Original Article

doi: 10.16926/par.2025.13.03

Effect of visual feedback on the badminton serve accuracy in training and match conditions

Jan Carboch ACD, **Dominik Ďurčo** BC

Charles University, Faculty of Physical Education and Sport, Czech Republic

Authors' Contribution: A – Study Design, B – Data Collection, C – Statistical Analysis, D – Manuscript Preparation, E – Funds Collection

Abstract: Players in badminton don't have full feedback about their shot accuracy unless the opponent allows the shuttlecock to impact the ground. Borderline in/out situations often arise while receiving a backhand short serve, which is the most common serve type in elite badminton. The aim of this study is to evaluate the accuracy of badminton players' short backhand serves under two different visual feedback conditions: one with limited visual feedback of the shuttlecock trajectory (simulated match condition using occlusion) and one with full visual feedback, including the visibility of shuttlecock impact (training condition). We observed 12 badminton players in this experiment. They executed a total of 960 serves in training and simulated match conditions. The results showed a difference in the short serve accuracy impacting the serves significantly closer to the line in training conditions (M = 25.0 ± 7.1) compared to simulated match conditions (M = 40.6 ± 10.6) $p < 0.001$, $d = 1.45$. Based on the findings we suggest exercises as an implication, that could improve the serve accuracy and can be adopted to practice sessions. Finally, this study provides evidence that visual occlusion restricting the visual feedback and serve outcome affects the short serve accuracy in badminton.

Keywords: game performance, visual perception, occlusion, skill acquisition, motor learning

Corresponding author: Jan Carboch, email: carby@post.cz

Recevied: 12.02.2024; Accepted: 5.11.2024; Published online: 8.01.2025

Citation: Carboch J, Ďurčo D. Effect of visual feedback on the badminton serve accuracy in training and match conditions. Phys Act Rev 2025; 13(1): 26-34. doi: 10.16926/par.2025.13.03

INTRODUCTION

Badminton shots provide the players only limited visual feedback on their shot accuracy. Like in other sports games, the players must obtain essential skills to hit the shuttlecock to a desired location repeatedly and efficiently [1,2]. However, in badminton the players hit the shuttlecock from a volley unless the opponent does not hit the incoming shuttlecock. They need to estimate the flight trajectory, and if they assume the shuttlecock will impact the outside the court area, they let it bounce, and the rally ends. They lose a point if they assume incorrectly. This action can be tricky and risky when receiving a short serve, as the shuttlecock impacts very close to the short service line [3]. Visual information acquisition affects all aspects of movement - planning, control, and evaluation of movement [4] and the athletes must react quickly to the opponent's action [5-7]. As the shuttlecock does not bounce on the ground between the shots during the rally, it challenges the receiver's visual perception system and quick decision-making, whether the shot (especially the short serve) will land in or out.

It has been found that, at the performance level, the serve accuracy can be affected by the presence of an opponent on the court, which is different to training conditions without the opponent [8]. In most cases, the presence of an opponent takes away the possibility of inherent feedback about the shuttlecock's impact because the opponent returns the shuttlecock, i.e. the player can not see where the shot will land. In interceptive sports such as tennis, badminton, or squash, it has been proven that elite players can better anticipate the ball's flight trajectory than lesser-skilled players [9-11]. Anticipation is an essential area of game performance [12]. Players use contextual or kinematic information to predict subsequent events associated with the ability to respond appropriately to such events [13-16]. Both of these pieces of information are further used to estimate the location of a moving object and will lead to a subsequent reaction (shot) [17]. After executing the serve in the match conditions, the receiver uses kinematic information about the shuttlecock's trajectory to anticipate it. The server usually does not have proper feedback about the serve accuracy. The server only reaches the information where the serve lands if the opponent lets the shuttlecock fall on the ground. Therefore, the server must rely only on inherent feedback [2,18]. The only case when the serving player gets complete information about the shot accuracy is when the opponent lets the serve impact the ground.

In training conditions, there are various exercises to improve the serve. Many of these drills involve serving into an empty court, where the shuttlecock hits the ground and can be evaluated as a good serve or out, depending on the impact location. The advantage is that the player can evaluate the trials himself. However, the serve impact location is not the only criterion [19]. The opponent's position on the court affects the choice of the serve type and accuracy. The opponent positioned closer to the serving line encourages the server to hit a shorter serve, with great emphasis on the low height of the shuttlecock above the net. Thus, the serving player can gradually "try" to find out which short serve the opponent will return and which length he will estimate as too short. However, this requires extensive experience and excellent anticipation skills. Next to the serve length, the other factor affecting the serve efficiency is the shuttlecock's net height and trajectory.

