RELATIONSHIPS BETWEEN CARDIORESPIRATORY FITNESS AND PHYSICAL PERFORMANCE COMPONENTS IN U12 BASKETBALL PLAYERS

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Abstract *Purpose: This study sought to examine the relationship between cardiorespiratory fitness and physical performance components—agility, flexibility, and lower-body explosive power—in children under 12 years of age (U12) engaged in a basketball training program. Methods: A total of 94 children (under 12) from Tirana, Albania, participated in basketball training three times weekly and were evaluated. The 20-meter shuttle run test was assessed to evaluate cardiorespiratory fitness (total laps). Agility was assessed through the 10x5 meter shuttle run and the agility T-Test. Flexibility was measured with the Sit & Reach test, while explosive power was examined using the standing long jump test. Pearson correlation coefficients were employed to examine the relationships between shuttle run performance and various physical performance components. Results: A significative negative correlation was identified between shuttle run performance and the 10x5 meter agility test (r = -0.240, p = 0.020), although no significant association was detected with the Agility T-Test (r = -0.143, p = 0.179). The shuttle run performance shown no significant link with flexibility (r = 0.037, p = 0.724), but demonstrated a significate positive correlation with lower-body explosive power (r = 0.316, p = 0.002). Conclusion: Cardiorespiratory fitness in young basketball players is markedly correlated with agility and lower-body power, however not with flexibility. These findings highlight the significance of aerobic conditioning in enhancing multifaceted physical performance in child sports environments.*

Keywords: *cardiorespiratory endurance; agility; explosive strength; flexibility; adolescent basketball.*

Introduction

The examination of the relationships between cardiorespiratory fitness (CRF) and various components of physical performance among U12 basketball players is critical, given the foundational role that fitness level plays in athletic development. Evidence suggests that CRF is an essential determinant of performance capabilities in youth athletes, including in basketball. Improvements in various facets of physical fitness, particularly through sports engagement, can significantly enhance CRF, contributing to better athletic outcomes and health benefits (Spahi et al., 2016). Firstly, CRF is widely acknowledged as one of the most reliable indicators of physical performance in athletes. Research identifies maximal oxygen uptake (VO2 max), a common measure of CRF, as a significant predictor of success in endurance sports and related activities (Srivastava et al., 2024). Among young athletes, including basketball players, incorporating structured physical activity is crucial for improving CRF, and consequently, their overall performance on the court (Chen et al., 2021; (Ibikunle & Enumah, 2016; Leoprayogo et al., 2020). In basketball, where the demands are both aerobic and anaerobic, well-developed CRF allows young players to sustain higher intensity levels throughout games, enhancing their ability to execute skillful plays and maintain longer durations of physical activity without significant fatigue (Ibikunle & Enumah, 2016, 2016; Li, 2023).

Furthermore, studies indicate that various training modalities, including strength and endurance training, synergistically improve CRF and sport-specific skills (Gäbler et al., 2018). As highlighted in previous findings, concurrent training sessions that combine strength (to build muscular endurance) with aerobic components (to enhance CRF) have been shown to yield better overall performance improvements in youth athletes (Gäbler et al., 2018). This concurrent approach can specifically benefit young basketball players, who require a mix of both fitness components due to the game’s high intensity and variable pace.

Moreover, psychological aspects such as motivation and lifestyle choices also play a critical role in shaping CRF outcomes among young athletes. Factors influencing training consistency and engagement can significantly impact fitness levels, as noted in studies assessing various youth sports classes (Arrum et al., 2024). The motivation levels among players, alongside optimal training regimens, promote not only improved physical fitness but also a more enjoyable and sustainable involvement in basketball (Arrum et al., 2024).

Additionally, research highlights that increased CRF during early adolescence not only benefits immediate athletic performance but has implications for long-term health and performance (Liu et al., 2020). For instance, maintaining adequate CRF levels through youth sports participation helps mitigate risks related to obesity and chronic lifestyle diseases in later years, reinforcing the need for structured physical training at young ages (Liu et al., 2020). Lastly, the condition of anemia has been identified as a predictor of reduced physical fitness levels among athletes, demonstrating that factors related to health and nutrition significantly impact CRF and overall performance (Eli-Cophie et al., 2024). Thus, promoting comprehensive training programs, ensuring adequate nutrition, and fostering a supportive environment can substantially enhance the physical performance capabilities of U12 basketball players. This study sought to examine the relationship between cardiorespiratory fitness and physical performance components—agility, flexibility, and lower-body explosive power—in children under 12 years of age (U12) engaged in a basketball training program.

