Non-specific coordination tests for female volleyball players: reliability, discriminative ability and usefulness

Pruebas de coordinación no específica para jugadoras de voleibol femeninas: fiabilidad, capacidad discriminativa y aplicabilidad

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Abstract

Objective: This study aims to determine the reliability and discriminative ability of the non-specific coordination battery tests.
Methods: The sample in this study was 98 female volleyball players aged 15.20±1.00 years from six clubs in Bosnia and Herzegovina. Coordination abilities were assessed with six tests measuring balance (Bench walk with three turns), reaction speed (Stopping the rolling ball test), kinesthetic-differentiation of legs and arms (Target standing broad jump test and Target sitting throw test), and space-orientation abilities (Shuttle run reactive and non-reactive test). The first step was to determine the subgroup of 13 players' test-retest reliability using the test-retest method. Discriminative ability was used to analyze the performance between different playing positions and situational performance.
Results: The relative reliability was excellent (ICC: 0.76 to 0.89) in all tests except for the Target sitting throw test, whose reliability was fair (ICC: 0.58). The absolute parameters of reliability: standard error of measurement (SEM) variations were low. The SEM was higher than the SWC (0.2) for all variables, indicating marginal usefulness for small changes, and lower than SWC (1.2) for most variables, suggesting good usefulness for larger changes. The minimal detectable change (MDC) varied, with smaller values for some tests (e.g., 0.50–0.72 s) and larger values for others (e.g., 23.73 cm for TST), reflecting differing precision levels. Afterward, one-way ANOVA detected no significant inter-positional differences in all tests. A significant difference was found between more successful and less successful players.
Conclusion: The obtained results reveal that this battery test is reliable and valid for estimating non-specific coordination abilities among female volleyball players.

Keywords

Technique, sport-specific skills, kinesthetic differentiation, space-orientation ability.

Resumen

Objetivo: Este estudio tiene como objetivo determinar la fiabilidad y la capacidad discriminativa de la batería de pruebas de coordinación no específica.
Métodos: La muestra estuvo compuesta por 98 jugadoras de voleibol femeninas con una edad promedio de 15.20±1.00 años, provenientes de seis clubes en Bosnia y Herzegovina. Las habilidades de coordinación se evaluaron mediante seis pruebas que midieron el equilibrio (caminar sobre un banco con tres giros), la velocidad de reacción (prueba de detención de la pelota rodante), la diferenciación cinestésica de piernas y brazos (prueba de salto horizontal a un objetivo y prueba de lanzamiento sentado a un objetivo), y las habilidades de orientación espacial (prueba de carrera lanzada reactiva y no reactiva). El primer paso fue determinar la fiabilidad test-retest en un subgrupo de 13 jugadoras utilizando el método de test-retest. La capacidad discriminativa se utilizó para analizar el rendimiento entre diferentes posiciones de juego y el desempeño situacional.
Resultados: La fiabilidad relativa fue excelente (ICC: 0.76 a 0.89) en todas las pruebas, excepto en la prueba de lanzamiento sentado a un objetivo, cuya fiabilidad fue justa (ICC: 0.58). Los parámetros absolutos de fiabilidad, como el error estándar de medición (SEM), mostraron variaciones bajas. El SEM fue mayor que el SWC (0.2) para todas las variables, indicando una utilidad marginal para cambios pequeños, y menor que el SWC (1.2) para la mayoría de las variables, sugiriendo una buena utilidad para cambios mayores. El cambio mínimo detectable (MDC) varió, con valores menores en algunas pruebas (por ejemplo, 0.50–0.72 s) y mayores en otras (por ejemplo, 23.73 cm para TST), reflejando diferentes niveles de precisión. Posteriormente, un ANOVA de una vía no detectó diferencias significativas entre las distintas posiciones en todas las pruebas. Se encontró una diferencia significativa entre jugadoras más efectivas y menos efectivas.
Conclusión: Los resultados obtenidos revelan que esta batería de pruebas es confiable y válida para estimar las habilidades de coordinación no específica en jugadoras de voleibol femeninas.

