Sex differences in body composition and physical fitness of young basketball players

Differencias sexuales en la composición corporal y la condición física de jóvenes jugadores de baloncesto

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Abstract

Introduction: Throughout adolescence, sex differences are observed for anthropometric, body composition, and physical fitness variables.
Objective: This study's aims were: (1) to explore differences in anthropometry, body composition, and physical fitness performance between male and female youth basketball players, and (2) to examine the relationships between body composition, strength, and balance performance.
Methodology: Forty-nine regional youth basketball players (27 males; mean age = 14.3 ± 1.2 years), were assessed for body composition, strength, speed, upper-limb coordination, and balance performance.
Results: As expected, males were taller (p = 0.002), with lower body fat (p < 0.001) and increased fat-free mass (p < 0.002) than females. Body fat correlated significantly with strength (handgrip: r_s = -0.47, p < 0.001; countermovement jump: r_s = -0.72, p < 0.001; squat jump: r_s = -0.73, p < 0.001; horizontal jump: r_s = -0.76, p < 0.001), upper-limb speed and coordination (r_s =-0.32, p = 0.027), and 20-m sprint performance (r_s = 0.72, p < 0.001), but not with balance tasks. Body mass and fat-free mass were negatively associated with balance, indicating reduced postural control.
Conclusions: These findings underscore the importance of accounting for sex differences when developing training programs for youth basketball players. Also, coaches and their staff should monitor body composition, particularly body fat, to enhance explosive strength and speed. Fat-free mass positively influences balance ability, highlighting the role of body composition in physical fitness.

Keywords

Body fat; female; male; muscle strength; postural balance.

Resumen

Introdución: Durante la adolescencia se observan diferencias entre sexos en las variables antropométricas, de composición corporal y de condición física.
Objetivo: Los objetivos de este estudio fueron: (1) explorar las diferencias en la antropometría, la composición corporal y el rendimiento de la condición física entre jóvenes jugadores y jugadoras de baloncesto, y (2) examinar las relaciones entre la composición corporal, la fuerza y el rendimiento del equilibrio.
Metodología: Cuarenta y nueve jóvenes jugadores de baloncesto de nivel regional (27 varones; edad media = 14.3 ± 1.2 años) fueron evaluados en cuanto a composición corporal, fuerza, velocidad, coordinación de los miembros superiores y rendimiento del equilibrio.
Resultados: Como era de esperar, los varones eran más altos (p = 0.002), presentaban menor grasa corporal (p < 0.001) y mayor masa libre de grasa (p < 0.002) que las mujeres. La grasa corporal se correlacionó significativamente con la fuerza (prensión manual: r_s = −0.47, p < 0.001; salto con contramovimiento: r_s = −0,72, p < 0,001; salto en sentadilla: r_s = −0.73, p < 0.001; salto horizontal: r_s = −0.76, p < 0.001), con la velocidad y la coordinación de los miembros superiores (r_s = −0,32, p = 0.027) y con el rendimiento en el sprint de 20 m (r_s = 0.72, p < 0.001), pero no con las tareas de equilibrio. La masa corporal y la masa libre de grasa se asociaron negativamente con el equilibrio, lo que indica un control postural reducido.
Conclusiones: Estos hallazgos subrayan la importancia de tener en cuenta las diferencias entre sexos al desarrollar programas de entrenamiento para jóvenes jugadores de baloncesto. Además, los entrenadores y su cuerpo técnico deberían monitorizar la composición corporal, en particular la grasa corporal, para mejorar la fuerza explosiva y la velocidad. La masa libre de grasa influye positivamente en la capacidad de equilibrio, lo que destaca el papel de la composición corporal en la condición física.

Palabras clave

Equilibrio postural; femenino; fuerza muscular; grasa corporal; masculino.

