3943-Article Text-16005-1-4-20250529.docx

by Turnitin Ku

Submission date: 05-Jun-2025 07:06PM (UTC+0300)
Submission ID: 2586341523
File name: 3943-Article_Text-16005-1-4-20250529.docx (85.25K)
Word count: 2963
Character count: 17210

Journal Physical Health Recreation (JPHR)
Volume * Nomor * ; Bulan ****
https://jurnal.stokbinaguna.ac.id/index.php/JPHR
e-ISSN : 2747- 013X

Biomechanical Analysis of Tennis Spin Serve Technique Using Kinovea in Beginner Athletes in South Sulawesi

Ians Aprilo[1], Poppy Elisano Arfanda[2], M. Adam Mappaompo[3], Yusnadi[4], Andi Rizal[5], Hasbi Asyhari[6]

{ians.aprilo@unm.ac.id[1], poppy.elisano@unm.ac.id[2], m.adam mappaompo@unm.ac.id[3], yusnadi@unm.ac.id[4], andi.rizal@unm.ac.id[5], hasbi.asyhari@unm.ac.id[6]}

Universitas Negeri Makassar, Jl. A. P. Pettarani, Tidung, Kec. Rappocini, Kota Makassar, Sulawesi Selatan 90222[1], Universitas Negeri Makassar, Jl. A. P. Pettarani, Tidung, Kec. Rappocini, Kota Makassar, Sulawesi Selatan 90222[2], Universitas Negeri Makassar, Jl. A. P. Pettarani, Tidung, Kec. Rappocini, Kota Makassar, Sulawesi Selatan 90222[3], Universitas Negeri Makassar, Jl. A. P. Pettarani, Tidung, Kec. Rappocini, Kota Makassar, Sulawesi Selatan 90222[4], Universitas Negeri Makassar, Jl. A. P. Pettarani, Tidung, Kec. Rappocini, Kota Makassar, Sulawesi Selatan 90222[5], Universitas Negeri Makassar, Jl. A. P. Pettarani, Tidung, Kec. Rappocini, Kota Makassar, Sulawesi Selatan 90222[6]

Abstract. This study aims to analyze the spin serve technique in novice tennis players, with an emphasis on trunk rotation and dynamic balance, using Kinovea motion analysis software. A total of 30 novice athletes, aged 14–16 years, from South Sulawesi, became the subjects in this study. Data were collected through high-speed video recording from three angles and analyzed using Kinovea to observe seven stages of tennis court service, namely: coiling, ball toss, backswing, uncoiling, strike zone, follow-through, and fall-in. The results showed that the effective spin serve technique is greatly influenced by optimal trunk rotation with an average of 8.32 and good dynamic balance with an average of 72.03. These findings indicate that players with proper trunk rotation and balance tend to produce more accurate and powerful serves. Kinovea has been proven effective as an objective tool in evaluating the quality of the spin serve technique.

Keywords: tennis court, spin serve, trunk rotation, dynamic balance, Kinovea

1 Introduction

Spin serve in tennis is one of the most complex and strategic technical skills, because it requires optimal coordination between trunk rotation, arm speed, and dynamic balance. As the opening shot in the game, serve plays an important role in controlling the course of the match, and among the various types of serve, the spin serve is known to be able to produce unpredictable ball directions with high or sideways bounces, making it difficult for opponents to return. The success of this technique is greatly influenced by biomechanical factors, especially trunk rotation which plays a role in producing torque which is then transmitted to the arms and racket, as well as dynamic balance which maintains postural stability when there is a rapid transfer of body weight in the service phase. The game of tennis itself requires mastery of high technique,

. Correspondence author: First Author/Second Author/Third Author, Medan State University, Indonesia.
Email:

speed, coordination, and physical and mental strength so that errors in aspects of trunk rotation and dynamic balance can have a direct impact on reducing the accuracy and quality of the spin serve as a whole.(Murata & Fujii, 2022; Aprilo et al., 2023; Aprilo et al., 2021).

However, in training practice, the mastery of spin service techniques in many beginner to intermediate-level athletes is still not optimal. Many coaches only rely on subjective observations without the support of technology, which often results in inaccurate technique corrections. Factors such as synchronous trunk rotation and dynamic balance during and after the service are critical elements that determine the effectiveness and accuracy of the spin. Therefore, a more objective and measurable motion analysis approach is needed.(Brocherie & Dinu, 2022; Murata & Fujii, 2022;Palmer et al., 2018).

