ORIGINAL ARTICLE

The influence of sexual dimorphism on the manifestation of coordination abilities of volleyball players aged 15-17

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Abstract

Background and Study Aim: Sexual dimorphism plays a crucial role in the design of training programs for athletes. Therefore, understanding the influence of sexual dimorphism on various abilities is essential for optimizing training regimens. The aim of this study is to determine the influence of sexual dimorphism on the manifestation of coordination abilities in young volleyball players aged 15–17.

Material and Methods: Volleyball players aged 15–17 years participated in the study (n=92, training experience – 5–7 years). Fifty of them were girls, and forty-two were boys. Motor tests were used to determine the level of coordination preparedness of the volleyball players. The study assessed kinesthetic differentiation, spatial orientation, reaction, coupling, binding of movements, and balance skills. Statistical data processing was carried out using Microsoft Excel and SPSS programs.

Results: For most of the compared indicators of coordination abilities, there was no significant difference between male and female volleyball players aged 15–17 ($p>0.05$). In the "Shuttle run with back forward" test, which determined the ability of volleyball players to quickly rebuild motor activity, boys outperformed girls by 5.6% ($p<0.05$). In the "Sprint test with the given rhythm", boys significantly outperformed girls by 16.6% ($p<0.001$). However, control exercises that determined the relative indicators of the above qualities did not show a significant difference. No significant differences ($p>0.05$) were found in the indicators that characterized the subjects' ability to demonstrate balance in both groups. Girls outperformed boys by 4.2% in terms of sagittal displacement of the center of mass. Comparison of the magnitude of latent periods of simple and complex visual-motor reaction by groups did not reveal significant differences among boys and girls.

Conclusions: The results of the study indicate the need to implement targeted training programs to address and mitigate gender differences in coordination abilities among young volleyball players. These programs should focus on enhancing specific coordination skills. This approach ensures balanced development. Purposeful sports training can help overcome inherent physiological differences. By doing so, it leverages the benefits of tailored training to promote equality in athletic performance.

Keywords: volleyball, players, abilities, coordination, dimorphism.

Introduction

Sports training is a complex system involving various phenomena, relationships, and behaviors of its components. Achieving the goal of sports preparation is challenging. Nurturing top athletes capable of optimum performance in any conditions requires thorough knowledge of individual, age-specific, sexual, and developmental peculiarities.

In this context, creating a model of rational long-term sports preparation is essential. This model should include the application of adequate and effective training methods, appropriate training

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loads, and suitable frequency and follow-up in training cycles [1, 2, 3]. A constituent part of a sports training in volleyball is the fulfillment of various tasks which are called components of a sports preparation. Individual components are represented in sport training in various ratios depending on the period in which the athlete is situated. When the athlete is in full preparation for a competition or tournament, the preparation contains predominantly technical and tactical means. In the period of one or two months prior to the beginning of the competition period, the conditioning prevails. However, it is important not to forget about maintaining a certain level of conditioning as well as a certain level of coordination [4, 5, 6].

The level of coordination abilities in volleyball markedly underlies the quality, tempo, and stability of acquired sports skills, as well as their perfect utilization in game activities. Since the components of coordination develop mostly in the period before puberty, the crux of the development of coordination abilities falls into the period specified by the stage of elementary sport preparation. Analysis of activity in sports games shows that many athletes have shortcomings in individual technical prerequisites. Particularly in the conditions of a game, the player is often not able to master the technique optimally and utilize the experience obtained during training. One reason for this can be an insufficiently developed coordination base of an athlete. These inadequacies can be removed if a goal-oriented and systematic program for the development of coordination abilities is conducted in parallel with the skills acquisition phase. Knowing the coordination prerequisites limiting performance in sports games is essential to increase the sport preparedness of a player [7, 8, 9].

As it is known, puberty occurs on average at the ages of 13–14. It is at this time that the biological development curve rises sharply, and there is a so-called puberty jump. In some children (accelerators), the puberty jump occurs at 12–13 years, while in others (retardants), it occurs much later, at the age of 14–16 years. Therefore, the accelerators, despite having the same chronological age as the retardants, are 2–4 years ahead of the latter in the pace of biological development [10, 11].