Introduction

During adolescence, sex differences are observed for body composition and physical fitness tasks (Lefevre et al., 1998). According to the literature, the influence of growth and maturation, which vary widely among individuals and between sexes, results in performance disparities between male and female athletes (Malina et al., 2004). Young male athletes often exhibit superior body size and fat-free mass, and lower body fat than females (Lesinski et al., 2020; Malina et al., 2004), which impacts their performance in physical fitness tasks. Among adolescent team sport athletes, larger sex differences in physical performance were observed between the U14 and U16 age groups, favoring boys, especially due to the impact of maturation (Tingelstad et al., 2025). Consequently, in adulthood, research has also shown that males tend to outperform females by 10% to 30% in athletic events, depending on the specific physical demands of the activity (Hunter et al., 2023).

Key components of physical fitness include body composition, muscle strength, and bone development (Goswami et al., 2014; Malina et al., 2004). Throughout adolescence, increases in skeletal size and muscle mass lead to greater muscle strength in males. On the other hand, females tend to gain less stature and muscle mass while accumulating significant body fat (Goswami et al., 2014). Previous literature has reported the negative influence of fatness on performance, particularly in tasks requiring body movement or projection through space, such as jumping and running (Malina et al., 2004; Malina & Geithner, 2011). In contrast, muscle strength is associated with improved force-time characteristics that enhance athletes' overall performance (Suchomel et al., 2016).

Basketball is among the most prominent team sports that has gained global recognition due to its fast-paced performance, involving high-intensity actions (Asal et al., 2025). Thus, a significant emphasis has been placed on studying players' strength, aerobic, and anaerobic capacities (Hassan, 2025; Mancha-Triguero et al., 2019). On the other hand, balance, defined as the ability to maintain the body's center of gravity over the base of support (Pollock et al., 2000), appears to be a less-studied capacity within the overall youth sports literature. Besides injury prevention, balance has also been related to sports performance (Hrysomallis, 2011). Indeed, in basketball, players are frequently subjected to physical contact and various situations involving balance instability, such as shooting, changes of direction, and boxing out (Boccolini et al., 2013). Additionally, a recent systematic review found that balance training is valuable for improving physical fitness and skill-related performance in basketball players (Wang et al., 2025). However, when evaluating sex differences in balance performance among youth players, inconsistent results have been found, although it may be speculated that females should outperform their male peers in balance tasks (Schedler et al., 2019).

Overall, sex differences in body composition and physical fitness characteristics have been explored in youth sports (Bauer et al., 2021; Ingebrigtsen et al., 2013; O'Brien-Smith et al., 2020; Perroni et al., 2018). However, most existing research has focused on boys, creating a significant gap in understanding how physical attributes develop in girls and how their development trajectories compare between sexes (Tingelstad et al., 2023). Additionally, most previous research in youth sports has prioritized body composition, speed, strength, and power outputs (Tingelstad et al., 2025; Tingelstad et al., 2023), while balance ability has been largely disregarded. Given the major impact of balance on motor competence, injury prevention, and performance enhancement, it is crucial to conduct in-depth research on this topic to support the design of suitable and effective training programs.

Therefore, the current study's aims were twofold: (1) to explore differences in anthropometry, body composition, and physical fitness performance between male and female youth basketball players, and (2) to examine the relationships between body composition, strength, and balance performance. Based on previous research, it is hypothesized that: (1) sex differences should emerge in body composition and physical fitness, favoring male players, and (2) significant relationships should be found between body composition parameters, particularly body fat and fat-free mass, strength, and balance performance.

Method

Participants

This study included 49 Portuguese youth basketball players (27 males). All players were selected to represent a regional team in Portugal, competing in the main national tournament organized by the Portuguese Basketball Federation. All procedures implemented in this study were approved by the Ethics Committee of the University of Madeira (151/CEUMA/2024), and written informed consent to participate was obtained from all individuals and their respective legal guardians.

Procedure

This is a cross-sectional study. All measurements were performed during the morning on four consecutive days. All testing procedures were conducted in a laboratory setting, except for the 20-m linear sprint, which was performed on an official basketball court.

Instrument

Anthropometry and body composition

Stature was measured to the nearest 0.1 cm using a stadiometer (SECA 213, Hamburg, Germany). Body composition was evaluated through hand-to-foot bioelectrical impedance analysis (InBody 770, Cerritos, CA, USA). All measurements were conducted in a laboratory during the early morning, while participants were fasting, barefoot, and wearing only their underwear. Among body composition variables, body mass, body fat percentage (BF%), and fat-free mass (FFM) were retained for analysis.