With the development of motion analysis technology, coaches and researchers can now evaluate biomechanical components in detail. One of the widely used software is Kinovea, an open-source application that is able to analyze the angle of movement, speed, and stability of movement based on video footage. Kinovea, as an easily accessible and accurate video-based motion analysis software, offers an innovative solution to analyze technical performance in detail. With frame-by-frame and angle measurement features, Kinovea allows for a scientific biomechanical evaluation of the service movement. However, so far there are still limited scientific studies that specifically use Kinovea to analyze trunk rotation and dynamic balance in the context of spin serves.(Aprilo et al., 2019; Aprilo et al., 2022; Jacquier-Bret & Gorce, 2024).

This study uses a technology-based scientific approach in coaching tennis techniques, especially at the stage of mastering fundamentals. Objective analysis is needed to produce targeted training interventions. This study integrates software-based video analysis with a biomechanical approach in the context of spin service, especially those that simultaneously evaluate aspects of trunk rotation and dynamic balance. This study uses Kinovea as a tool for analyzing trunk rotation and dynamic balance simultaneously in service techniques. The findings of this study are expected to be a scientific basis for coaches and athletes in designing more precise and effective service technique training programs.

Therefore, this study was conducted to analyze the tennis spin service technique using Kinovea software with a focus on two main biomechanical variables, namely trunk rotation and dynamic balance. This study aims to provide an empirical description of the contribution of both aspects to the quality of effective spin service.

2 Method

This is a pre-experimental report. A quantitative descriptive research approach was employed, comprising thirty novice tennis players from South Sulawesi, ages fourteen to sixteen. This study was carried out on the tennis court at Makassar State University's Faculty of Sport Science. To record motion, a Canon EOS 1100D DSLR camera was used. Five meters to the right of the server position box and perpendicular to the service line, the first camera was positioned to capture sideways body motions during service. To determine which ball entered, a second camera was positioned in the center, directly on the center line, to record the ball's trajectory as it entered the service box. The third camera was positioned behind the athlete to capture their body tilt as the ball struck the racket. In order to assess and compare the phases of spin service in tennis, data were processed using Kinovea. Measurements of trunk rotation and dynamic balance are included in this analysis, along with the seven stages of tennis service (coiling, ball

toss, backswing, uncoiling, strike zone, follow-through, and fall-in). The average (mean) and standard deviation are determined for every movement and its outcomes in order to process statistical data.

3 Result

Based on the results of descriptive statistical data measurements of trunk rotation and dynamic balance in 30 beginner tennis athletes from South Sulawesi aged 14-16 years, the following data were obtained:

Table 1. Supporting Data

	N	Amount	Average	Standard Deviation
Trunk Rotation	30	249.50	8.32	1.52
Dynamic Balance	30	2161.00	72.03	8.31

Table 1 shows the results of tennis spin service movements, the following data were obtained, for trunk rotation the number was 249.50, the average was 8.32 and the standard deviation was 1.52. For dynamic balance the number of data was 2161, the average was 72.03 and the standard deviation was 8.31.

Based on the measurement results, descriptive statistical data was obtained for the tennis spin service as shown in Table 2.

Table 2. Descriptive Statistics

	N	Range	Min	Max	Mean		Standard Deviation	Variance
					Statistics	Standard Error		
Tennis Spin Serve	30	6	11	17	15	0.28	1.53	2.35

According to data analysis results from Table 2, there are 30 samples with a maximum value of 17, a minimum value of 11, a standard deviation of 1.53, a variance of 2.35, and a value range of 6.

Table 3. Data Frequency Distribution

Category			Frequency
Low	X<M-1SD	X<14	4
Currently	M-1SD≤X<M+1SD	14≤X≤17	20
Tall	M+1SD≤X	17≤X	6

Table 3 shows 4 athletes in the low category, 20 in the medium category, and 6 in the high category.