At the age of 15, the biological development curve flattens as it accounts for post-pubertal development (completion of puberty jump). At this age, all patterns of sexual dimorphism begin to appear. Up to the age of 10, boys and girls have roughly the same rate of increase in total body size. From 11 to 12 years old, girls are ahead of boys, and at 13–15 years old, boys surpass girls in the rate of height increase. It is known that without a special training, the ability to master complex coordinated movements develops up to 15 years, and the maximum increase in strength occurs up to 16 years. In addition, the level of speed-force qualities develops up to 17 years, and the functional capacity of the body increases up to 16 years [12, 13].

The advantage of men over women in conditioning abilities (strength, speed, and endurance) is 10–20% or more. This advantage appears as early as the age of 6–10 years, weakens somewhat during puberty (12–14 years), and then increases again. Conversely, at different stages of ontogeny, women outperform men in the mobility (flexibility) of different joints by 20–30% [14, 15]. Research into the neurodynamic characteristics of athletes has shown that males have a higher speed of sensorimotor reactions based on the main characteristics of the functional mobility of nervous processes (according to the exposure of signal and time output to minimal exposure) [3, 16].

Fewer scientific studies have been conducted on the topic of sexual dimorphism in the field of coordination abilities. Most of these studies involve school-age children and students who were not systematically involved in sports. In some works, no significant differences were found in most indicators of the coordination abilities of men and women [17, 18]. The authors explain this by the relatively equal level of development of perceptual, mnemonic, intellectual, and sensorimotor processes that provide control mechanisms and regulation of complex movements. Other authors [19, 20] note that gender differences in the development of coordination abilities are noticeable as early as 6–10 years and increase after puberty.

Therefore, further observations and experiments involving qualified young athletes are required. There is a revealed contradiction between the need to determine the influence of sexual dimorphism on the manifestation of coordination abilities of young volleyball players, on the one hand, and the insufficient scientific development of methodological support for solving this pedagogical task, on the other hand. This determines the practical and scientific relevance of the study problem.

Hypothesis. It is assumed that identifying gender differences in the level of development of coordination abilities in young volleyball players aged 15–17 will allow for increased effectiveness of coordination training in particular and the training process in general.

The purpose of this study is to determine the influence of sexual dimorphism on the manifestation of the coordination abilities of young volleyball players aged 15–17.

Materials and Methods

Participants

Volleyball players aged 15–17 years participated in the study (n=92, training experience – 5–7 years). Fifty of them are girls and forty-two are boys. The

adolescents and their parents were informed about all the features of the study, and the parents gave their consent to their children's participation in the experiment. The research protocol was approved by the university's ethics committee.

Research Design

Well-known motor tests were used to determine the level of coordination preparedness of volleyball players [21, 22, 23]. As part of the study, the level of kinesthetic differentiation, spatial orientation, reaction, restructuring and coordination of movements, and balance skills were determined.

Well-known motor tests were used to determine the level of coordination preparedness of volleyball players [21, 22, 23]. As part of the study, the level of kinesthetic differentiation, spatial orientation, reaction, restructuring and coordination of movements, and balance skills were determined. The following tests were used:

- Test 1: "Backwards a tennis ball throw test (points)" [21].
- Test 2: "Overstepping the gymnastic stick (s)" The stick was held by the athlete's straight arms. In the initial position, the athlete holds the stick with straightened arms. At the coach's signal, the athlete oversteps the stick 5 times with the right leg and 5 times with the left leg. The time of task fulfillment was measured in seconds [23].
- Test 3: "Numbered medicine ball run test (s)" [21].
- Test 4: "Time difference between running to the numbered balls and shuttle running (5× 3 m), s".
- Tests 5–8: Balance of volleyball players was determined using a computer stabilography. Stabilographic studies were conducted to study the quantitative criteria of static stability during the implementation of standard positions: the Mortiz-Romberg pose. The main quantitative criteria of static postures of young volleyball players were indicators: MO(x) – frontal displacement of the center of mass (CM); MO(y) – sagittal displacement of the CM; V – the average speed of movement of the CM; Koef Romb – Romberg coefficient [24]
- Test 9: "Shuttle run with back forward (3×10 m)" (s) [22].
- Test 10: Difference in time between running "Shuttle run (3×10 m)" and "Shuttle run with back forward (3×10 m)" (s).
- Tests 11–12: Subjects' abilities to feel the rhythm were assessed using the test: "Sprint test with the given rhythm" [21]. Test equipment: 11 gymnastic hoops with a diameter of 80 cm, measuring tape, stopwatch. First, the athlete runs 30 m. Then the athlete runs the distance again with 11 hoops arranged on it at maximum speed with an accuracy of 0.01 s. Result: 1) time of running 30 m; 2) time of running 30 m through the hoops; 3) difference between the time of running the 1st and 2nd distances.
- Test 13: "Movement rhythm observation" (s); Description: The player skips over the rope for 20 s in a certain tempo which they choose. The examiner counts the number of rope skips during the given period. In the second part of the test, the tested person carries out the same number of skips as in the first part. The examiner measures the time it takes to fulfill the task. Deviation from 20 s will be the criterion of success in the given test [25].
- Tests 14–16: Measuring a simple and complex visual-motor reaction. To determine the latent period of a simple and complex visual-motor reaction, the Psychodiagnostics computer program was used [26].