The optimal shuttlecock's trajectory during a short backhand serve is a curve with the highest peak before the shuttlecock reaches the net and with the lowest possible flight over the net [19]. In match conditions, the intended point of impact should be on the service line. The authors tested performance players according to the mentioned parameters of their serve. The players managed to hit only 30% of their serves, meeting the criteria for a correct serve. The backhand serve dominates in men's elite badminton [20]. Therefore, a higher percentage of correct serves could be assumed. Vial et al. [8] monitored the accuracy of serves based on the impact location with and with an opponent (i.e. match conditions). Based on computer modelling, they calculated that 33% of serves were out (too short) when simulating the match condition. This result suggests a powerful effect of feedback limitation on serve accuracy. The heterogeneity of the results encourages further investigation of this issue, which will be the topic of this study. The aim is to evaluate the accuracy of the short backhand serve of badminton players with limited visual feedback of shuttlecock impact (match condition) and full visual feedback of the impact (training condition). This research is important due to the lack of existing studies examining how varying levels of visual feedback impact players' performance, especially in the context of skill execution. By exploring how varying levels of visual information affect players' performance, this study provides insights into the role of visual feedback in skill execution. Understanding these effects could contribute to the development of training methods that better replicate match conditions, potentially improving player accuracy and overall performance.

MATERIALS AND METHODS

Participants

Twelve adult national-level badminton players (7 male and 5 female) participated in this study. They were 23.6±2.6 years old, had badminton experience of 12.4±3.1 years and had a national mean ranking of 15.7±14.2. All the players regularly play in national and international tournaments throughout the season and play. We used convenience sampling based on players' availability. The players had no injuries or other limitations and could fully participate in testing. The study was approved by the Ethics Committee at the Faculty of Physical Education and Sport, at Charles University, no. 2752022, in accordance with the Declaration of Helsinki. All participants were informed of the risks and benefits of the study and provided written informed consent prior to participating.

Methods and procedures

The experiment took place on a badminton court, and the accuracy of short backhand serve was tested. They had a standard badminton warm-up, including stretching, hitting and serving. The participants were instructed to perform short backhand serves like in a match and finish the rally. Testing always took place in pairs - the server and the receiver. Each participant performed four sessions (20 serves each) in two conditions - with and without occlusion. After each session, the server and receiver swapped their roles. The first and fourth sessions were the occlusion condition [21,22]. The visual feedback was limited to simulate the match conditions (the players had no information about the shuttlecock impact). The participants took the serving and receiving positions (Figure 1A). The server hit a short backhand serve. The receiver let the incoming shuttlecock impact the ground and hit another shuttlecock he held in his/her hand as a return shot at the same time he/she would have hit the incoming shuttlecock. The occlusion was reached by lifting an opaque foil from under the net by the assistant at the serve racket-shuttlecock contact. This foil disallowed the server to see the shuttlecock impact on the ground. The server could see the serve trajectory above the net only. After the receiver hit the net lift shot as a return, the players continued to finish the rally. There were approximately 20 seconds between the rally and the next serve.

The second and third sessions were without occlusion, simulating the training conditions. The participants served shuttlecocks without the return shot or rally and could see the shuttlecock impact on the ground. In this case, the non-serving player (receiver) only removed the shuttlecock after the impact. All the trials were recorded with a video camera Sony HDR-CX405B. The video camera was placed on a tripod directly above the short line, a height of 2 meters and 40 cm from the centre line (Figure 1B). Before each test, a calibration procedure was done.

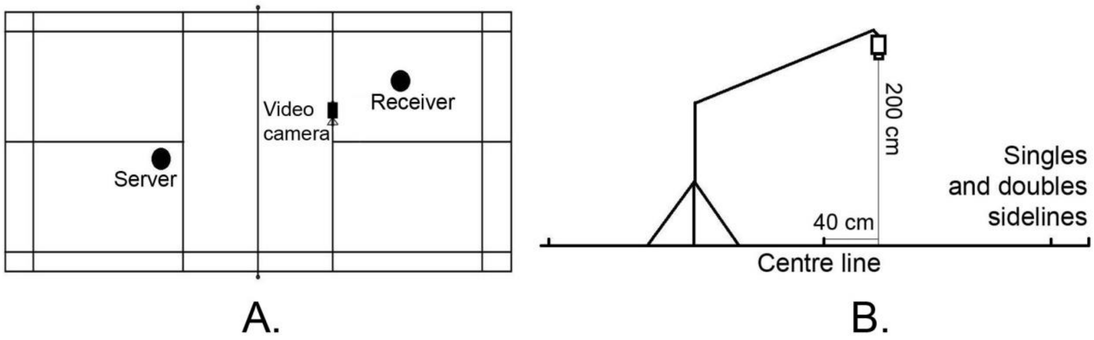

Figure 1. A. Experimental set-up; B. Video camera location on the court. The view is from the back of the court towards the net.