Palabras clave

Técnica; habilidades específicas del deporte, diferenciación cinestésica, capacidad de orientación especial..

Introduction

As in other sports, coordination, technique, and skills need to be well-developed in volleyball. Young athletes need to be challenged throughout training by learning a broad spectrum of motor skills. As a result, they can achieve high motor abilities, which will help them learn and improve sport-specific skills at a later age (Clark, 2007; Kirk & Gorely, 2000). Recently, a large number of researchers have been dealing with the problem of coordination in elementary school children. This is not only because coordination can be found in every movement structure, but also because coordination can be highly developed during sensitive periods of child development (Boichuk et al., 2020; Ljach & Witkowski, 2010).

In volleyball, coordination is especially important for adapting to the unpredictable nature of the game. Players must respond quickly to complex stimuli such as changes in ball trajectory or opponent movement, which requires advanced spatial orientation, reaction time, and rhythm (Gjinovci et al., 2017). These demands become even more specialized depending on the playing positions, for example, setters require rhythm and fine motor control, while libero players rely on reaction speed and dynamic balance (Bobula et al., 2024; García-de-Alcaraz & Usero, 2019; Wang et al., 2025).

By understanding the process of young sports development, coaches in any sport, including volleyball, can avoid mistakes that may lead to reduced development of coordination abilities, which are most unlikely to be made up later (Boichuk et al., 2020; Đolo et al., 2022). Furthermore, improving the quality of training by including all coordination abilities in the early stage of sports development contributes to achieving high sports results (Šimonek, 2014). Therefore, general coordination abilities are vital in mastering techniques and solving complex motor tasks that are common in modern volleyball (Boichuk et al., 2023; Pion et al., 2015). Consequently, a high level of development of coordination abilities leads to easier mastering of new and complicated game techniques and tactical skills, and a faster adaptation towards the changes brought by the volleyball game (Bujang et al., 2019).

Even though there are several different divisions, most authors divide coordination into five basic abilities: kinesthetic differentiation, reaction ability, rhythmic ability, balance, and space-orientation ability (Šimonek, 2014; Starosta et al., 2003). Each of them plays an important role in mastering volleyball. In the last several decades, some studies have focused on researching tests for general coordination abilities since they are more suitable for application to young athletes before playing sports (Boichuk et al., 2018, 2019). In many ways, these investigations yield results by combining coordination with morphology, the nervous system, or other factors. Nonetheless, previous studies omitted more profound observations of coordination necessities for volleyball and provided more insight into the selection of volleyball players. These studies tend to omit key aspects of volleyball-specific coordination demands, such as the ability to perform precise and rapid movements due to unpredictable ball trajectories and the requirements of different playing positions. The focus has been shifted more towards players' selection criteria than a deeper understanding of general coordination abilities that underpin successful volleyball performance.

Coordination requirements of volleyball for improving general skills in these age groups are high due to the need for advanced attack preparation and court defense, which are part of the complex volleyball structure (Boichuk et al., 2017). Likewise, complex movement structures of opponents and teammates to get the finest out of the rally (competition) demand improvement in all the coordination abilities mentioned above.

Consequently, coordination is important for selecting female volleyball players (Mostaert et al., 2022; Pion et al., 2015). Equally important are the playing positions in volleyball with their specific tasks during matches. Initially, the playing positions were more universal, but by changing the rules and developing tactics, those positions evolved into more specialized ones. Moreover, apart from the anthropometric profile of players, coordination plays a crucial role in distinguishing between these positions (Cabarkapa et al., 2022). No information on differences in coordination abilities among playing positions has been found.