Statistical analysis

Statistical data processing was carried out using Microsoft Excel and SPSS programs. The following parameters were determined for each indicator: arithmetic mean ( ), standard deviation (δ), standard error (m), and significance of differences according to Student's t-test with the corresponding significance level (p). Differences were considered significant at a significance level of $p<0.05$.

Results

The obtained data (Table 1) show that there is no significant difference ($p>0.05$) between male and female volleyball players aged 15–17 for most of the compared indicators of coordination abilities, studied with the help of motor and laboratory tests. The study revealed a somewhat greater accuracy in the performance of the control exercise "Backwards a tennis ball throw test" in young male volleyball players compared to females. This difference was 7.8%, but was not statistically significant ($p>0.05$). The results of the experiment showed the advantage of the boys by 4.2% in the "Numbered medicine ball run test". However, the difference between the "Numbered medicine ball run test" and the "5×3 m shuttle run", which also showed the ability of players for spatial orientation, did not show such an advantage. No significant differences were found in the parameters that characterized the subjects' ability to maintain equilibrium in both groups ($p>0.05$). However, it is worth noting that the indicator characterizing the sagittal displacement of the center of mass was close to significant, in which female volleyball players exceeded male volleyball players by 4.2%.

In the "Running 3×10 m with the back to the direction of movement" test, which determined the ability of volleyball players to quickly rebuild movements, boys outperformed girls by 5.6% ($p<0.05$). Another indicator that characterized the

Table 1. Gender differences in the development of coordination abilities between male and female volleyball players aged 15–17 years

№	Indicator	Boys			Girls			t	p
		X̄	δ	m	X̄	δ	m		
1	"Backwards a tennis ball throw test", points	13.9	2.4	0.46	12.9	2.6	0.46	1.34	0.184
2	Overstepping the gymnastic stick (coordination of movements), s	13.1	1.3	0.23	13.4	1.5	0.29	0.67	0.501
3	Numbered medicine ball run test, (orientation), s	13.2	1.2	0.22	13.7	1.1	0.18	1.7	0.094
4	The difference in running time to the numbered balls and shuttle running 5 × 3 m (orientation), s	2.4	0.96	0.18	2.5	0.95	0.15	0.56	0.58
5	MO(x), mm	2.5	1.45	0.31	2.4	1.74	0.58	0.11	0.065
6	MO(y), mm	5.9	4.2	1.17	3.4	2.4	0.77	1.17	0.103
7	V, mm/s	10.5	2.9	0.62	9.1	1.9	0.61	1.36	0.18
8	Romberg coefficient, %	77.3	12	2.5	82.5	7.2	2.3	1.26	0.22
9	"Shuttle run with back forward (3x10 m)", s	10.7	1.1	0.2	11.3	0.7	0.13	2.5	0.015
10	The ratio of running time 3×10 m with the face and back to the direction of movement (restructuring of movements), s	2.83	0.46	0.08	2.89	0.5	0.09	0.44	0.66
11	"Sprint test with the given rhythm", s	5.59	0.38	0.07	6.52	0.35	0.08	8.3	0.001
12	Difference between 30-meters running and 30-meters running over hoops, s	0.9	0.32	0.06	1.06	0.27	0.07	1.63	0.11
13	"Movement rhythm observation", s	0.58	0.48	0.1	0.56	0.45	0.1	0.1	0.92
14	SVMR, ms	338.9	26.1	7.88	352.9	37.6	6.76	1.14	0.26
15	RCh 1-3, ms	487.4	42.9	12.9	507.3	35.1	6.01	1.55	0.13
16	RCh 2-3, ms	548.6	50.8	15.3	559.9	46.3	7.9	0.69	0.49