Methods

Ninety-four children under the age of 12 (U12) participated in this study. All participants participated in basketball training program conducted three times weekly in Tirana, Albania. Parental or guardian agreement was secured for all children, and the study adhered to ethical requirements for research involving minors.

Data collection occurred at the training facilities during standard training hours to minimize interruption to the participants' routines. All evaluations were conducted over multiple sessions by qualified people utilizing defined protocols. Anthropometric measurements were conducted initially, succeeded by physical performance assessments, with enough rest intervals implemented between sessions to reduce tiredness.

Measurement

Anthropometric Measurements: Body height (cm) and body weight (kg) were assessed utilizing a stadiometer and a digital scale, respectively. Body Mass Index (BMI) is determined by dividing weight in kilograms by the square of height in meters (kg/m²).

Cardiorespiratory Endurance: The 20-meter shuttle run test (Beep Test) was employed to evaluate aerobic fitness. The aggregate count of laps completed was documented.

Agility: Two agility assessments were conducted:

The Agility T-Test assesses velocity, directional alteration, and movement regulation. 10x5 Meter Shuttle Run, evaluating agility and rapid directional shifts.

Flexibility: The Sit and Reach Test was employed to evaluate hamstring and lower back flexibility.

Lower-Body Power: The Standing Long Jump Test was administered to assess explosive leg strength.

Statistical analysis

Descriptive statistics, including mean, standard deviation, minimum, and maximum values, were computed for all variables. Pearson correlation coefficients were employed to analyze the associations between cardiorespiratory endurance (measured by shuttle run laps) and many other physical fitness metrics. The threshold for statistical significance was established at $p < 0.05$.

Table 1. *Descriptive statistics for body height, body weight, and BMI*

	N	Minimum	Maximum	Mean	Std. Deviation
Body Height	94	135.0	185.0	157.2	11.5
Body Weight	94	26.0	87.0	51.3	12.1
BMI	94	2.4	20.0	7.0	3.3
Valid N (listwise)	94				

Note. Table 1 presents the descriptive statistics for body height, body weight, and BMI among the 94 participants. The mean body height was 157.2 cm (SD = 11.5), with values ranging from 135.0 to 185.0 cm. The average body weight was 51.3 kg (SD = 12.1), ranging from 26.0 to 87.0 kg. BMI values had a mean of 7.0 (SD = 3.3), with a minimum of 2.4 and a maximum of 20.0. These values suggest a relatively wide distribution across all measured variables.

Table 2. *Descriptive statistics for various physical performance tests*

	N	Minimum	Maximum	Mean	Std. Deviation
Total Laps Shuttle Run	94	11.0	67.0	36.309	12.7490
Agility T test	90	12.3	23.3	15.375	2.0878
Agility 10x5m	94	17.2	31.8	21.459	2.2412
Sit & Reach	92	8.0	33.5	20.543	5.3645

Standing long jump	94	94.0	213.4	152.344	25.6297
Valid N (listwise)	89				

Table 2 displays descriptive statistics for various physical performance tests. The mean number of laps completed in the shuttle run was 36.31 (SD = 12.75), with a range from 11 to 67 laps. For the Agility T-Test, based on 90 participants, the average completion time was 15.38 seconds (SD = 2.09), with a minimum of 12.3 and a maximum of 23.3 seconds. The 10x5 meter agility run had a mean time of 21.46 seconds (SD = 2.24), ranging from 17.2 to 31.8 seconds. In the Sit & Reach flexibility test, participants reached an average of 20.54 cm (SD = 5.36), with scores spanning from 8.0 to 33.5 cm. Lastly, the Standing Long Jump showed a mean distance of 152.34 cm (SD = 25.63), with a minimum of 94.0 cm and a maximum of 213.4 cm. These results indicate considerable variability in physical performance among the participants.

