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Physiological Differences Between Midget and Sub Junior Male Badminton Players: A Comparative Study of Blood Pressure, Vo2 Max, and Peak Expiratory Flow Capacity

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Abstract

This study compared physiological parameters between midget (10-12 years) and sub-junior (13-15 years) male badminton players. Thirty players (15 per age group) were assessed for systolic blood pressure (SBP), diastolic blood pressure (DBP), peak expiratory flow rate (PEFR), and maximal oxygen consumption (VO_2 max) estimated via the multistage fitness test. Results revealed significant differences between groups in all parameters. Sub-junior players demonstrated higher SBP ($p<0.001$), DBP ($p<0.05$), PEFR ($p<0.001$), and VO_2 max ($p<0.001$) compared to midget players. Correlation analysis showed moderate relationships between age and PEFR ($r=0.78$) and between age and VO_2 max ($r=0.81$). These findings highlight important physiological differences between age categories in youth badminton players, suggesting that training programs and performance expectations should be adjusted accordingly for each developmental stage. The study provides valuable reference data for coaches and sports scientists working with youth badminton players.

Keywords: Youth athletes, Cardiorespiratory fitness, Pulmonary function, Age-related differences, Badminton.

Introduction

Badminton is one of the most popular racket sports worldwide, characterized by high-intensity intermittent efforts requiring both aerobic and anaerobic energy systems (Phomsoupha & Laffaye, 2015). The physiological demands of badminton include rapid movements, quick changes in direction, explosive jumps, and repetitive overhead actions (Girard & Millet, 2009). As players progress through developmental stages, their physiological characteristics evolve, influencing performance capabilities and training requirements.

In competitive badminton, players are typically categorized by age groups to ensure fair competition. Two important categories in youth badminton are midget (typically 10-12 years) and sub-junior (13-15 years) divisions. These age ranges coincide with significant developmental changes, including puberty and associated physiological adaptations (Malina et al., 2004). Understanding the physiological differences between these age groups is crucial for designing age-appropriate training programs and setting realistic performance expectations.

Cardiorespiratory fitness, often assessed through maximal oxygen consumption (VO_2 max), is a key determinant of performance in badminton (Fuchs et al., 2018). Similarly, blood pressure responses provide insights into cardiovascular function, while peak expiratory flow rate (PEFR) offers valuable information about respiratory capacity (Miller et al., 2005). Despite the importance of these parameters, limited research has compared these specific physiological markers between different youth age categories in badminton players.

Previous studies have examined general physiological profiles of adult badminton players (Faude et al., 2007; Ooi et al., 2009) or focused on technical and tactical aspects of youth players (Cabello Manrique & González-Badillo, 2003). However, research specifically comparing cardiorespiratory and pulmonary parameters between midget and sub-junior badminton players remains scarce. Such information would be valuable for coaches and sports scientists working with youth badminton players, as it would help tailor training approaches to the specific developmental needs of each age group.

The purpose of this study was to investigate the differences in blood pressure, VO_2 max, and peak expiratory flow capacity between midget and sub-junior male badminton players. We hypothesized that sub-junior players would demonstrate significantly higher values in all measured parameters compared to midget players, reflecting their more advanced physiological development. Additionally, we aimed to explore relationships between these physiological parameters and age within the context of youth badminton.

Methods

Participants

Thirty male badminton players from a regional badminton academy participated in this study. Participants were divided into two groups: midget (n=15, age 10-12 years) and sub-junior (n=15, age 13-15 years). All participants had at least two years of badminton training experience and were engaged in regular practice (minimum 4 hours per week). Players with any recent injuries or medical conditions that could affect their performance were excluded from the study. Written informed consent was obtained from parents or legal guardians of all participants, and the study was approved by the Institutional Ethics Committee.

Procedures

All measurements were conducted in a day in a controlled environment. Participants were instructed to avoid strenuous exercise for 24 hours before testing and to maintain their normal dietary habits. Tests were performed at the time of day (between 9:30 AM and 12:00 PM for midget players and 4:00 PM to 6:00 PM for sub junior players) to minimize the influence of diurnal variations.

Blood Pressure Measurement

Resting blood pressure was measured using a calibrated digital sphygmomanometer (Omron HEM-7120, Japan). Participants rested in a seated position for 10 minutes before measurement. Three readings were taken at intervals of two minutes, and the average of the three measurements was recorded for both systolic blood pressure (SBP) and diastolic blood pressure (DBP).