Note: X: Arithmetic mean; δ: Standard deviation; m: Standard error; t: Student's t-test value; p: Significance level; MO(x): Frontal displacement of the center of mass (CM); MO(y): Sagittal displacement of the CM; V: Average speed of movement of the CM; SVMR: Simple visual-motor reaction; RCh 1-3: Reaction time between signals 1 and 3; RCh 2-3: Reaction time between signals 2 and 3.

same quality and determined the difference between the "3×10 m shuttle run with the face and 3×10 m back to the direction of movement" no longer showed a significant difference between boys and girls ($p>0.05$). A similar result was obtained when testing for a significant difference in the sense of rhythm between boys and girls who systematically engage in volleyball. In the first test, "Sprint with the given rhythm," boys significantly outperformed girls by 16.6% ($p<0.001$). However, in the other two tests, which also determined the presence of a significant difference in the sense of rhythm in the two groups, this difference was not found ($p>0.05$). This is because, in these control exercises, the influence of speed qualities on the test results was eliminated.

A comparison of the latent periods of simple and complex visual-motor reactions in the two groups did not reveal any significant differences between boys and girls. Under the condition of increasing the sensorimotor complexity of the activity, young volleyball players spent less time performing the test compared to girls ($p>0.05$).

Discussion

The aim of this study was to determine the influence of sexual dimorphism on the manifestation of coordination abilities in young volleyball players aged 15–17. The results indicated that there were no significant differences between boys and girls in most of the coordination ability indicators. However, boys outperformed girls in specific tests, such as the "Running 3×10 m with the back to the direction of movement" and the "Sprint test with the given rhythm."

Scientific studies on the topic of sexual dimorphism in the field of coordination qualities have been conducted less compared to those that reflect the peculiarities of this process in the development of conditioning abilities and somatic indicators. The conducted study confirmed the data of other authors [2, 27] that sexual dimorphism in the development of coordination abilities of young volleyball players is not so clearly manifested in comparison with those who do not systematically

do sports. Under the influence of training, gender features of the development of motor coordination undergo fewer changes compared to conditioning qualities [28, 29, 30]. A similar conclusion was reached by P. Hirtz [20], who conducted a study with boys and girls of the lyceum who were not systematically involved in sports. The author established a reliable advantage of boys over girls in indicators of the ability to rebuilding, coupling and binding of movements, and rhythm. However, this advantage was absent in the indicators of the ability to maintain static and dynamic balance, kinesthetic differentiation, speed of reaction, and spatial orientation.

The absence of significant differences in most of the indicators we studied can be interpreted as a relatively equal level of development of perceptual, mnemonic, intellectual, and sensorimotor processes, which provide mechanisms of control and regulation of complex movements at the central level in volleyball players. These data correspond to the results of studies by other authors [31, 32, 33].

In turn, the reliable superiority of boys over girls ($p < 0.05$) in tests for a sense of rhythm and the rebuilding of movements can be explained by the influence of speed and speed-power qualities on the test results. Supporting this interpretation, after determining the relative indicators of rhythm sensation and the rebuilding of movements in young volleyball players, which levelled the influence of the above qualities, no significant difference was found ($p > 0.05$). Other researchers hold a similar opinion [34, 35, 36]. They are convinced that if the coordination complexity of the motor task increases or the result in the "coordination" tests is associated with a significant manifestation of conditioning abilities (speed, speed-power), then the reliability of the differences in favor of male volleyball players increases compared to the data of female players.

The results of the conducted experiment showed a close to significant advantage of boys over girls in the spatial orientation test. Interesting explanations are provided by a number of authors regarding patterns of manifestations of this quality in representatives of different sexes. It is known that men demonstrate a higher level of this quality than women [10]. This assumption is partially supported by the results of another study [37]. However, a study involving athletes found no significant differences between men and women [16, 38]. For example, Sadovsky found that in taekwondo, women have an advantage in tests for accuracy of reproduction of spatial parameters of movements, as well as in maintaining balance. Along with this, the absence of gender differences was shown in studies involving representatives of other sports [39]. Still, the superiority of males who do not systematically engage in sports in spatial orientation indicators has been repeatedly noted. Ultimately, purposeful sports training reduces and even eliminates the advantages of men in this ability, due to the evolutionary and biological prerequisites of this phenomenon.