Static strength

The handgrip test was used to assess static strength. The protocol included three alternating data collection trials for each arm using a hand dynamometer (Jamar Plus+, Chicago, IL, USA). Between trials, a 60-second rest interval was ensured. During the assessment, participants stood and were instructed to hold the dynamometer in one hand, laterally to the trunk, with the elbow at 90° (Gerodimos, 2012). Participants were asked to squeeze as hard as possible for about two seconds in this position. The trial was repeated if the dynamometer came into contact with the participant's body or if the elbow position changed from 90º. The best score of the three trials was retained for analysis.

Lower-body explosive strength

Three tests were conducted to assess lower-body explosive strength: the countermovement jump (CMJ), the squat jump (SJ), and the standing long jump (SLJ). The CMJ and SJ were performed using the Optojump Next (Microgate, Bolzano, Italy) and included four data collection trials, separated by a 30-second rest interval. Participants' hands were placed on their waists during both jumping tests. In the SLJ, a tape measure was used to record the maximum distance jumped in two trials. Before data collection, three experimental trials were conducted to ensure the proper execution of each testing procedure. Participants were encouraged to jump to a maximum height or as far as possible during each assessment. The best score from each trial was used for analysis.

Linear speed

The 20 m sprint test was implemented to assess speed performance. Participants completed two maximal sprint trials, each followed by a 2-minute rest interval. Sprint time was recorded in seconds using Witty-Gate photocells (Microgate, Bolzano, Italy), and the best score was retained for analysis.

Balance

The Biodex Balance System SD (Biodex, Shirley, NY, USA) was used for balance assessment. The modified clinical test of sensory integration of balance (mCTSIB) protocol was implemented to quantify postural sway under four conditions designed to assess the contribution of different sensory inputs (visual, vestibular, and somatosensory) (Goble et al., 2019): (1) eyes open, firm surface; (2) eyes closed, firm surface; (3) eyes open, unstable surface; and (4) eyes closed, unstable surface. Each condition is assessed using 30-second trials, during which the system records the degree of tilt to measure postural sway. After each trial, a 30-second rest interval was provided to adjust participants' positioning and foot pla-

cement according to the software's instructions. The result of the mCTSIB is the sway index, representing the mean absolute deviation of the participant's average position during the test. The higher the sway index, the more unsteady the participant was during the test.

Upper-limb speed and coordination

The plate tapping test evaluated upper-limb speed and coordination through rapid hand movements. During the test, two circles and a rectangle are affixed to a table, with the rectangle positioned centrally between the two circles, spaced 40 cm apart. The participant was positioned facing the table and placed one hand on the rectangle, while the other hand started on the circle on the opposite side. At the signal, the participants moved their hands back and forth between the circles as quickly as possible. The test involved performing 25 complete motion cycles (touching the near circle and returning to the starting circle), totaling 50 taps in the shortest possible time. Each participant completed two trials, and the fastest time recorded was considered the best result.

Data analysis

Descriptive statistics are presented as means ± standard deviations. The Mann-Whitney U test explored differences between male and female players in anthropometry, body composition, and physical fitness assessments. Then, Spearman's Rho correlations were used to examine the relationships among age, anthropometry, body composition, and physical fitness indicators. The statistical analyses were conducted using IBM SPSS Statistics 29.0 (SPSS Inc., Chicago, IL, USA), with a significance level of 0.05.

Results

Table 1 summarizes descriptive statistics and group differences by sex for age, body composition, and physical fitness performance. Males were significantly taller (p = 0.002) and presented less BF% (p < 0.001) and superior FFM (p = 0.002) compared to females. Regarding strength performance, boys outperformed girls significantly in all testing procedures. Boys also showed statistically significant improvements in sprint time (p = 0.011) and upper-limb speed and coordination (p = 0.004). No statistical significances were observed between groups in balance indicators.

Table 1. Descriptive statistics and comparison between groups for anthropometry, body composition, and physical fitness components.