Statistical analyses

Altogether, we analyzed 960 serves. Firstly, we counted all serves that were "in" and "out" (too short). Secondly, we measured the closest distance of the shuttlecock impact distance from the (net) edge of the short service line [3,7]. The data obtained from the video recordings were evaluated in the Kinovea software (version 0.9.5) and processed into Jamovi (version 2.3) software. Descriptive characteristics (mean, standard deviation, and 95% confidence interval) were used in the analysis. Levene's test homogeneity was used to assess the homogeneity of the data. We used independent samples t-tests to analyze the difference between the conditions for each participant. Welch's t-test was used in case of homogeneity violation. To assess normality, we used the Shapiro-Wilk test, which indicated that the data were normally distributed (p = 0.90). Using the mean values from each participant under both conditions, we calculated paired samples t-tests and Cohen d [22].

RESULTS

The distances of the impact locations from the service line for all 960 serves are displayed in Figure 2. From all the serves we observed, there were 11 (2.3%) outs when the vision was occluded and 52 (10.8%) outs under normal conditions. This suggests that participants played more cautiously when they could not see the outcome, and took more risks near the line when they knew the outcome. All other serves landed in the court-designated serve area. Table 1 shows descriptive statistics of the serve distance under occluded and normal visual conditions. The participants reached better serve accuracy under normal vision. The paired sampled t-test showed a significant difference between the occlusion condition (M = 40.6±10.6 cm) and normal condition (M = 25.0±7.1 cm) $t(11)=5.01$, $p < 0.001$, $d=1.45$. The participants served further from the short service line under occlusion conditions. Looking at each participant's data, nine out of twelve reached statistical differences with significantly lower values in normal conditions. These significant differences are supported by large effect sizes except for Participant 2, with moderate effect. These results indicate an effect in serve accuracy between the occlusion and normal conditions.

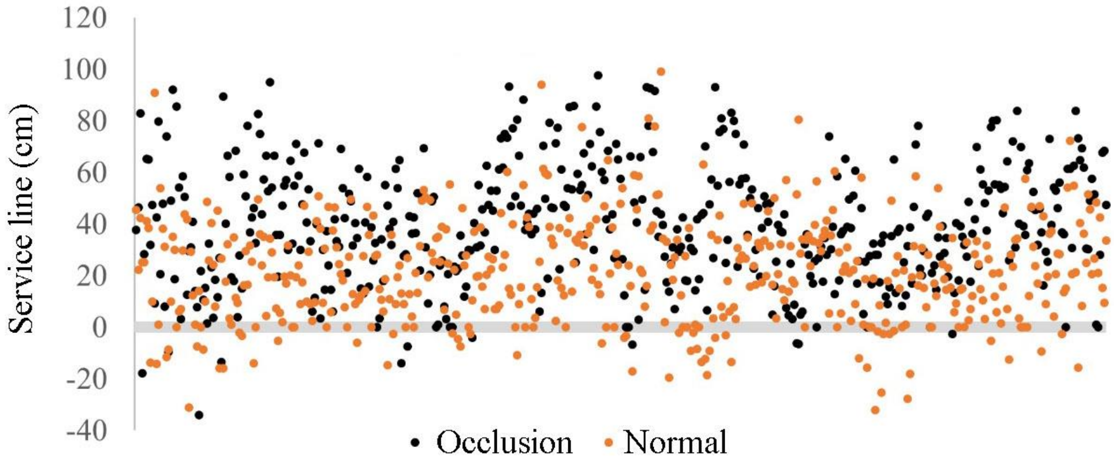

Figure 2. The distances of the impact locations from the service line for all serves under occlusion and normal conditions. The line at point 0 represents the service line. Positive values indicate good serves, with the distance measured from the service line, while negative values represent serves that are too short (out serves). This figure only shows the distance from the service line.