By the way, the study of the evolutionary prerequisites of coordination abilities becomes a valuable contribution to the general explanation of gender differences in those who do not play sports. A number of hypotheses have been proposed to explain the advantages of men in the manifestation of these abilities from an evolutionary perspective. According to one hypothesis, women were forced to reduce the volume of movements during the reproductive periods of their lives due to childbearing and maternal care. In turn, men continued to perform actions related to the manifestation of coordination abilities during hunting or participation in war [40]. According to another hypothesis, the responsibility of ancient men for obtaining food contributed to the development of spatial orientation abilities associated with hunting. The hypothesis about the participation of men in armed conflicts suggests that ancient people travelled long distances, participated in skirmishes with other groups, competed for food resources, and captured women. Another hypothesis suggests that successful hunters received a higher social status in ancient society and improved their spatial qualities, which in turn contributed to the achievement of such status. In any case, the evolutionary approach allows for a better understanding of the nature of spatial orientation and its importance for the coordination potential of those who systematically engage in sports and sports games, in particular.

Recent studies involving professional athletes using magnetic resonance imaging showed an increased thickness of the cerebral cortex in the area of visual-spatial control [41]. In particular, it was found that in male athletes, the processing of spatial signals is localized in the right hemisphere, while in female athletes there is no leading hemisphere. A special role in spatial orientation belongs to a specialized region of the brain – the hippocampus. Its function is to determine the location and options for moving to the next position. The hormonal status of those who systematically engage in sports also significantly affects the manifestations of spatial orientation. It is known that lower testosterone levels in men contribute to the development of spatial abilities, while in female athletes more successful spatial orientation is associated with higher testosterone levels [42].

Thus, the research results we obtained indicate the expediency of taking into account gender characteristics in the development of coordination abilities in the training process of volleyball players aged 15–17. Considering this phenomenon will contribute to the rapid and qualitative mastering of technical skills and improving the competitive activity of young athletes. Along with this, further

research is needed to determine the structure of players' preparedness. By determining the value of each ability in the structure of special preparedness, it is possible to clearly plan the sample size of the load for each age period, gender, and for the individual development of children and adolescents. It is thought that it is time to pay more attention to the application of a systemic approach in implementing the individualization of the training process for young volleyball players.

Conclusions

1. The study showed no significant difference between the groups of male and female volleyball players aged 15–17 in most of the studied indicators of coordination preparedness. The only exceptions were those tests whose results were influenced by the speed capabilities of the players.
2. The lack of reliable differences in the development of coordination abilities between boys and girls who systematically play volleyball can be interpreted as a relatively equal level of development of perceptual, mnemonic, intellectual, and sensorimotor processes, which provide mechanisms of control and regulation of complex movements at the central level.
3. To explain gender differences in the development of coordination abilities, it is advisable to study the evolutionary prerequisites for the development of these abilities in representatives of both sexes. It is also necessary to analyze the results of psychophysiological studies, which explain the peculiarities of the organs and systems of the body responsible for the management and regulation of the motor activity of volleyball players.
4. The advantage of males who do not systematically play sports in the development of coordination abilities has been shown more than once. However, targeted sports training reduces and even eliminates the advantages of men in these abilities, which are determined by the evolutionary and biological prerequisites of this phenomenon.

Conflict of interests

The authors declare that there is no conflict of interests.