Variable	Males (n = 27)	Females (n =22)	*p*
Age (years)	14.5 ± 1.2	14.1 ± 1.1	0.874
Height (cm)	174.1 ± 10.3	161.7 ± 7.0	0.002
Body mass (kg)	63.1 ± 11.8	59.3 ± 14.1	0.060
Body fat (%)	10.6 ± 6.3	24.4 ± 8.2	<0.001
Fat-free mass (kg)	56.2 ± 10.3	43.9 ± 6.8	0.002
Handgrip - Dominant (kg)	34.4 ± 7.2	26.2 ± 3.6	<0.001
Handgrip - Non-dominant (kg)	33.1 ± 7.5	25.9 ± 4.8	<0.001
Countermovement jump (cm)	31.7 ± 6.2	23.2 ± 4.0	<0.001
Squat jump (cm)	30.7 ± 5.7	21.8 ± 3.8	<0.001
Horizontal jump (cm)	218.7 ± 27.3	173.2 ± 23.0	<0.001
20m sprint (s)	3.59 ± 0.26	3.76 ± 0.29	0.011
mCTSIB Condition 1	0.98 ± 0.42	1.03 ± 0.29	0.677
mCTSIB Condition 2	1.63 ± 0.64	1.74 ± 0.53	0.322
mCTSIB Condition 3	1.62 ± 0.49	1.69 ± 0.31	0.677
mCTSIB Condition 4	4.38 ± 1.07	4.75 ± 1.14	0.874
Plate Tapping (s)	12.8 ± 1.5	15.0 ± 2.7	0.004

Modified Clinical Test of Sensory Integration of Balance (mCTSIB); Condition 1 (eyes open, firm surface); Condition 2 (eyes closed, firm surface); Condition 3 (eyes open, unstable surface); Condition 4 (eyes closed, unstable surface).

Tables 2 and 3 summarize the relationships between age, anthropometry, body composition, and physical fitness performance. Among the body composition parameters, BF% emerged with the higher number of significant relationships with strength indicators (handgrip: rs = -0.47, p < 0.001; CMJ: rs = -0.72, p < 0.001; SJ: rs = -0.73, p < 0.001; horizontal jump: rs = -0.76, p < 0.001), upper-limb speed and coordination (rs =-0.32, p = 0.027), and 20-m sprint performance (rs = 0.72, p < 0.001).

No significant relationships were found between BF% and balance performance. In contrast, chronological age (CA), stature, body mass, and FFM showed substantial correlations with balance indicators. Among the variables assessed, body mass presented the highest number of significant correlations with balance (mCTSIB 1: rs = -0.44, p = 0.002; mCTSIB 2: rs = -0.32, p = 0.027; mCTSIB 3: rs = -0.48, p < 0.001; mCTSIB 4: rs = -0.59, p < 0.001), followed by FFM and CA.

Table 2. Correlation coefficients exploring the relationships between age, body composition, and physical fitness performance.

Variable	Handgrip	CMJ	SJ	SLJ	Plate Tapping	20m Sprint
Age	0.48**	0.25	0.22	0.46**	0.15	-0.19
Stature	0.80**	0.50**	0.50**	0.75**	-0.11	-0.50**
Body mass	0.62**	0.15	0.14	0.28	0.10	-0.01
Body fat %	-0.47**	-0.72**	-0.73**	-0.76**	0.32**	0.72**
Fat-free mass	-0.83**	0.54**	0.54**	0.68**	-0.12	-0.42**

CMJ (countermovement jump); SJ (squat jump); SLJ (standing long jump); ** $p \leq 0.01$; * $p \leq 0.05$

Table 3. Correlation coefficients exploring the relationships between age, body composition, and balance performance.