Table 4. Descriptive Statistical Results of Kinovea Analysis of 7 Stages of Tennis Spin Service

No	Stages	N	Amount	Average	SD	%
1	Coiling	30	47	1.57	0.50	39
2	Ball Toss	30	77	2.57	0.50	64
3	Backswing	30	66	2.20	0.66	55
4	Uncoiling	30	47	1.57	0.50	39
5	Strike Zone	30	64	2.13	0.90	53
6	Follow Through	30	78	2.60	0.50	65
7	Fall In	30	71	2.37	0.50	59

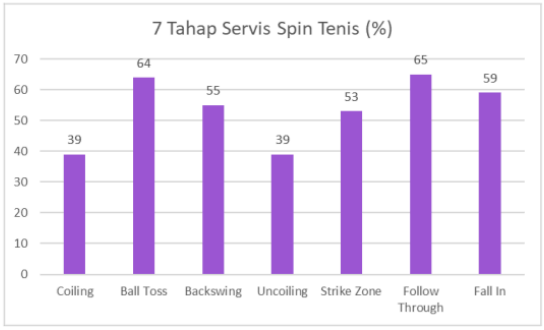

Figure 1. Results of Kinovea Analysis of 7 Stages of Tennis Spin Serve

Table 4 and Figure 1 explain the 7 phases of the research subject's movements in the early stages, namely circular movements of 39%, throwing the ball movement of 64%, swinging backward movement of 55%, releasing the roll movement of 39%, hitting the ball movement of 53%, following the trajectory movement of 65% and falling movement of 59%.
Based on the results of preliminary research, it was concluded that the spin service steps in tennis had not been carried out correctly by the research subjects.

4 Discussion

The results of this study indicate that the quality of spin serve technique in novice tennis athletes is greatly influenced by two main biomechanical aspects, namely trunk rotation and dynamic balance. Video analysis using Kinovea software allows accurate visualization and measurement of the seven stages of service, namely: coiling, ball toss, backswing, uncoiling, strike zone, follow-through, and fall-in. These findings provide a scientific basis for the importance of each phase in creating an effective and accurate service.

Trunk rotation is a key element in generating effective spin and power in tennis serves. The biomechanics of trunk rotation are essential in improving service performance. A study involving professional tennis players revealed that higher peak angular velocity of trunk rotation was associated with increased ball speed, highlighting the role of trunk rotation in serving (van Trigt et al., 2024; Zhang & Chen, 2024). The use of inertial sensors also confirmed that coordinated upper body rotation, coupled with a strong leg drive, contributed to increased racket and ball speed. Maximal rotation in the backswing and uncoiling phases played a major role in increasing ball speed and spin, as well as optimizing core muscle use to achieve high serve speeds.(Brocherie & Dinu, 2022; van Trigt et al., 2024). These findings collectively reinforce the understanding that trunk rotation is critical in generating speed and spin, providing valuable insights for training and coaching strategies in improving service mechanics.

Dynamic balance plays a critical role in maintaining body stability during tennis serves, which directly affects serve accuracy and overall performance (Caballero et al., 2021; Beckmanni et al., 2021). Research has shown that balance performance measured through non-specific movements is not directly related to serve performance, suggesting that dynamic balance may influence tennis performance through mechanisms other than serve execution. High-level tennis players' postural control during the serve revealed individual balance control preferences and increased movement variability throughout the service stroke. This variability highlights the complexity of balance in dynamic actions such as serving, suggesting that balance control is not uniform but rather tailored to individual movement strategies.(Zemková & Kováčiková, 2023; Caballero et al., 2021; Novak et al., 2023).

Targeted training can improve dynamic balance, which in turn can improve performance on the court. This suggests that dynamic balance is not only a characteristic of skilled players, but also an attribute that can be modified through specific training interventions. Overall, dynamic balance is critical to effective tennis performance, influencing trunk stability during dynamic movements such as serving. Although research has identified a correlation between balance and performance, this relationship is complex and can be influenced by a variety of factors, including age, skill level, and training interventions. Professional tennis players have better balance during and after contact. Players who lack dynamic balance often exhibit technical errors, such as losing position after serving or having difficulty controlling the ball.(Shi et al., 2023; Ergin & Arslan, 2020).

Analysis of the seven service phases including coiling, ball toss, backswing, uncoiling, strike zone, follow-through, and fall-in reveals how important each phase is in producing an effective serve. The results of this study indicate that in the coiling and backswing phases, novice players often make mistakes in utilizing the power of body rotation. Players who optimize the backswing phase with proper body rotation are able to create a more efficient energy transfer to the racket and ball.(Gorce & Jacquier-Bret, 2024; Lambrich & Muehlbauer, 2023; Lambrich & Muehlbauer, 2022). The ball toss and strike zone phases also greatly determine the success of a spin serve. Players who have better ball control in the ball toss phase and who are in the right position in the strike zone can produce more accurate serves and have more consistent spin. The accuracy of the ball toss is closely related to the success of the serve, especially in a spin serve.(Kocib et al., 2020; Carboch, 2016). The follow-through and fall-in phases also play an important role in maintaining dynamic balance after the ball is hit, which is related to stability and efficiency of movement. In this study, players who showed good follow-through movements, with maintained body control, had better ability to maintain balance and improve service accuracy. Correct follow-through allows for a smooth body transition to the ready position for the next movement.(Jacquier-Bret & Gorce, 2024; Gorce & Jacquier-Bret, 2024).