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References

1. Platonov V, Nikitenko A. Agility and coordination testing in hand-to-hand combat sports. *Polish Journal of Sport and Tourism*. 2019;26(2):7–13. https://doi.org/10.2478/pjst-2019-0008
2. Šimonek J. *Coordination Abilities in Volleyball*. De Gruyter Open Poland; 2014. https://doi.org/10.2478/9783110370317
3. Voronova V, Khmelnitska I, Shynkaruk O, Borysova O, Kostyukevich V, Zhovnych O. Gender peculiarities of personality's qualities development in football. *Journal of Physical Education and Sport*. 2020;20:484–9.
4. Ramirez-Campillo R, García-de-Alcaraz A, Chaabene H, Moran J, Negra Y, Granacher U. Effects of plyometric jump training on physical fitness in amateur and professional volleyball: a meta-analysis. *Frontiers in Physiology*. 2021;12:636140. https://doi.org/10.3389/fphys.2021.636140
5. Kumar G, Shukla A, Chhoker A, Thapa RK. Identification of Factors Determining Winning in Men's and Women's Beach Volleyball: a Logistical Regression Approach. *Teorìâ ta Metodika Fìzičnogo Vihovannâ*. 2021;21(1):26–35. https://doi.org/10.17309/tmfv.2021.1.04
6. Özgül F, Atan T, Kangalgil M. Comparison of the command and inclusion styles of physical education lessons to teach volleyball in middle school. *Physical Educator*. 2019;76(1):182–96. https://doi.org/10.18666/TPE-2019-V76-I1-8481
7. Mota T, Afonso J, Sá M, Clemente FM. An agility training continuum for team sports: from cones and ladders to small-sided games. *Strength and Conditioning Journal*. 2022;44(1):46–56. https://doi.org/10.1519/SSC.0000000000000653
8. McNeil DG, Spittle M, Mesagno C. Imagery training for reactive agility: Performance improvements for decision time but not overall reactive agility. *International Journal of Sport and Exercise Psychology*. 2021;19(3):429–45. https://doi.org/10.1080/1612197X.2019.1696866
9. Muratova G. Methodology of selection and use of mobile games as a means of connected formation of technical skills and development of physical qualities of volleyball players. *Galaxy International Interdisciplinary Research Journal*. 2022;10(12):992–3.
10. Issurin V. *Athletic Talent: Identification and Development:* Ultimate Athlete Concepts; 2017.
11. Bompa TO, Buzzichelli C. *Periodization: theory and methodology of training*. Human kinetics; 2019. https://doi.org/10.5040/9781718225435
12. Desbrow B. Youth Athlete Development and Nutrition. *Sports Medicine*. 2021;51(1):3–12. https://doi.org/10.1007/s40279-021-01534-6
13. da Silva Athayde MS, Kons RL, Dopico-Calvo X, de Góes GH, Detanico D. Influence of maturation