Table 1. Statistics and effect sizes for the result in occluded and normal condition of each participant and overall

No.	Occlusion (match) condition Mean±SD	Normal (training) condition Mean±SD	Mean difference	SE difference	95% Confidence interval		*T*-test	df	*p*	Effect size Cohen *d*
					Lower	Upper				
1	46.5±28.1	39.5±23.7	7.01	6.26	-5.48	19.5	1.12	68	0.265	0.27
2	27.4±17.1*	19.2±15.6	8.16	3.97	0.24	16.08	2.06	68	0.044	0.50
3	#49.1±24.6***	21.2±15.7	27.99	4.90	18.22	37.77	5.72	64	< 0.001	1.36
4	46.7±18.9***	24.0±13.9	22.72	3.75	15.26	30.18	6.06	77	<0.001	1.36
5	26.4±18.5	29.0±18.0	-2.53	4.12	-10.74	5.69	-0.61	76	0.54	-0.14
6	37.4±17.8***	23.5±16.5	13.86	3.90	6.09	21.62	3.56	76	< 0.001	0.81
7	32.1±16.4***	14.5±11.3	17.53	3.47	10.60	24.45	5.05	67	< 0.001	1.22
8	27.4±19.5	27.4±16.5	0.00	4.17	-8.32	8.31	0.00	74	0.998	0
9	37.4±15.1***	17.6±11.9	19.86	3.11	13.66	26.06	6.38	74	< 0.001	1.46
10	55.2±20.0***	21.9±17.6	33.33	4.30	24.76	41.9	7.75	75	< 0.001	1.77
11	47.9±19.9***	29.5±19.4	18.45	4.45	9.59	27.31	4.15	76	< 0.001	0.94
12	54.1±21.0***	33.4±18.6	20.70	4.50	11.74	29.65	4.60	76	< 0.001	1.04
Total	40.6±10,6***	25.0±7.1	15.60	3.11	8.74	22.40	5.01	11	< 0.001	1.45

Legend: # Welch T-test. Significantly different than in normal conditions ($p < 0.05$)*; ($p < 0.001$)***.

DISCUSSION

We focused on the influence of visual feedback on badminton serve. The most important result of the work is the significant influence of visual feedback on the short backhand serve. Occlusion testing deprived players of information about the outcome as a form of external feedback. Chen et al. [24] have described previous studies where the effect of limiting visual feedback was recorded as the elimination of knowledge about the outcome of the action. In motor learning, such an approach had beneficial effects but adverse effects on the quality and accuracy of actions [2]. At this level, we do not talk about the motor learning of the participants, but it is possible to observe the negative impact of the lack of feedback about the result of the serve.

Limited visual feedback, i.e., match conditions, significantly affects the short backhand serve accuracy. Participants hit the shuttlecocks farther from the service line and hit fewer outs in occlusion conditions than in full-vision conditions. In this match condition with occlusion, we reached only 4.5% out serves. These data contradict the study of Vial et al. [8], which reported that 30% of serves during the matches were too short and impacted out. There can be a couple of explanations for this. The data for this study was obtained from elite players' matches using a computer modelling of serve trajectory. The receiver hit a return shot, and the computer calculated the rest of the shuttlecock trajectory, which may be imperfect. The other reason could be that the servers hit the serves intentionally short to make the receiver's conditions for return shots more difficult. They took a calculated risk that the receiver would return the serve anyway, not to risk a potential ace and reach a more favourable situation. Lastly, the receiver position can also affect the serve accuracy [25]. In doubles matches, the receiver can take a more aggressive position closer to the net, which often happens due to the difference in length of the serving territory. Positioning the receiver in doubles would increase the number of outs in match conditions with limited feedback because the server is aware that a serve played higher over the net or with a longer flight trajectory will likely result in a quick loss of the point. Players hit 3% of serves on the line in this occlusion condition. Conversely, elite players hit the line in 37% of cases [8]. The difference in these results could be due to the level of the players or the accuracy of the regression equation that calculated the shuttlecock flight trajectory and impact location in that study. Our participants did not manage to approach the value of the elite players, even under normal conditions, when they had full visual feedback and the opportunity to see the entire flight trajectory and impact location.

The results demonstrate a more consistent serving level in normal conditions where the players can see the impact location. With 38% efficiency, we reached comparable results to Wong et al. [26], where badminton players with eight years of experience hit 33% serve within 20 cm from the service line. Our result of national-level players reached mean values 2 cm closer to the line than less skilled badminton players [3]. Even though this value is not very impressive, we attribute it to the skill level of players.