Therefore, the main purpose of this study was to determine the test-retest reliability and discriminative ability to assess non-specific coordination abilities. Reliable tests are essential for valid assessment, while discriminative ability is key to distinguishing between different performance profiles. Recent findings by Đolo, Grgantov, and Kuvačić (2023) have shown that coordination tests can demonstrate strong reliability and reveal differences between skill levels. By focusing on general coordination tests, this study provides valuable methods for coaches and researchers to assess coordination at early stages of development and to guide future studies into the development of position-specific coordination.

Method

Study Design

In this study, the test-retest reliability and discriminative ability were assessed. A subsample of 13 female participants performed all tests in two testing sessions, separated by a seven-day break, to assess test-retest reliability. Furthermore, the discriminative ability was determined by analyzing the differences among players of different playing positions and situational performance. Players were instructed by their coaches to avoid factors that could affect their performance on the testing days, such as refraining from any physical activity before and during the testing days, and refraining from consuming caffeine-containing beverages and low-fiber diets. The testing was conducted in June 2021 with a temperature ranging from 21 to 24°C. All measurements were performed after the warm-up, which consisted of 10 minutes of jogging and mobility exercises. A demonstration was given by an experienced measurer who introduced them to all testing procedures with one preparatory attempt.

Participants

The study involved a group of 98 U-17 female volleyball players (age 15.2±1 years, body height 171.1±6.4 cm, sitting height 89.6±4.8 cm, body weight 62.2±8.35 kg, training experience 4.3±1.1 years) from six volleyball clubs in Bosnia and Herzegovina. These clubs were part of a convenience sample, consisting of teams that agreed to participate in the testing. All participating clubs compete in a two-tier regional youth competition system: Super League and First League, modeled after the senior women's league. Although not randomly selected, the sample includes players from competitive training groups within the relevant age category, providing valuable insights into this population. The players specified their playing positions (setter, middle blocker, libero, opposite hitter, and passer-hitter) and were asked for parental consent to conduct the testing. Coaches also agreed to participate and were given a clear explanation of the study. Players had been involved in a minimum of two years of training and trained 2 hours per session, four days per week.

Combining two criteria: (i) Placement of teams in the competition (Super League and 1st League) and (ii) Quality of individual players within their team, the situational performance of the players was assessed. In the second criterion, coaches categorize their team players into three groups: (1) leading team players; (2) the rest of the starting players and players entering the game, thus contributing to the team result; (3) players who rarely or never enter the game. Table 1 presents a combination of these criteria. Further details on this classification approach can be found in Grgantov, Katić, and Janković (2006). Coaches give each player a score from 1 to 5. Those players who scored 4 and 5 were more successful, and less successful players were the ones who scored 3, 2, and 1. Accordingly, the sample was divided into two subsamples: more successful (n = 39) and less successful (n = 59) players. During the analysis, eight players without an assigned playing position were excluded. No history of injuries or diseases that could affect test performance was observed.

Table 1. The situational performance of the players according to the two criteria.

Team Placement	Within Team Players' Quality Evaluated by the Coach		
	Group 1	Group 2	Group 3
Super League	5	4	3
1st League	3	2	1

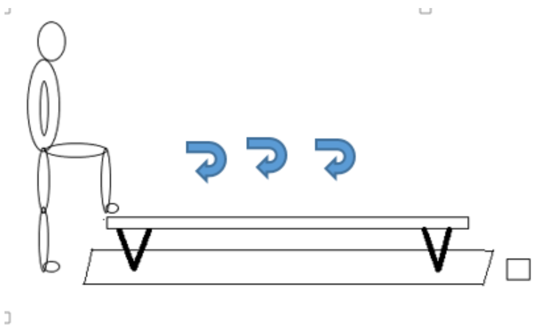
Measures

Coordination abilities were assessed with six tests measuring balance, reaction speed, kinesthetic differentiation, and space-orientation abilities. All tests were carried out under the same conditions by a team of trained researchers, all of whom hold PhDs in kinesiology. Before testing began, the team received detailed instructions to ensure consistency in how the tests were administered and scored. This standardization helped reduce potential differences between evaluators and improve the overall reliability of the assessments.