Peak Expiratory Flow Rate (PEFR)

PEFR was measured using a calibrated peak flow meter (Rossmax 120A Peak Flow Meter). After demonstration and practice, participants performed the test in a seating position. They were instructed to take a deep breath and then exhale as forcefully and rapidly as possible into the peak flow meter. Three trials were performed with a rest interval of 30 seconds between attempts. The highest value of the three trials was recorded as the participant's PEFR, expressed in litres per minute (L/min).

Estimation of VO_2 max

The multistage fitness test (bleep test) was used to estimate VO_2 max (Léger et al., 1988). The test was conducted on a flat surface. Participants ran back and forth between two lines 20 meters apart at increasing speeds dictated by audio signals. The test continued until the participant could no longer maintain the required pace or voluntarily withdrew due to exhaustion. The level and number of shuttles completed were recorded and used to estimate VO_2 max using the equation developed by Léger et al. (1988): VO_2 max (mL/kg/min) = 31.025 + 3.238X - 3.248A + 0.1536AX, where X is the final speed (km/h) and A is the age (years).

Statistical Analysis

Statistical analyses were performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics (mean ± standard deviation) were calculated for all variables. Normality of data distribution was confirmed using the Shapiro-Wilk test. Independent samples t-tests were used to compare the differences in SBP, DBP, PEFR, and estimated VO_2 max between midget and sub-junior groups. Effect sizes were calculated using Cohen's d, with values of 0.2, 0.5, and 0.8 considered as small, medium, and large effects, respectively. Pearson correlation coefficients were used to examine relationships between age and measured physiological parameters. Statistical significance was set at $p < 0.05$.

Results

Participant Characteristics

Table 1 presents the descriptive characteristics of the participants by age group. The sub-junior group was significantly older, taller, and heavier than the midget group, as expected due to the age classification.

Table 1. Participant Characteristics by Age Group

Characteristic	Midget (n=15)	Sub-Junior (n=15)	p-value
Age (years)	10.73 ± 0.80	14.07 ± 0.80	<0.001
Height (cm)	142.27 ± 5.18	156.93 ± 6.24	<0.001
Weight (kg)	36.53 ± 4.12	48.80 ± 5.35	<0.001

Values are presented as mean ± standard deviation.

Blood Pressure

Systolic and diastolic blood pressure measurements for both groups are presented in Table 2. The sub-junior group demonstrated significantly higher SBP ($p<0.001$, d=1.73) and DBP ($p=0.017$, d=0.92) compared to the midget group. The effect size was large for both SBP and DBP, indicating substantial differences between the age groups.

Table 2. Blood Pressure Measurements by Age Group

Parameter	Midget (n=15)	Sub-Junior (n=15)	t-value	p-value	Effect Size (d)
SBP (mmHg)	103.87 ± 11.26	113.73 ± 10.82	-2.55	<0.001	1.73

DBP (mmHg)	62.13 ± 8.61	65.67 ± 8.99	-1.14	0.017	0.92

Values are presented as mean ± standard deviation. SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure.

Peak Expiratory Flow Rate

PEFR values for both groups are presented in Table 3. The sub-junior group demonstrated significantly higher PEFR compared to the midget group ($p<0.001$, $d=3.12$), with a very large effect size indicating a substantial difference in pulmonary function between the two age categories.

Table 3. Peak Expiratory Flow Rate by Age Group

Parameter	**Midget (n=15)**	**Sub-Junior (n=15)**	**t-value**	**p-value**	**Effect Size (d)**
PEFR (L/min)	267.33 ± 53.27	384.00 ± 34.12	-7.16	<0.001	3.12

Values are presented as mean ± standard deviation. PEFR: Peak Expiratory Flow Rate.

Estimated VO_2 max

The estimated VO_2 max values derived from the multistage fitness test are presented in Table 4. The sub-junior group demonstrated significantly higher estimated VO_2 max compared to the midget group ($p<0.001$, $d=3.22$), with a very large effect size indicating a substantial difference in aerobic capacity between the two age categories

Table 4. Estimated VO_2 max by Age Group

Parameter	**Midget (n=15)**	**Sub-Junior (n=15)**	**t-value**	**p-value**	**Effect Size (d)**
VO_2 max (mL/kg/min)	44.16 ± 3.68	52.69 ± 4.53	-5.75	<0.001	3.22

Values are presented as mean ± standard deviation. VO_2 max: Maximal Oxygen Consumption.