A similar style of practice exercise, like our occlusion condition, is sometimes applied in training sessions. However, the players usually do not monitor the impact distance but only monitor the serve out and in. Like in this study and such practice exercises, the emphasis is not on the exact trajectory but on the serve effectivity and the subsequent reaction of the opponent's return shot action.

Based on our results, evaluating the short serves in such exercises mentioned above would be appropriate, according to the accuracy of the impact location and the shuttlecock flight height over the net. A quick change of focus to the second shuttlecock can prevent the full feedback, which will imitate the match condition. However, the receiving player does not have the opportunity to hit an offensive shot as a return shot and put pressure on the server in this case.

In this research type, it is very challenging to reach full match conditions (or it is unreal to do such research in a competitive match). We tried to imitate these conditions using more straightforward methods, which could be one of the limitations. It would also be appropriate to measure both players when they alternate in serving, just like in a match. Future research could track the change in the trajectory of the shuttlecock's flight and evaluate the serve based on more factors mentioned above than just the distance of the impact from the line. Additionally, various receiver positions should be considered.

IMPLICATIONS

We propose two exercises that could be included in practice sessions focusing on the serve accuracy based on the shuttlecock impact location and visual feedback awareness. These exercises approach the match conditions and can be easily used in practice or modified to the coach's desire.

Exercise I

The court has a marked serve impact area (e.g. 20x20 cm) bordered by the short service line and centre line. The server tries to hit a short serve in this area, as in the match. The receiver standing opposite to the server responds to the serve by hitting another shuttlecock from his hand (lift shot) to the back of the serving player's court and letting the original shuttlecock impact the ground. The players play a rally on the half court where the player served. The coach/observer monitors and counts the number of serves in the designated area and provides feedback about the number of successful attempts after ten trials.

Exercise II

The players are positioned the same as in exercise I. The server hits a short serve, and the receiver plays a short net shot using another shuttlecock from his hand. The players finish the rally. After the serve is executed, an assistant occludes the shuttlecock ground impact area by raising a curtain or opaque foil (e.g. attached to the net) that prevents the server from watching the shuttlecock impact. Several impact areas, e.g. 10 cm long from the short service line, are marked in the service box. After each rally, the server verbally expresses in which area (how far from the line) he thinks his serve landed and consults the serve outcome with the coach.

CONCLUSION

We analyzed the influence of visual feedback on the short serve in badminton. We provided significant evidence that visual occlusion restricting the feedback and serve outcome affects the serve accuracy. The participants achieved a significantly larger shuttlecock impact point distance from the short service line in occlusion conditions than in full vision conditions. They also hit fewer outs in occlusion conditions. We provide exercises that can be used in training sessions when practising the serve accuracy. These exercises serve as an example and can be modified or combined with other exercises. Since players receive a comparable amount of visual feedback (limited) during matches as in occlusion tests, using occlusion techniques as a specific training tool for the match conditions would be appropriate.

Acknowledgments: The work was supported by the Charles University Cooperation Sport Science – Biomedical and Rehabilitation Medicine.

Conflicts of Interest: The authors declare no conflict of interest.