Table 3. *Pearson correlation coefficients between cardiorespiratory fitness with agility*

		Agiilty 10x5m	Agiilty T test
Total Laps Shutlle Run	Pearson Correlation	-.240*	-0.143
	Sig. (2-tailed)	0.020	0.179
	N	94	90

Note. Table 3 shows the Pearson correlation coefficients between the total laps in the shuttle run (cardio respiratory fitness) and two agility test measures (agility): the 10x5 meter run and the Agility T-Test. A statistically significant negative correlation was found between shuttle run performance and the 10x5 meter agility test (r = -0.240, p = 0.020), indicating that participants who completed more laps tended to perform better (i.e., faster) on this agility test. However, the correlation between shuttle run laps and the Agility T-Test was not statistically significant (r = -0.143, p = 0.179).

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3. *Pearson* correlations between shuttle run test performance (cardiorespiratory fitness) and two physical fitness components (flexibility and explosive power)

		Sit Reach	Standing long jump
Total Laps Shutlle Run	Pearson Correlation	0.037	.316**
	Sig. (2-tailed)	0.724	0.002
	N	92	94

Note. Table 4 presents the correlations between shuttle run test performance (cardiorespiratory fitness) and two physical fitness components (flexibility and explosive power): flexibility (sit & reach test) and lower-body explosive power (standing long jump test). The correlation between shuttle run laps and Sit & Reach scores was positive but not statistically significant (r = 0.037, p = 0.724). In contrast, a significant positive correlation was observed between shuttle run performance and standing long jump test (r = 0.316, p = 0.002), suggesting that greater cardiovascular endurance is moderately associated with better lower-body explosive strength.

**. Correlation is significant at the 0.01 level (2-tailed).

Discussion

The present study examined the relationship between cardiorespiratory fitness, as measured by the shuttle run test, and various components of physical fitness—including agility, flexibility, and lower-body explosive power—in children under 12 years of age engaged in basketball training.

The results revealed a significant negative correlation between shuttle run performance and the 10x5 meter agility test (r = -0.240, p = 0.020), suggesting that higher levels of aerobic endurance are associated with better (i.e., faster) agility performance in this test. However, no significant correlation was found between shuttle run performance and the Agility T-Test (r = -0.143, p = 0.179). This discrepancy may be due to the different movement demands and coordination requirements of the two agility tests. The 10x5 meter test involves shorter, repeated sprints with rapid directional changes, which may be more reflective of the movement patterns in basketball and more strongly influenced by aerobic capacity in this age group.

Regarding flexibility and lower-body power, no significant correlation was observed between shuttle run performance and the Sit & Reach test (r = 0.037, p = 0.724), indicating that cardiorespiratory fitness may not be strongly related to flexibility in children. In contrast, a moderate positive correlation was found between shuttle run performance and the Standing Long Jump (r = 0.316, p = 0.002), suggesting that children with better aerobic fitness tend to perform better in tasks requiring lower-body explosive strength. This finding aligns with previous research indicating that well-developed aerobic capacity may support repeated high-intensity efforts, which can positively impact performance in explosive movements. Research indicates that elevated levels of cardiorespiratory fitness, measured by maximal oxygen uptake (VO2 max), correlate with enhanced athletic performance in younger athletes (Gäbler et al., 2018). This fitness parameter is particularly significant in basketball due to the sport's intermittent high-intensity demands, necessitating athletes to alternate between aerobic and anaerobic energy systems (Leoprayogo et al., 2020).

Furthermore, examining the influence of lifestyle factors on cardiorespiratory fitness helps elucidate variations in performance levels among young athletes. Motivation, efficient time management, and lifestyle decisions profoundly influence CRF outcomes in adolescents, with basketball players frequently encountering distinct motivational dynamics compared to their counterparts in other sports (Arrum et al., 2024). This indicates that cultivating an engaging training environment is essential for the advancement of CRF and associated performance measures.

Training programs tailored for young basketball players can significantly benefit from recognizing these physiological and motivational factors. Consistent engagement in endurance and strength training, as shown by relevant studies, improves cardiorespiratory fitness, hence favourably affecting performance in competitive scenarios.

Conclusion

In conclusion, the findings of this study highlight a modest but significant relationship between cardiorespiratory fitness and certain aspects of physical fitness in children participating in recreational basketball. Specifically, aerobic endurance was positively associated with agility (10x5 meter run) and lower-body explosive strength (standing long jump), but not with flexibility or performance in the Agility T-Test. These results suggest that training programs for young athletes may benefit from integrating endurance and strength components to enhance overall physical performance. Future research should explore these relationships longitudinally and in more diverse populations to better understand the developmental interplay between fitness components in youth sports.

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