Variable	mCSTIB Condition 1	mCSTIB Condition 2	mCSTIB Condition 3	mCSTIB Condition 4
Age	-0.49**	-0.22	-0.55**	-0.54**
Stature	-0.42**	-0.22	-0.46**	-0.50**
Body mass	-0.44**	-0.32*	-0.48**	-0.59**
Body fat %	0.09	-0.07	0.05	0.07
Fat-free mass	-0.42**	-0.23	-0.48**	-0.59**

Modified Clinical Test of Sensory Integration of Balance (mCTSIB); Condition 1 (eyes open, firm surface); Condition 2 (eyes closed, firm surface); Condition 3 (eyes open, unstable surface); Condition 4 (eyes closed, unstable surface); ** $p \leq 0.01$; * $p \leq 0.05$

Discussion

The present study assessed differences between male and female youth basketball players in anthropometric, body composition, and physical fitness variables. As expected, male players were significantly taller and showed lower BF% than female players. No differences were observed between groups in balance performance; however, boys outperformed girls significantly in static strength, lower-body explosive strength, speed, and upper limb speed and coordination. BF% emerged with the highest number of significant relationships with strength, speed, and upper-limb speed and coordination performance. Substantial and negative relationships were observed between body mass, FFM, and mCTSIB tests, reflecting the positive effects of body mass and FFM on postural control.

The current results highlight the greater body size of male youth players compared to females, which is attributed to sex-associated variations in growth and development (Malina et al., 2004). Males were significantly taller, with lower BF% and higher FFM than girls, consistent with sex differences in body form and function that increase at puberty towards adulthood (Joyner et al., 2025).

Regarding physical fitness, substantial differences were observed in strength, speed, and upper-limb speed and coordination, with males significantly outperforming female players. The results are consistent with previous reports in the literature, particularly concerning lower-body explosive strength and speed performance (Sánchez-Díaz et al., 2021). Indeed, since males had lower BF% and greater FFM, it would be expected that superior performance would occur in tasks requiring projection (jumps) and rapid movements, due to the combined detrimental effect of BF% and the positive influence of FFM on these actions (Malina et al., 2004). In the current study, the relationships between body composition and physical fitness parameters also indicate a significant and negative correlation between BF% and jumping tasks (Table 2), suggesting that higher BF% is associated with lower jumping scores. Conversely, BF% was significantly and positively correlated with speed, implying that higher fat levels correspond to superior sprinting times. Indeed, previous research has highlighted the unfavorable impact of BF% on vertical jumps (Nikolaidis, 2013), endurance (Esco et al., 2018), and speed and agility (França et al., 2024a), among young athletes.

In contrast, no significant sex differences were observed in balance performance, although males showed better mean scores in all testing conditions than females. In a previous systematic review with meta-analysis aimed at investigating sex-related differences in balance performance among adolescents, inconsistent results were reported (Schedler et al., 2019). While girls showed favorable measures

of static balance, boys performed better in proactive balance (Schedler et al., 2019). In another study involving 295 athletes aged 15.6 ±1.2) years, males displayed worse results than females on the Y-Balance Test (Miller et al., 2017). The same conclusion was reported in a sample of 56 school athletes aged 16.4 ± 0.1 years, with females outperforming males in the Y-Balance Test (Kramer et al., 2019). According to the literature, integrating sensory information from the visual, sensorimotor, and vestibular systems, along with generating appropriate muscle synergies, enables humans to achieve and maintain balance in both static and dynamic conditions (Woollacott & Shumway-Cook, 1990). Several studies have reported that girls tend to exhibit superior balance performance compared to boys of the same age, which has been attributed to more effective sensory integration (Steindl et al., 2006), and advanced neuromuscular development (Eguchi & Takada, 2014). On the other hand, boys were reported to achieve better measures of dynamic balance, which require moving the center of mass to the limits of stability (Schedler et al., 2019). Since boys exhibit greater muscular strength during adolescence, they may have an advantage over girls in dynamic balance tasks (Schedler et al., 2019). Overall, the current study's findings do not support the existence of sex differences in balance tasks among youth basketball players, which may be related to their training regimen. Basketball training typically includes frequent exposure to activities that challenge postural control, such as dribbling, jumping, and rapid changes of direction. These tasks can provide sport-specific stimuli that foster the balance ability despite sex differences in body composition and physical fitness.