Bench walk with 3 turns test (BW3T)

To evaluate the volleyball players' balance ability, the Bench walk with 3 turns (BW3T) test was used, in which the participant stands behind a 3-m long bench (Broďáni & Šimonek, 2012). The bench is turned upside down, and the movement is performed on the narrower side, which is 10 cm wide. Before the signal is provided, the player has a stronger leg on the bench. At a signal, the child stands on the bench and attempts to walk to the other end, making three 360° turns. If the examinee loses their balance, they can touch the ground up to 2 times; each touch represents one negative second added to the final measured time, or, otherwise, becomes a reason for the test to be repeated. The final score is gathered from the time of the starting signal to the touch of the ground behind the bench.

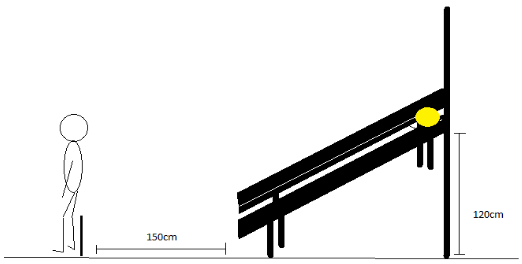
Figure 1. Visual representation of the BW3T test.



Stopping the rolling ball test (SRB)

Reaction speed was assessed by applying the Stopping the rolling ball test (SRB) (Šimonek, 2014). The player is standing behind two benches that have a 5 cm distance between them, 150 cm from the lower edge of the benches, with his back turned away in the opposite direction (without seeing the ball). Benches were placed at a height of 120 cm so the volleyball could roll. The meter was attached to the bench's surface, allowing the ball to roll down it. The measurer held a ball at the top of the benches (meter), and after the audio signal, he released the ball. The player's task was to turn around, run to the ball, and stop it with both hands as quickly as possible. The traveled distance of the ball was recorded after each attempt.

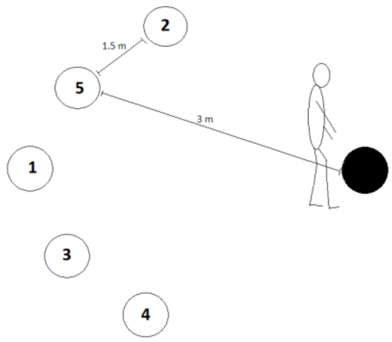
Figure 2. Visual representation of the SRB test.



Shuttle run reactive test (SRrt)

For assessing space orientation, the Shuttle run (reactive) test was used (Ljach & Witkowski, 2010). Six balls are arranged in the following way: one is in the center, and in front of it is the tested player standing. The others are arranged behind the tested person in a semicircle, and they all have a number on them (1-5). All balls are 3m away from the ball in the center (No. 0) and 1.5 m apart from each other. The tested player starts by standing with his back to the balls. The balls are randomly distributed at the moment the player takes their position, so they do not know which position corresponds to which number. Having called one number out of 5, the tested person runs to the ball with the called number, touches it, and returns to touch the ball No. 0. At the moment of touching the ball No. 0, the administrator calls another number of the balls (1 to 5). The same is repeated with the third number of a ball. The test finishes with touching the ball in the center after the return from the third ball. There was one preparatory attempt and three measured ones.

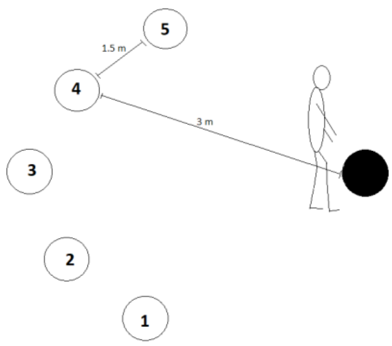
Figure 3. Visual representation of the SRrt test.