5 Conclusion

This study shows that trunk rotation and dynamic balance are two biomechanical components that greatly determine the effectiveness of the spin serve technique in novice tennis players. The results of the analysis with Kinovea showed that technical errors were mostly found in the coiling, backswing, and follow-through phases, which resulted in decreased spin quality and serve accuracy. Players who were able to maintain optimal body rotation and dynamic balance throughout the entire service phase showed better performance. In addition, the use of Kinovea as a motion analysis device has been proven to provide accurate quantitative information on the angle of motion and body posture stability, making it very useful in the process of evaluating and improving techniques. A video analysis-based technology approach such as Kinovea needs to be widely integrated into training programs, especially in the basic technique mastery stage, to improve the effectiveness of learning spin serve techniques systematically and scientifically.

References

Aprilo, I., Asmawi, M., & Tangkudung, J. (2019). Concept Development on Spin Serve Exercise Model of Lawn Tennis Based Kinovea. *Proceedings of the 1st International Conference on Advanced Multidisciplinary Research (ICAMR 2018)*, 28–33. https://doi.org/https://doi.org/10.2991/icamr-18.2019.8

Aprilo, I., Asmawi, M., & Tangkudung, J. (2021). The Effectiveness Of Exercise Spin Serve Model. *Journal of Indonesian Physical Education and Sport*, *7*(1), 14–27.

Aprilo, I., Asmawi, M., & Tangkudung, J. (2022). Kinovea-Based : Tennis Spin Serve Analysis. *Journal of Physical Education, Sport, Health and Recreations*, *11*(2), 7985. https://doi.org/https://doi.org/10.15294/active.v11i2.55643

Aprilo, I., Hakim, H., Arfanda, P. E., Susilo, & Halim, A. (2023). Coiling Exercises Effect On Tennis Spin Serve. *Journal of Physical Education, Sport, Health and Recreations*, *12*(3), 247–253.

Beckmanni, J., Fimpel, L., & Wergin, V. V. (2021). Preventing a loss of accuracy of the tennis serve under pressure. *PLoS ONE*, *16*(July), 1–13. https://doi.org/10.1371/journal.pone.0255060

Brocherie, F., & Dinu, D. (2022). Biomechanical estimation of tennis serve using inertial sensors: A case study. *Frontiers in Sports and Active Living*, *4*(5). https://doi.org/10.3389/fspor.2022.962941

Caballero, C., Barbado, D., Hérnandez-Davó, H., Hernández-Davó, J. L., & Moreno, F. J. (2021). Balance dynamics are related to age and levels of expertise. Application in young and adult tennis players. *PLoS ONE*, *16*(4 April), 1–12. https://doi.org/10.1371/journal.pone.0249941

Carboch, J. (2016). The toss of the professional and the competitive tennis player: serving from the ad-court. *Auc Kinanthropologica*, *52*(1), 58–66. https://doi.org/10.14712/23366052.2016.4

Ergin, E., & Arslan, E. (2020). *The Effect of 8 Week Balance Training on the Agility, Strength, Balance Performance and Tennis Skills of 10-14 Year Old Tennis Players*. 170–180.

Gorce, P., & Jacquier-Bret, J. (2024). Are there kinematic and kinetic parameters correlated with racket velocity during the tennis serve? A preliminary comparison between a slow and a fast serve for performance improvement. *Frontiers in Sports and Active Living*, *6*(October), 1–13. https://doi.org/10.3389/fspor.2024.1451174

Jacquier-Bret, J., & Gorce, P. (2024). Kinematics characteristics of key point of interest during tennis serve among tennis players: a systematic review and meta-analysis. *Frontiers in Sports and Active Living*, *6*(July). https://doi.org/10.3389/fspor.2024.1432030