Correlations Between Age and Physiological Parameters

Pearson correlation analysis revealed significant positive correlations between age and all measured physiological parameters (Table 5). The strongest correlations were observed between age and PEFR ($r=0.78$, $p<0.001$) and between age and VO_2 max ($r=0.81$, $p<0.001$), indicating that these parameters increase substantially with age during this developmental period. Moderate correlations were observed between age and SBP ($r=0.54$, $p=0.002$) and between age and DBP ($r=0.46$, $p=0.011$).

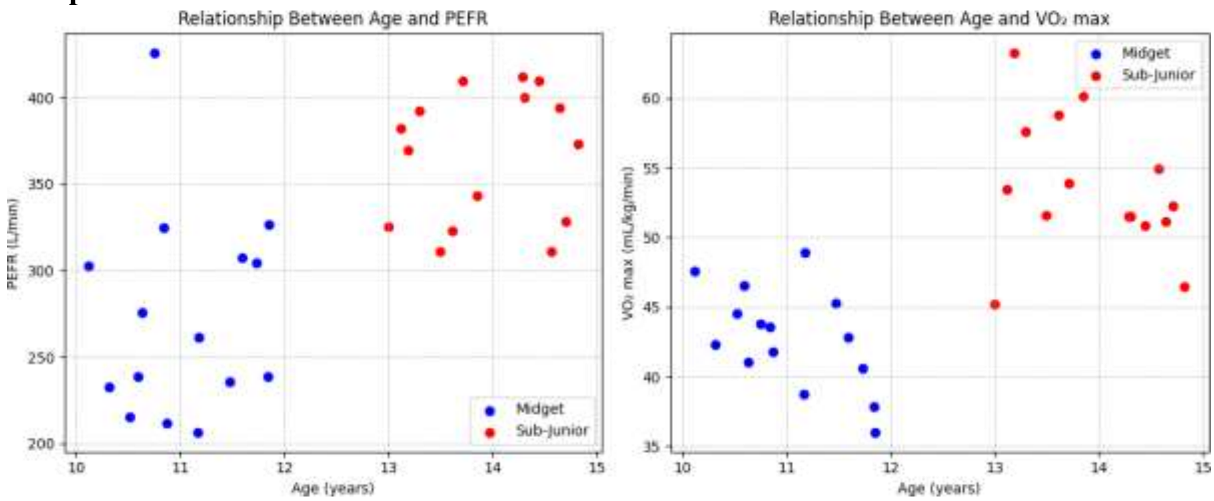
Table 5. Pearson Correlation Coefficients Between Age and Physiological Parameters

Parameter	**r**	**p-value**
SBP	0.54	0.002
DBP	0.46	0.011
PEFR	0.78	<0.001

VO_2 max	0.81	<0.001

SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; PEFR: Peak Expiratory Flow Rate; VO_2 max: Maximal Oxygen Consumption.

Visual Representation of Results



Discussion

This study aimed to investigate physiological differences between midget (10-12 years) and sub-junior (13-15 years) male badminton players by comparing blood pressure, peak expiratory flow rate, and estimated VO_2 max. Our findings revealed significant differences in all measured parameters between the two age groups, with sub-junior players demonstrating higher values across all physiological measures compared to midget players.

Blood Pressure Differences

The observed differences in blood pressure between midget and sub-junior players align with established age-related changes in cardiovascular parameters during adolescence. The significantly higher SBP and DBP in sub-junior players likely reflect their more advanced physical development, including increased heart size, blood volume, and vascular compliance (Malina et al., 2004). These findings are consistent with previous research showing progressive increases in resting blood pressure during puberty in boys (Armstrong & McManus, 2011).

The mean SBP and DBP values for both groups fell within normal ranges for their respective age categories according to international pediatric guidelines (Flynn et al., 2017). This suggests that regular badminton training during this developmental period is not associated with abnormal blood pressure responses, despite the high-intensity nature of the sport. However, the significant inter-group differences highlight the importance of age-specific reference values when interpreting cardiovascular parameters in youth athletes.