Shuttle run non-reactive test (SRnr)

The balls are arranged in the same way as in a reactive Shuttle run test. The tested person runs in order from the first ball, then returns to the center ball, and repeats this process for each of the five balls. The test finishes with the touching of the ball in the center after the return from the fifth ball. There was one preparatory attempt and three measured ones.

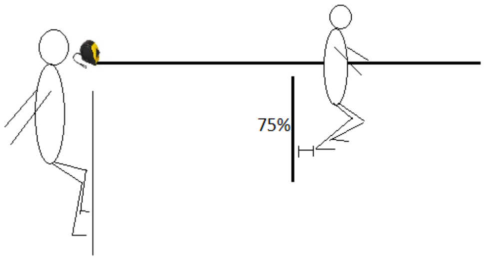
Figure 4. Visual representation of the SRnr test.



Target standing broad jump test (TSBJ)

In the TSBJ test (Broďáni & Šimnoek, 2010), the participant jumps to a maximum distance 3 times. After marking the 75% distance of his maximal performance, the tested person tries to jump three times with his heels as close as possible to the given mark. An average of the three measured results is recorded.

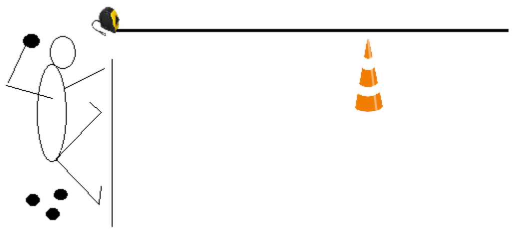
Figure 5. Visual representation of the TSBJ test.



Target sitting throw (TST)

In the Target sitting throw test (TST)(Brod'áni & Šimnoek, 2010), a measurer stretches a measuring tape (approximately 50m long) on the floor surface. The player is sitting at the baseline with legs spread and throws a tennis ball 3 times to a maximum distance. The best result is recorded. In the second part of the test, 50% of the maximum result is marked with a cone on the floor. The tested person had ten attempts to throw at the target on the ground. A deviation from the 50% mark is recorded.

Figure 6. Visual representation of the TST test.



Data analysis

The intraclass correlation coefficient (ICC) was used to test the relative reliability within sessions for the second group of the same age. The ICC scores are considered poor if less than 0.39, between 0.40 and 0.59 fair, between 0.60 and 0.75 good reliability, and excellent if larger than 0.75 (Ko & Li, 2016). Furthermore, to determine the usefulness of the non-specific coordination tests over repeated trials, the standard error of measurement (SEM) was assessed using the following formula: [$SEM = SD \times \sqrt{1 - ICC}$]. The smallest worthwhile change (SWC) was used to observe differences between SEM and SWC by various effect sizes (0.2, 0.6, and 1.2) multiplied by the between-participant standard deviation. If the SEM was higher for all variables than the SWC, the test was rated as marginal; when the SEM was similar to the SWC, the test was rated as satisfactory; and if the SEM was below the SWC, the SWC test indicated good usefulness (Hopkins, 2004). Moreover, the minimal detectable change was calculated with the following formula: [$MDC = SEM \times 1.96 \times \sqrt{2}$] to monitor progress so that intra-trial variations do not inaccurately suggest a change. The normality of the sample was tested using the Kolmogorov-Smirnov test ($p > 0.05$). After confirming the homogeneity of variances using Levene's test, which showed no significant violations ($p > 0.05$ for all variables), one-way ANOVA was used to assess the difference between players in different playing positions (setters vs. passer-hitters vs. opposite players vs. middle blockers vs. libero players) and situational performance in terms of discriminative ability. Compared to that, the Student's paired t-test was assessed to determine the difference between more successful and less successful players. Also, Cohen's d was used, with the magnitude of d qualitatively interpreted using the following thresholds: <0.2, trivial; 0.2 to 0.6, small; 0.6 to 1.2, moderate; 1.2 to 2.0, large; and 2.0 to 4.0, very large (Hopkins, 2000). The statistical analysis was performed using SPSS Statistics 27.0 for Windows. The statistical significance for all tests was set at $p<0.05$.