Kocib, T., Carboch, J., Cabela, M., & Kresta, J. (2020). Tactics in tennis doubles: analysis of the formations used by the serving and receiving teams. *International Journal of Physical Education, Fitness and Sports*, *9*(2), 45–50. https://doi.org/10.34256/ijpefs2026

Lambrich, J., & Muehlbauer, T. (2022). Physical fitness and stroke performance in healthy tennis players with different competition levels: A systematic review and meta-analysis. *PLoS ONE*, *17*(6 June), 1–15. https://doi.org/10.1371/journal.pone.0269516

Lambrich, J., & Muehlbauer, T. (2023). Biomechanical analyses of different serve and groundstroke techniques in tennis: A systematic scoping review. *PLoS ONE*, *18*(8 August), 1–17. https://doi.org/10.1371/journal.pone.0290320

Murata, M., & Fujii, N. (2022). Control of the spin in a tennis serve focusing on the motion of the upper limb and trunk. *Taiikugaku Kenkyu (Japan Journal of Physical Education, Health and Sport Sciences)*, *59*(2), n/a. https://doi.org/10.5432/jjpehss.14007.e

Novak, D., Sinković, F., Bilić, Z., & Barbaros, P. (2023). The Effects of a Short Virtual Reality Training Program on Dynamic Balance in Tennis Players. *Journal of Functional Morphology and Kinesiology*, *8*(4). https://doi.org/10.3390/jfmk8040168

Palmer, K., Jones, D., Morgan, C., & Zeppieri, G. (2018). Relationship Between Range of Motion, Strength, Motor Control, Power, and the Tennis Serve in Competitive-Level Tennis Players: A Pilot Study. *Sports Health*, *10*(5), 462–467. https://doi.org/10.1177/1941738118785348

Shi, Z., Xuan, S., Deng, Y., Zhang, X., Chen, L., Xu, B., & Lin, B. (2023). The effect of rope jumping training on the dynamic balance ability and hitting stability among adolescent tennis players. *Scientific Reports*, *13*(1), 1–10. https://doi.org/10.1038/s41598-023-31817-z

van Trigt, B., Faneker, E., Leenen, A. J. R., Hoekstra, A. E., & Hoozemans, M. J. M. (2024). Uncovering the hidden mechanics of upper body rotations in tennis serves using wearable sensors on Dutch professional players. *Frontiers in Sports and Active Living*, *6*(January). https://doi.org/10.3389/fspor.2024.1463299

Zemková, E., & Kováčiková, Z. (2023). Sport-specific training induced adaptations in postural control and their relationship with athletic performance. *Frontiers in Human Neuroscience*, *16*(January). https://doi.org/10.3389/fnhum.2022.1007804

Zhang, Y., & Chen, Z. (2024). Kinematic differences in forehand serve-receiving techniques of the male tennis players at low and high-speed serves. *Scientific Reports*, *14*(1), 26586. https://doi.org/10.1038/s41598-024-77564-7

3943-Article Text-16005-1-4-20250529.docx

ORIGINALITY REPORT

18%	10%	5%	12%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Universitas Negeri Jakarta Student Paper	8%
2	journal.universitaspahlawan.ac.id Internet Source	1%
3	journal.unnes.ac.id Internet Source	1%
4	jurnal.stokbinaguna.ac.id Internet Source	1%
5	journal.unj.ac.id Internet Source	1%
6	Submitted to University of Chichester Student Paper	1%
7	Submitted to Mount Vernon City School District Student Paper	1%
8	scindeks-clanci.ceon.rs Internet Source	<1%
9	journals.plos.org Internet Source	<1%
10	tmfv.com.ua Internet Source	<1%
11	James E. Maddux. "Subjective Well-Being and Life Satisfaction - A Social Psychological	<1%

Perspective", Routledge, 2024
Publication

12	download.atlantis-press.com Internet Source	<1%
13	perpustakaan.poltekkes-malang.ac.id Internet Source	<1%
14	Walter Ho. "Quality Physical Education - Global Perspectives", Routledge, 2025 Publication	<1%
15	pmc.ncbi.nlm.nih.gov Internet Source	<1%
16	stokbinaguna.ac.id Internet Source	<1%
17	www.kif.unizg.hr Internet Source	<1%
18	Muslimin Muslimin, Wawan Krismanto, Ummul Khaeriyah. "The Effect of the Puzzle-Media-Assisted Problem-Based Learning Model on the Science Learning Activity of Class V Students", Journal of Education and Computer Applications, 2025 Publication	<1%

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	On		