REFERENCES

1. Phomsoupha M, Laffaye G. The science of badminton: Game characteristics, anthropometry, physiology, visual fitness, and biomechanics. Sports Med 2015; 45(4): 473–495. doi: 10.1007/s40279-014-0287-2
2. Schmidt RA, Lee TD. Motor learning and performance: From principles to application. Champaign, IL:Human Kinetics; 2019.
3. Carboch J, Ďurčo D, Zrníková SM. Practicing badminton serve with the absence of visual feedback. Phys Act Rev 2022; 10(2): 32–38. doi: 10.16926/par.2022.10.20
4. Cortis C, Pesce C, Capranica L. Inter-limb coordination dynamics: effects of visual constraints and age. Kinesiology 2018; 50: 133–139.
5. Carboch J, Praveckova P, Smejkalova P, et al. Visual constraints and swing timing in softball batting: pitcher vs. pitching machine. Phys Act Rev 2022; 10: 68–76. doi: 10.16926/par.2022.10.08
6. Góra T, Mosler D, Ortenburger D, Wąsik J. Sex differences in utilizing effective mass among taekwon-do athletes performing turning and side kick. Phys Act Rev 2024; 12(2): 78-85. doi: 10.16926/par.2024.12.23
7. Wasik J, Mosler D, Gora T, Scurek R. Conception of effective mass and effect of force – measurement of taekwon-do master. Phys Act Rev 2023; 11(1): 11-16. doi: 10.16926/par.2023.11.02
8. Vial S, Croft JL, Schroeder RT, et al. Does the presence of an opponent affect object projection accuracy in elite athletes? A study of the landing location of the short serve in elite badminton players. Int J Sports Sci Coach 2020; 15: 412–417. doi: 10.1177/1747954120915670
9. Abernethy B, Zawi K. Pickup of essential kinematics underpins expert perception of movement patterns. J Mot Behav 2007; 39: 353–367. doi: 10.3200/JMBR.39.5.353-368
10. Shim J, Carlton LG, Kwon Y-H. Perception of kinematic characteristics of tennis strokes for anticipating stroke type and direction. Res Q Exerc Sport 2006; 77: 326–339. doi: 10.1080/02701367.2006.10599367
11. Williams AM, Jackson RC. Anticipation in sport: Fifty years on, what have we learned and what research still needs to be undertaken? Psychol Sport Exerc 2018; 42: 16–24. doi: 10.1016/j.psychsport.2018.11.014
12. Loffing F, Cañal-Bruland R. Anticipation in sport. Curr Opin Psychol 2017; 16: 6-11. doi: 10.1016/j.copsyc.2017.03.008
13. Carboch J, Brenton, J, Reischlova E, Kocib T. Anticipatory information sources of serve and returning of elite professional tennis players: A qualitative approach. Int J Sports Sci Coach 2023; 18(3): 761–771. doi: 10.1177/17479541221092345
14. Huang J, Hsu HJ. Approximating strike zone size and shape for baseball umpires under different conditions. Int J Perform Anal Sport 2020; 20: 133-149. doi: 10.1080/24748668.2020.1726156
15. Morris-Binelli K, van Rens FECA, Müller S, Frank B, Larkin P, Button C. Psycho-perceptual-motor skills are deemed critical to save the penalty corner in international field hockey. Psychol Sport Exerc 2020; 51: 101753. doi: 10.1016/j.psychsport.2020.101753
16. Vernon G, Farrow D, Reid M. Returning serve in tennis: A qualitative examination of the interaction of anticipatory information sources used by professional tennis players. Front Psychol 2018; 9: 895. doi: 10.3389/fpsyg.2018.00895
17. Müller S, Abernethy B. Expert anticipatory skill in striking sports: A review and a model. Res Q Exerc Sport 2012; 83(2): 175-187. doi: 10.5641/027013612800745059
18. Magill RA. Motor learning and control. New York:McGraw-Hill; 2004
19. Vial S, Cochrane J, J. Blazevich A, et al. Using the trajectory of the shuttlecock as a measure of performance accuracy in the badminton short serve. Int J Sports Sci Coach 2019; 14: 91–96. doi: 10.1177/1747954118812662
20. Carboch J, Smocek P. Serve and return in badminton: Gender differences of elite badminton players. Int J Phys Educ Fit Sports 2020; 9: 44–48. doi: 10.34256/ijpefs2014
21. Müller S, Brenton J, Rosalie SM. Methodological considerations for investigating expert interceptive skill in in situ settings. Sport Exerc Perform Psychol 2015; 4: 254–267. doi: 10.1037/spy0000044
22. Renshaw I, Oldham ARH, Davids K, Golds T. Changing ecological constraints of practice alters coordination of dynamic interceptive actions. Eur J Sport Sci 2007; 7(3): 157–67. doi: 10.1080/17461390701643026
23. Cohen J. Statistical power analysis for the behavioral sciences. 2nd ed. Hillsdale, NJ: Lawrence Earlbaum Associates; 1988

24. Chen YL, Hsu JH, Tai DHL, Yao ZF. Training-Associated Superior Visuomotor Integration Performance in Elite Badminton Players after Adjusting for Cardiovascular Fitness. Int J Environ Res Public Health 2022; 19(1): 468. doi: 10.3390/ijerph19010468
25. Gawin W, Beyer C, Hasse H, Büsch D. How to attack the service: An empirical contribution to rally opening in world-class badminton doubles. Int J Perform Anal Sport 2013; 13(3): 860-871. doi: 10.1080/24748668.2013.11868694
26. Wong TKK, Ma AWW, Liu KPY, Chung LMY, Bae YH, Fong SSM, Ganesan B, Wang HK. Balance control, agility, eye-hand coordination, and sport performance of amateur badminton players: A cross-sectional study. Medicine (Baltimore). 2019; 98(2): e14134. doi: 10.1097/MD.0000000000014134