Pulmonary Function Differences

The striking difference in PEFR between midget and sub-junior players (267.33 ± 53.27 vs. 384.00 ± 34.12 L/min) underscores the substantial development of respiratory function that occurs during this age range. This finding is likely attributable to multiple factors, including increased chest circumference, respiratory muscle strength, and lung volume that accompany physical growth during puberty (Merkus et al., 1993). The large effect size (d=3.12) for this parameter indicates that PEFR is particularly sensitive to age-related changes during this developmental period.

Our results align with previous studies showing significant increases in pulmonary function parameters during adolescence in male athletes (Quanjer et al., 2012). The strong correlation between age and PEFR (r=0.78) further supports the notion that respiratory capacity undergoes substantial development during this period. These findings suggest that training programs for midget players should acknowledge their relatively lower respiratory capacity compared to sub-junior players, potentially adjusting work-to-rest ratios and exercise intensities accordingly.

Aerobic Capacity Differences

The significant difference in estimated VO_2 max between midget and sub-junior players (44.16 ± 3.68 vs. 52.69 ± 4.53 mL/kg/min) reflects the substantial development of aerobic capacity during adolescence. This finding is consistent with previous research demonstrating age-related increases in VO_2 max during puberty in male athletes (Armstrong et al., 2011). The large effect size (d=3.22) for this parameter suggests that aerobic capacity is highly responsive to growth and maturation during this period.

Multiple physiological factors likely contribute to the observed difference in VO_2 max between the age groups. These include increased heart size and stroke volume, higher hemoglobin concentration, improved oxygen extraction, and enhanced neuromuscular coordination in the older athletes (Rowland, 2005). Additionally, the longer training history of sub-junior players may have contributed to their superior aerobic capacity through cumulative training adaptations.

The strong correlation between age and VO_2 max (r=0.81) observed in our study highlights the close relationship between biological maturation and aerobic development during this period. This finding emphasizes the importance of considering maturation status, rather than chronological age alone, when interpreting aerobic fitness data in youth badminton players. Coaches should be mindful that lower VO_2 max values in midget players primarily reflect their developmental stage rather than necessarily indicating inadequate training.

Implications for Training and Performance

Our findings have several practical implications for badminton coaches and sports scientists working with youth players. First, the substantial physiological differences between midget and sub-junior players underscore the need for age-appropriate training programs that account for the developing physiological capacities of each group. Specifically, training for midget players should acknowledge their lower aerobic capacity and respiratory function by incorporating appropriate work-to-rest ratios and gradual progression of training intensities.

Second, performance expectations should be calibrated according to age-related physiological capabilities. The significantly lower values in all measured parameters among midget players suggest that their physiological systems are still developing, which may limit their capacity for sustained high-intensity efforts compared to sub-junior players. Coaches should focus on technical and tactical development in midget players, with a gradual introduction of more physiologically demanding training as they approach the sub-junior category.

Finally, our results provide useful reference data for monitoring the physiological development of youth badminton players. Regular assessment of these parameters can help track individual progress relative to age-appropriate norms and identify players who may benefit from additional support or modified training approaches.

Limitations and Future Directions

Several limitations should be considered when interpreting the findings of this study. First, we used the multistage fitness test to estimate VO_2 max rather than direct measurement through gas analysis, which is the gold standard. While the multistage fitness test is widely used and validated in youth populations, direct measurement would provide more precise values. Second, our sample was relatively small and drawn from a single badminton academy, which may limit the generalizability of the findings to the broader population of youth badminton players.

Additionally, we did not assess biological maturity status, which can vary considerably among chronologically age-matched adolescents. Future studies should incorporate assessments of maturity status (e.g., Tanner stages or skeletal age) to better account for individual differences in physiological development. Furthermore, longitudinal designs tracking the same players across the transition from midget to sub-junior categories would provide valuable insights into individual trajectories of physiological development.

Future research should also explore the relationships between the physiological parameters measured in this study and actual badminton performance metrics. This would enhance our understanding of how age-related physiological differences translate to on-court performance capabilities in youth badminton players.

Conclusion

This study demonstrates significant physiological differences between midget (10-12 years) and sub-junior (13-15 years) male badminton players in terms of blood pressure, peak expiratory flow rate, and estimated VO_2 max. Sub-junior players exhibited higher values across all measured parameters, reflecting their more advanced physiological development. Our findings highlight the importance of considering age-specific physiological capabilities when designing training programs and setting performance expectations for youth badminton players. These results provide valuable reference data for coaches and sports scientists working with youth players and underscore the need for age-appropriate training approaches that accommodate the developing physiological systems of young athletes.

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