According to the results of the present study, body mass and FMM exhibited significant and negative correlations with balance testing conditions. The results suggest a positive effect of body mass and FFM on balance performance, as lower mCTSIB scores indicate lower postural sway and, therefore, better balance ability. Although previous research on the relationships between balance and body composition parameters in youth sports remains scarce, FFM has been positively associated with physical fitness components, such as muscle strength (Esco et al., 2018; Kasović et al., 2022). In turn, muscle strength was reported as beneficial for postural control (França et al., 2024b; França et al., 2023; Hammami et al., 2016). In general, the current findings offer important insights for youth basketball by highlighting the need to monitor body composition, particularly BF% and FFM, during the training process.

Limitations of the study

The current study presents some limitations that must be recognized. This was a cross-sectional investigation with a limited sample size, and therefore, caution is recommended when generalizing the results. Additionally, the analysis did not consider the participants' maturity status, although biological maturation might play a significant role in body composition and physical fitness performance. Despite these limitations, research on sex differences in body composition and physical fitness components among youth basketball players remains scarce, particularly on balance ability, which is assessed in detail in the present study.

Conclusions

Although sex differences would be expected, favoring boys in body composition and physical fitness performance, this study highlights the need to design tailored training programs in youth basketball based on the unique characteristics of both males and females. Besides raising awareness of sexual dimorphism, the current results provide valuable insights for coaches on the body composition and physical fitness profiles of male and female players. The findings underscore the importance of monitoring body composition during youth basketball development, especially body fat, to prevent its detrimental effects on explosive strength and speed. Additionally, fat-free mass appears to be a significant and positive influencer of balance ability, underscoring the role of body composition in physical fitness tests.

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References

Asal, F. H., Hammad, S. H., Shabib, S. S., Sabaar, H. J., & Yousif, M. A. H. (2025). The explosive power of the legs and its relationship with types of shooting in basketball. *Retos*, *71*, 1228-1238. https://doi.org/10.47197/retos.v72.117559

Bauer, J., Panzer, S., & Muehlbauer, T. (2021). Side differences of upper quarter Y balance test performance in sub-elite young male and female handball players with different ages. *BMC Sports Science, Medicine and Rehabilitation*, *13*, 1-8. https://doi.org/10.1186/s13102-021-00364-3

Boccolini, G., Brazzit, A., Bonfanti, L., & Alberti, G. (2013). Using balance training to improve the performance of youth basketball players. *Sport Sciences for Health*, *9*(2), 37-42. https://doi.org/10.1007/s11332-013-0143-z

Eguchi, R., & Takada, S. (2014). Usefulness of the tri-axial accelerometer for assessing balance function in children. *Pediatrics International*, *56*(5), 753-758. https://doi.org/10.1111/ped.12370

Esco, M. R., Fedewa, M. V., Cicone, Z. S., Sinelnikov, O. A., Sekulic, D., & Holmes, C. J. (2018). Field-based performance tests are related to body fat percentage and fat-free mass, but not body mass index, in youth soccer players. *Sports*, *6*(4), 105. https://doi.org/10.3390/sports6040105

França, C., Gouveia, É. R., Martins, F., Ihle, A., Henriques, R., Marques, A., Sarmento, H., Przednowek, K., & Lopes, H. (2024a). Lower-Body Power, Body Composition, Speed, and Agility Performance among Youth Soccer Players. *Sports*, *12*(5), 135. https://doi.org/10.3390/sports12050135

França, C., Martins, F., Lopes, H., Marques, A., de Maio Nascimento, M., Przednowek, K., Ihle, A., Campos, P., & Gouveia, É. R. (2024b). Knee muscle strength, body composition, and balance performance of youth soccer players. *BMC Sports Science, Medicine and Rehabilitation*, *16*(1), 206. https://doi.org/10.1186/s13102-024-00966-7

França, C., Martins, F., Martinho, D. V., Ihle, A., Marques, A., Sarmento, H., Clemente, F. M., Przednowek, K., Caballero Campo, P., & Gouveia, É. R. (2023). Bilateral asymmetry and the relationship between unilateral isokinetic strength and balance performance in male adolescent football players. *Montenegrin Journal of Sports Science and Medicine*, *12*(2), 33-39. https://doi.org/10.26773/mjssm.230905