Results

The within-session reliability results are presented in Table 2. In two-day sessions, the relative reliability was excellent in all tests except for the TST test, whose reliability was fair. The SEM exceeded the SWC at the smallest level for all variables, while SEM was below SWC values at moderate and large levels for most tests. The random error, represented by the MDC, ranged from small values to larger values for some tests, reflecting differing levels of reliability precision across the tests.

Table 2. Results of the reliability and usefulness of the non-specific coordination tests

Variable	Test	Re-Test	ICC	SEM	SWC(0.2, 0.6, 1.2)	MDC
BW3T (s)	14.27±3.54	15.38±5.10	0.89	1.35	0.82, 2.46, 4.92	3.73
SRB (cm)	135.02±15.62	163.53±20.70	0.82	7.52	3.58, 10.75, 21.49	20.78
SRrt (s)	8.37±0.39	8.07±0.43	0.76	0.26	0.1, 0.32, 0.64	0.72
SRnr (s)	11.77±0.65	11.39±0.48	0.80	0.18	0.08, 0.25, 0.50	0.50
TSBJ (cm)	3.26±2.40	3.52±2.67	0.80	0.94	0.43, 1.28, 2.57	2.60
TST (cm)	49.3±13.21	63.42±39.72	0.58	8.56	2.64, 7.93, 15.85	23.73

All values are presented as mean ± SD; ICC = intraclass correlation coefficient; SEM = standard error of measurement; SWC = smallest worthwhile change; MDC = minimal detectable change.

The Kolmogorov-Smirnov test showed that all data were normally distributed. After analyzing the subgroup for reliability and usefulness, Table 3 presents inter-positional differences by applying one-way ANOVA on the sample of female volleyball players. As shown in the table, there were no significant differences between all six non-specific tests.

Table 3. Inter-positional differences analyzed by one-way ANOVA for the non-specific coordination tests on the total sample of 98 young female volleyball players.

Variable	Setter (n = 17)	Passer-hitter (n = 35)	Opposite player (n = 16)	Middle blocker (n = 19)	Libero (n = 11)	F(p)
BW3T(s)	16.21±3.74	15.39±0.65	16.32±4.68	17.12±3.08	15.48±3.00	0.64(0.64)
SRB (cm)	137.53±14.04	136.53±19.75	136.69±12.07	134.52±20.35	133.11±19.87	0.12(0.97)
SRrt (s)	11.25±0.55	11.14±0.96	11.41±0.88	11.79±0.88	11.71±0.75	1.87(0.12)
SRnr (s)	8.49±0.56	8.42±0.68	8.47±0.55	9.01±0.65	8.59±0.58	2.43(0.06)
TSBJ (cm)	4.03±2.22	4.87±2.89	3.80±2.94	4.39±3.11	5.31±3.35	0.71(0.59)
TST (cm)	50.91±25.85	58.40±25.55	64.37±26.16	60.92±16.53	71.89±28.86	1.39(0.24)

All values are presented as mean ± SD. F – ratio of between-group to within-group variance; p – probability value.

Differences between more successful and less successful players are presented in Table 4, where more successful female volleyball players achieved better results than less successful ones in all tests. Moderate effect sizes were found in the SRB and SRrt tests, indicating better performance in more successful players. Small but significant differences were observed in the BW3T, SRnr, TSBJ, and TST tests.

Table 4. Differences were analyzed by independent t-test for non-specific coordination between less successful and more successful young female volleyball players.