level on the development of physical performance in young combat sports athletes: a scoping review. *Sport Sciences for Health*. 2023:1–10. https://doi.org/10.1007/s11332-023-01147-8
14. Fransen J, Bush S, Woodcock S, Novak A, Deprez D, Baxter-Jones AD, et al. Improving the prediction of maturity from anthropometric variables using a maturity ratio. *Pediatric Exercise Science*. 2018;30(2):296-307. https://doi.org/10.1123/pes.2017-0009
15. Baxter-Jones AD. Physical growth and development in young athletes: factors of influence and consequence. *Kinesiology Review*. 2019;8(3):211–9. https://doi.org/10.1123/kr.2019-0024
16. Korobeynikov G, Korobeinikova L, Chernozubz A. Psychophysiological peculiarities of sexual dimorphism in athletes. *Psychology Research*. 2012;2(6):336. https://doi.org/10.17265/2159-5542/2012.06.002
17. Sadowski J. Dominant coordination motor abilities in combat sports. *Journal of Human Kinetics*. 2005;13:61.
18. Heller J, Peric T, Dlouha R, Kohlikova E, Melichna J, Novakova H. Physiological profiles of male and female taekwon-do (ITF) black belts. *Journal of sports sciences*. 1998;16(3):243–9. https://doi.org/10.1080/026404198366768
19. Ljach W, Witkowski Z. Development and training of coordination skills in 11-to 19-year-old soccer players. *Human Physiology*. 2010;36(1):64–71. https://doi.org/10.1134/S0362119710010081
20. Hirtz P, Starosta W. Sensitive and critical periods of motor co-ordination development and its relation to motor learning. *Journal of Human Kinetics*. 2002;7:19–28.
21. Peker AT, Vural M. Comparison of Some Coordinative Abilities in Terms of Team and Individual Sports. *Journal of Education and Training Studies*. 2019;7(8):67–72. https://doi:10.11114/jets.v7i8.4333
22. Nimphius S, Callaghan SJ, Bezodis NE, Lockie RG. Change of direction and agility tests: Challenging our current measures of performance. *Strength & Conditioning Journal*. 2018;40(1):26–38. https://doi.org/10.1519/SSC.0000000000000309
23. Raczek J, Mynarski W, Ljach W. *Developing and Diagnosing of Coordination Motor Abilities*. Katowice: AWF Katowice; 2002.
24. Dominguez-Navarro F, Casaña J, Perez-Dominguez B, Ricart-Luna B, Cotolí-Suárez P, Calatayud J. Dynamic balance and explosive strength appears to better explain single leg hop test results among young elite female basketball athletes. *Scientific Reports*, 2023;13(1):5476. https://doi.org/10.1038/s41598-023-31178-7
25. Šimonek J, Horička P, Hianik J. Differences in pre-planned agility and reactive agility performance in sport games. *Acta Gymnica*. 2016;46(2):68–73. https://doi.org/10.5507/ag.2016.006
26. Kozina ZL, Repko O, Safronov D, Kozin S, Evarnickii I, Grebniova I. System of development of coordination abilities of young climbers 6–7 years. *Health, Sport, Rehabilitation*. 2018;4(4):62–71. https://doi.org/10.34142/HSR.2018.04.04.07
27. Bompa TO, Sarandan S. *Training and Conditioning Young Athletes*. Human Kinetics; 2022.
28. Queiroz DDR, Aguilar JA, Martins Guimarães TG, Hardman CM, Lima RA, Duncan MJ, et al. Association between body mass index, physical activity and motor competence in children: moderation analysis by different environmental contexts. *Ann Hum Biol*. 2020;47(5):417–24. https://doi.org/10.1080/03014460.2020.1779815
29. Zatsiorsky VM, Kraemer WJ, Fry AC. *Science and practice of strength training*. Human Kinetics; 2020.
30. Dubey S, Choudhary PK. Comparative analysis on selected coordinative abilities among female team sports players. *International Journal of Physical Education, Sports and Health*. 2023; 10(1): 6–11. https://doi.org/10.22271/kheljournal.2023.v10.i1a.2745
31. Schnabel G. Motor coordination the fundamental process of motor activity. In: Carbonaro G. (Ed.), *Motor coordination in sport and exercise*. Bologna: University of Bologna 2001. P. 89–106.
32. Starosta W. The concept of modern training in sport. *Studies in Physical Culture & Tourism*. 2006;13(2).
33. Paul DJ, Gabbett TJ, Nassis GP. Agility in team sports: Testing, training and factors affecting performance. *Sports Medicine*. 2016;46(3):421–42. https://doi.org/10.1007/s40279-015-0428-2
34. Söğüt M, Kirazci S, Korkusuz F. The effects of rhythm training on tennis performance. *Journal of Human Kinetics*. 2012;33:123. https://doi.org/10.2478/v10078-012-0051-3
35. Samsudin S, Setiawan I, Taufik MS, Solahuddin S. Volleyball fundamental movement learning model in primary school. *Teorìâ ta Metodika Fìzičnogo Vihovannâ*. 2021;21(3):194–9. https://doi.org/10.17309/tmfv.2021.3.02
36. Lyakh V. Differences in the level of development and proficiency in coordination motor abilities among female and male athletes of selected combat sports. *Journal of Kinesiology and Exercise Sciences*. 2021;31(96):11–23. https://doi.org/10.5604/01.3001.0015.7373
37. Stelmach P, Rydzik Ł, Ambroży, T. Sexual dimorphism in the level of special coordination ability of swimmers of the SportsChampionships Schools. *Journal of Human Sport and Exercise*. 2020;17:1–9. https://doi.org/10.14198/jhse.2022.171.13
38. Notarnicola A, Maccagnano G, Pesce V, Tafuri S, Novielli G, Moretti B. Visual-spatial capacity: gender and sport differences in young volleyball and tennis athletes and non-athletes. *BMC Research Notes*. 2014;7(1):1–5. https://doi.org/10.1186/1756-0500-7-57
39. Jeffreys I. *Agility development in youths. Strength and Conditioning for Young Athletes*: Routledge; 2013. P. 129–41. https://doi.org/10.4324/9780203147498-18
40. Issurin V, Lyach V. *Coordination abilities of athlets*. Muskegon: Ultimate Training Concepts; 2019.

41. Lennemann LM, Sidrow KM, Johnson EM, Harrison CR, Vojta CN, Walker TB. The influence of agility training on physiological and cognitive performance. *The Journal of Strength & Conditioning Research*. 2013;27(12):3300–9. https://doi.org/10.1519/JSC.0b013e31828ddf06
42. Livio L. *Cellular Physiology and Metabolism of Physical Exercise*. Milan: Springer; 2012.

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