Gerodimos, V. (2012). Reliability of handgrip strength test in basketball players. *Journal of Human Kinetics*, *31*, 25. https://doi.org/10.2478/v10078-012-0003-y

Goble, D. J., Brar, H., Brown, E. C., Marks, C. R., & Baweja, H. S. (2019). Normative data for the balance tracking system modified clinical test of sensory integration and balance protocol. *Medical Devices: Evidence and Research*, 183-191. https://doi.org/10.2147/MDER.S206530

Goswami, B., Roy, A. S., Dalui, R., & Bandyopadhyay, A. (2014). Impact of pubertal growth on physical fitness. *American Journal of Sports Science and Medicine*, *2*(5A), 34-39. https://doi.org/10.12691/ajssm-2-5A-8

Hammami, R., Chaouachi, A., Makhlouf, I., Granacher, U., & Behm, D. G. (2016). Associations between balance and muscle strength, power performance in male youth athletes of different maturity status. *Pediatric Exercise Science*, *28*(4), 521-534. https://doi.org/10.1123/pes.2015-0231

Hassan, A. (2025). The impact of CrossFit training on body composition, muscle strength, physiological adaptations, and the development of rebounding and footwork skills in basketball players. *Retos*, *70*, 788-804. https://doi.org/10.47197/retos.v69.115399

Hrysomallis, C. (2011). Balance ability and athletic performance. *Sports Medicine*, *41*(3), 221-232. https://doi.org/10.2165/11538560-000000000-00000

Hunter, S. K., Angadi, S. S., Bhargava, A., Harper, J., Hirschberg, A. L., Levine, B. D., Moreau, K. L., Nokoff, N. J., Stachenfeld, N. S., & Bermon, S. (2023). The biological basis of sex differences in athletic performance: consensus statement for the American College of Sports Medicine. *Translational Journal of the American College of Sports Medicine*, *8*(4), 1-33. https://doi.org/10.1249/TJX.0000000000000236

Ingebrigtsen, J., Jeffreys, I., & Rodahl, S. (2013). Physical characteristics and abilities of junior elite male and female handball players. *The Journal of Strength & Conditioning Research*, *27*(2), 302-309. https://doi.org/10.1519/JSC.0b013e31825499f

Joyner, M. J., Hunter, S. K., & Senefeld, J. W. (2025). Evidence on sex differences in sports performance. *Journal of Applied Physiology*, *138*(1), 274-281. https://doi.org/10.1152/japplphysiol.00615.2024

Kasović, M., Oreški, A., Vespalec, T., Gimunová, M., & Štefan, L. (2022). Associations between fat mass and fat free mass with physical fitness in adolescent girls: a 3-year longitudinal study. *Biology*, *11*(5), 783. https://doi.org/10.3390/biology11050783

Kramer, T. A., Sacko, R. S., Pfeifer, C. E., Gatens, D. R., Goins, J. M., & Stodden, D. F. (2019). The association between the functional movement screentm, y-balance test, and physical performance tests in male and female high school athletes. *International journal of sports physical therapy*, *14*(6), 911.

Lefevre, J., Beunen, G., Borms, J., & Vrijens, J. (1998). Sex differences in physical fitness in Flemish youth. *Medicine and Sport Science*, *43*, 54-67. https://doi.org/10.26603/ijspt20190911

Lesinski, M., Schmelcher, A., Herz, M., Puta, C., Gabriel, H., Arampatzis, A., Laube, G., Büsch, D., & Granacher, U. (2020). Maturation-, age-, and sex-specific anthropometric and physical fitness percentiles of German elite young athletes. *PLoS One*, *15*(8), e0237423. https://doi.org/10.1371/journal.pone.0237423

Malina, R. M., Bouchard, C., & Bar-Or, O. (2004). *Growth, maturation, and physical activity*. Human Kinetics.