Variable	Less successful (n = 59)	More successful (n = 39)	t(p)	d
BW3T(s)	16.91±3.38	14.92±3.68	2.55(<0.01)	0.56
SRB (cm)	141.04±17.63	128.03±14.05	3.38(<0.001)	0.81
SRrt (s)	11.68±0.87	11.01±0.70	3.72(<0.001)	0.85
SRnr (s)	8.71±0.64	8.38±0.59	2.30(0.02)	0.54
TSBJ (cm)	4.97±0.44	3.77±0.33	2.09(0.03)	0.46
TST (cm)	66.56±24.96	55.61±15.09	2.10(0.04)	0.53

All values are presented as mean ± SD; t – t-test value; p – probability value; d – effect size

Discussion

This study aimed to determine the reliability, discriminative ability, and usefulness of non-specific coordination battery tests. The main finding of this study is that almost all tests exhibit excellent test-retest reliability, except for the TST, which shows fair reliability. Following a study by Đolo, Grgantov, and Milić

(2020), the reliability of this test was even higher (0.73). Consequently, the error in performing the test can be much more pronounced with fewer participants. Nevertheless, the two tests, TST and TSBJ, analyzing kinesthetic-differentiation ability, are mostly disturbed in puberty, which can also be related to these results (Šimonek, 2016). Space orientation (Shuttle run test) is in conjunction with reaction speed (Stopping the rolling ball test) (Hirtz & Starosta, 2002). In that way, high results from this research indicate its performance dependency not only in these two abilities but also in all coordination abilities that are associated with each other.

The results of usefulness show that the amount of measurement error and noise in the test range from 0.18 to 1.35 s and 0.94 to 8.56 cm (2% to 28%), with those tests that had SEM higher than 10% differentiated in two measurements. Therefore, TSBJ and TST tests were differentiated. These non-specific coordination battery tests yielded lower results for SWC (0.2) compared to SEM, whose usefulness was rated as "marginal," as SEM values for SWC (0.6 and 1.2) were lower and indicated "good" usefulness for all tests. Accordingly, coordination tests could detect a real change that exceeds 0.6 and 1.2 times the standard deviation. Furthermore, MDC was calculated to control measurement precision, specifically to reveal real changes in measured performance between test and re-test. In the present study, the MDC for the time variable tests varied from 0.50 to 0.72 s, and the BW3T test had 3.73 s, which may raise concerns for the precision of the measure, as well as the SRB test, with a variation of 20.78 cm, and the TST test had 23.73 cm. Therefore, different interactions can be found that lead to changes between these two testing occasions, such as pressure, fatigue, arousal, concentration, stress, and motivation (Struzik et al., 2014). The BW3T test has abduction-adduction (i.e., turning around) movements and may lead to postural disturbance, leading to larger errors and high MDC variations (Đolo, Grgantov, & Jelaska, 2023). Also, the reaction speed SRB test is a multi-joint movement requiring large muscle group activation, leading to higher inter-trial variability, which produces measurement error (Smits-Engelsman & Wilson, 2013).

This study highlighted the discriminative ability with two objectives: (i) to determine whether there are differences between playing positions (ii) to estimate the difference between less successful and more successful young female volleyball players in non-specific coordination battery tests. Although the mean results show differences between playing positions, there is a non-significant difference between playing positions in all coordination tests. This finding confirms that coordination tests are equally important for performance in all playing positions in volleyball.

When comparing the mean results of playing positions, it can be noticed that passer-hitters tend to achieve better results than other playing positions, which may be related to the greater emphasis on their play in attack in this age group. Because play in attack is mainly based on passer-hitters (Voigt & Vetter, 2003). Therefore, to be successful in all game segments, they must possess all coordination abilities at a high level. Moreover, middle blockers have lower values mainly due to their anthropometric characteristics (tallest and heaviest players) (Palao et al., 2014; Toselli & Campa, 2018).

