Hossain Mohammad Hridoy — Investigation; Data curation; Visualization. Al Azim — Conceptualization; Methodology; Formal analysis; Supervision; Writing – review & editing; Project administration. Kamal Krishna Biswas — Conceptualization; Supervision.

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