Malina, R. M., & Geithner, C. A. (2011). Body composition of young athletes. *American Journal of Lifestyle Medicine*, *5*(3), 262-278. https://doi.org/10.1177/1559827610392493

Mancha-Triguero, D., García-Rubio, J., Calleja-González, J., & Ibáñez, S. J. (2019). Physical fitness in basketball players: A systematic review. *Journal of Sports Medicine and Physical Fitness*, *59*(10.23736), S0022-4707. https://doi.org/10.23736/S0022-4707.19.09180-1

Miller, M. M., Trapp, J. L., Post, E. G., Trigsted, S. M., McGuine, T. A., Brooks, M. A., & Bell, D. R. (2017). The effects of specialization and sex on anterior Y-balance performance in high school athletes. *Sports Health*, *9*(4), 375-382. https://doi.org/10.1177/1941738117703400

Nikolaidis, P. T. (2013). Body mass index and body fat percentage are associated with decreased physical fitness in adolescent and adult female volleyball players. *Journal of research in medical sciences: the official journal of Isfahan University of Medical Sciences*, *18*(1), 22.

O'Brien-Smith, J., Bennett, K. J., Fransen, J., & Smith, M. R. (2020). Same or different? A comparison of anthropometry, physical fitness and perceptual motor characteristics in male and female youth soccer players. *Science and Medicine in Football*, *4*(1), 37-44. https://doi.org/10.1080/24733938.2019.1650197

Perroni, F., Gallotta, M. C., Pisano, S., Reis, V. M., Emerenziani, G. P., Guidetti, L., & Baldari, C. (2018). Gender differences in anthropometric parameters and technical performance of youth soccer players. *Sport Sciences for Health*, *14*, 399-405. https://doi.org/10.1007/s11332-018-0456-z

Pollock, A. S., Durward, B. R., Rowe, P. J., & Paul, J. P. (2000). What is balance? *Clinical Rehabilitation*, *14*(4), 402-406. https://doi.org/10.1191/0269215500cr342oa

Sánchez-Díaz, S., Yanci, J., Raya-González, J., Scanlan, A. T., & Castillo, D. (2021). A comparison in physical fitness attributes, physical activity behaviors, nutritional habits, and nutritional knowledge between elite male and female youth basketball players. *Frontiers in Psychology*, *12*, 685203. https://doi.org/10.3389/fpsyg.2021.685203

Schedler, S., Kiss, R., & Muehlbauer, T. (2019). Age and sex differences in human balance performance from 6-18 years of age: A systematic review and meta-analysis. *PLoS One*, *14*(4), e0214434. https://doi.org/10.1371/journal.pone.0214434

Steindl, R., Kunz, K., Schrott-Fischer, A., & Scholtz, A. (2006). Effect of age and sex on maturation of sensory systems and balance control. *Developmental Medicine and Child neurology*, *48*(6), 477-482. https://doi.org/10.1017/S0012162206001022

Suchomel, T. J., Nimphius, S., & Stone, M. H. (2016). The importance of muscular strength in athletic performance. *Sports Medicine*, *46*(10), 1419-1449. https://doi.org/10.1007/s40279-016-0486-0

Tingelstad, L. M., Raastad, T., Myklebust, G., Gjerstad Andersen, T. E., Solstad, B. E., Bugten, J. B., & Luteberget, L. S. (2025). Age and Sex Differences in Physical Performance Among Adolescent Team Sport Athletes. *European Journal of Sport Science*, *25*(5), e12284. https://doi.org/10.1002/ejsc.12284

Tingelstad, L. M., Raastad, T., Till, K., & Luteberget, L. S. (2023). The development of physical characteristics in adolescent team sport athletes: A systematic review. *PLoS One*, *18*(12), e0296181. https://doi.org/10.1371/journal.pone.0296181

Wang, Z., Chen, N., Cao, S., Gao, L., Geok, S. K., & Liu, J. (2025). The effects of balance training on physical fitness and skill-related performance in basketball players: a systematic review. *BMC Sports Science, Medicine and Rehabilitation*, *17*(1), 1-14. https://doi.org/10.1186/s13102-025-01164-9

Woollacott, M. H., & Shumway-Cook, A. (1990). Changes in posture control across the life span—a systems approach. *Physical Therapy*, *70*(12), 799-807. https://doi.org/10.1093/ptj/70.12.799

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