Significant differences were found between the results of more successful and less successful volleyball players. According to Pion et al. (2015), high-level players had better motor coordination than average-level ones. Consequently, the successful performance of coordination abilities has an important role in future advancement in skill-based sports such as volleyball (Đolo, Grgantov, & Kuvačić, 2023). Observing players' performance of the space-orientation tests (Shuttle run reactive and non-reactive), it can be noticed that high results in more successful players were closely related to cognitive ability. This aligns with findings by Trecroci et al. (2021) on youth volleyball players, which demonstrated a significant relationship between cognitive functions and sport-specific physical performance. Their study suggests that athletes with higher cognitive abilities tend to perform better in a physically demanding task. Without being told the best way to perform the test, some of them found the easiest way to achieve good results by watching the other numbers while running. This observation is closely related to previous research (Vestberg et al., 2012; Walton et al., 2018). Also, the highest results of space-orientation ability have passer-hitters in both Shuttle run tests because they have similar movement structures during the game through field defense.

Regarding balance ability, during competition and training, maintaining controlled body movement is essential for players due to sport-specific situations in the game that contain postural disturbances (Fuchs et al., 2020). Equally, in the balance test, more successful players have the highest results. In reaction speed assessments where distance is used as the primary metric, middle blockers typically achieve the best results, likely due to their longer limb length. It is equally important to pay attention to the kinesthetic-differentiation ability, which controls movement in time, space, and dynamics. Kinesthetic memory helps players remember motor movements, such as jumping and throwing, to perform specific volleyball movements successfully. (Boichuk et al., 2020). In such a way, it can be noticed from the results of the TSBJ and TST tests that they have higher probability values, indicating the importance of higher mastery of non-specific kinesthetic-differentiation ability.

In the last few decades, researchers have become more involved in testing protocols to demonstrate the importance of coordination abilities in every sport. A high level of coordination abilities leads to a faster adaptation to complex motor tasks that are carried out in the volleyball game (Georgiy, 2019). Therefore, coaches need to implement all of them by age 7-12 when motor centers in the brain are intensively developing (90-95% of the maximum value) (Hudson et al., 2021). For that reason, children can perform complex motor tasks, which are characteristics of other team sports; coordination aims to learn and conduct these complex movements with increasing efficiency and control. In volleyball, as in other team sports, coordination involves learning and applying the techniques and tactics of the game, which are highly specialized and change with situations. In that way, the player with well-developed coordination abilities can make the best out of situations where the rule of three touches requires fine technique (Eider & Cieszczyk, 2004; Pion et al., 2015). Although variables such as training history and anthropometric characteristics were not included as covariates, no significant differences were found between groups in training experience, height, sitting height, or body weight, reducing the likelihood that these variables confounded the results.

This study has several limitations. It would have been valuable to analyze differences between more successful and less successful players within each position, rather than only across all positions. However, this was not feasible due to the small sample size. Second, success at a younger age does not guarantee success at the peak of a player's career. Therefore, while more successful players may differentiate from less successful ones in test results at a young age, this should not be interpreted as evidence that these tests can predict future success. Additionally, one of the main limitations of the reliability analysis is the small sample size (n = 13) used in the test-retest subgroup. While the results mainly showed high reliability coefficients, a small sample can inflate or deflate reliability estimates and reduce the generalizability of the findings. This may have particularly affected the TST test, which showed only fair reliability, as a larger sample might have yielded more stable estimates. Future research should consider replicating reliability analyses with larger and more representative subsamples to confirm these results. Finally, while the study assessed discriminative ability, future research should aim to establish convergent validity by comparing these results with other assessments considered gold standards.

Conclusions

The results of this study reveal that the battery test is reliable and useful for estimating non-specific coordination abilities among female volleyball players. This battery test can evaluate progress in playing position due to discriminative ability. Coaches need to be aware that non-specific coordination abilities have an essential role in preparing young players for specific situations that every sport requires. Further, more successful players had better coordination abilities than less successful players, which signifies how young volleyball players need to be challenged throughout training by learning a broad spectrum of motor skills. Based on the identified limitations, such as a small sample size and the need for additional analysis validity by comparing the results with other tests considered the gold standard, future studies should aim to include larger and more diverse samples. Solving these areas will strengthen the application of general coordination assessments and contribute to a deeper understanding of the role of players' development.

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