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Effectiveness of Tennis Ball Dropping Machine in Improving Forehand and Backhand Training for Tennis Court Athletes in West Tanjung Jabung

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ABSTRACT

This study aims to determine the effectiveness of the tennis ball dropping machine in improving forehand and backhand training performance among tennis court athletes in West Tanjung Jabung Regency. This quantitative research employed a pre-test and post-test design with 20 tennis athletes from West Tanjung Jabung as subjects. The research was conducted over five sessions from May to June 2025 at the West Tanjung Jabung tennis court. Data collection utilized forehand and backhand groundstroke skill tests designed by Ngatman with validity coefficients of 0.907 and 0.895, respectively. Statistical analysis employed a paired sample t-test and N-Gain analysis using SPSS. The results showed significant improvements in both stroke techniques. Forehand performance increased from 2.065 to 2.670 ($t = -6.027$; $p < 0.001$), while backhand performance improved from 1.840 to 2.535 ($t = -7.862$; $p < 0.001$). N-Gain analysis revealed 20.64% improvement for forehand and 22.34% for backhand, both categorized as low improvement but statistically significant. The tennis ball dropping machine proves effective as a training aid for developing fundamental stroke techniques. This technology-based approach provides consistent ball delivery, enhanced focus, and structured practice sessions that benefit tennis skill development programs.

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B. Acquisition of data;
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INTRODUCTION

Tennis is recognized as one of the most demanding sports requiring comprehensive physical conditioning, technical mastery, tactical understanding, and mental resilience (Bangun, 2016). The sport demands exceptional coordination and precise execution of fundamental techniques, particularly forehand and backhand strokes, which constitute the foundation of effective tennis performance. According to Maulidin et al. (2021), tennis is a sport that can be played by individuals of all genders and age groups, requiring extensive skill development and physical conditioning. The complexity of tennis movements necessitates systematic training approaches that

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emphasize both technical proficiency and consistent practice to achieve optimal performance outcomes (Sukadiyanto, 2005).

Contemporary tennis coaching has increasingly focused on the development of innovative training methodologies that enhance learning efficiency and skill acquisition. Traditional manual training methods, while effective, often present limitations in terms of consistency, accuracy, and training intensity. Coaches typically rely on manual ball feeding techniques during practice sessions, which can result in irregular ball trajectories, inconsistent timing, and variable training conditions that may hinder optimal skill development (Syahroni et al., 2020). The need for more structured and systematic training approaches has led to the exploration of technology-assisted training devices that can provide consistent and controlled practice environments for athletes.

Recent studies in sports technology have demonstrated the potential benefits of mechanical training aids in skill acquisition and performance enhancement (Kovacs et al., 2020). Training devices that provide consistent ball delivery have shown promise in improving technical proficiency by allowing athletes to focus on specific movement patterns without the variability inherent in manual feeding methods. However, limited research has been conducted specifically on the effectiveness of tennis ball dropping machines in developing fundamental stroke techniques among competitive tennis players (Nurhidayat, 2012). The gap between traditional training methods and technology-assisted approaches presents an opportunity to investigate more effective training strategies for developing forehand and backhand techniques.

This research aims to evaluate the effectiveness of a tennis ball dropping machine in improving forehand and backhand training performance among tennis athletes in West Tanjung Jabung Regency. The study seeks to compare training outcomes between manual ball feeding methods and the use of the tennis ball dropping machine, examining the specific technical improvements achieved through this technology-assisted training approach. Based on the theoretical framework established by Yam and Taufik (2021) regarding research hypothesis development, this study hypothesizes that tennis ball dropping machine training will significantly improve stroke performance compared to manual training methods. The novelty of this research lies in its systematic evaluation of a locally developed training device and its application within the Indonesian tennis development context.

METHODS

This study employed a quantitative research design using a pre-test and post-test experimental approach with a single-group design. The research was conducted to examine the effectiveness of tennis ball dropping machine training compared to manual training methods through systematic measurement and statistical analysis. The design was selected to provide a controlled comparison of performance outcomes before and after the implementation of the training intervention.

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The research was conducted from May to June 2025 at the tennis court facility in West Tanjung Jabung Regency. The study population consisted of all junior and senior tennis athletes affiliated with PELTI (Indonesian Tennis Association) West Tanjung Jabung. Using a total sampling technique, 20 active tennis athletes were selected as research subjects, representing the entire accessible population of competitive players in the region. Inclusion criteria included active membership in the tennis program, willingness to participate in the research, and availability throughout the study period.

Data collection utilized the Sport Skill Tennis Test developed by Ngatman (1999, revised 2017), specifically employing the forehand groundstroke test and backhand groundstroke test. The forehand groundstroke test demonstrated validity and reliability coefficients of 0.907 and 0.908, respectively, while the backhand groundstroke test showed validity and reliability values of 0.895 and 0.925. Each test required participants to execute 10 strokes toward designated target areas, with scoring based on accuracy and ball placement within specific zones valued from 1 to 5 points.

Statistical analysis was conducted using SPSS software, employing normality testing through the Shapiro-Wilk test, followed by a paired sample t-test to determine significant differences between pre-test and post-test results. N-Gain analysis was utilized to calculate the effectiveness percentage of the training intervention. The tennis ball dropping machine used in this study was a locally developed device capable of consistent ball delivery at predetermined heights and intervals, designed to provide standardized training conditions for stroke development.

RESULTS AND DISCUSSION

Normality Test Results

The normality test was conducted using the Shapiro-Wilk test to determine the distribution of data before hypothesis testing. For forehand performance, the test yielded a significance value of 0.558 ($p > 0.05$), indicating that the data were normally distributed. Similarly, for backhand performance, the significance value was 0.889 ($p > 0.05$), confirming normal distribution of the data. These results satisfied the prerequisite for parametric statistical testing, allowing the use of a paired sample t-test for hypothesis testing. The normal distribution of data ensures the validity and reliability of subsequent statistical analyses performed in this study.

Forehand Performance Outcomes

The statistical analysis revealed significant improvements in forehand performance following the implementation of tennis ball dropping machine training. Pre-test results showed a mean score of 2.065 (SD = 0.5050), while post-test measurements demonstrated substantial improvement to 2.670 (SD = 0.6208). The paired sample t-test yielded a t-value of -6.027 with 19 degrees of freedom and a significance level $p < 0.001$, indicating statistically significant improvement in forehand technique performance. The mean difference of -0.6050 represents a notable enhancement in stroke accuracy and consistency among the participants.

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Table 1.
Forehand Performance Comparison

Measurement	Mean	Standard Deviation	t-value	Significance
Pre-test	2.065	0.5050	-6.027	$p < 0.001$
Post-test	2.670	0.6208		
Mean Difference	-0.6050			

The N-Gain analysis for forehand performance revealed an average improvement of 0.21 with a percentage gain of 20.64%, categorized as low improvement but statistically significant. Individual performance varied considerably, with the highest N-Gain achieved by Ashabul Yamin (0.58, moderate category, 58% improvement) and the lowest by Xena (0.029, low category, 2.9% improvement). The range of improvement scores demonstrates individual differences in response to the training intervention. Despite the variation, the majority of participants showed improvement in their forehand technique performance following the use of the tennis ball dropping machine.

Backhand Performance Outcomes

Backhand performance analysis demonstrated even more pronounced improvements compared to forehand results. The pre-test mean score of 1.840 (SD = 0.4272) increased significantly to 2.535 (SD = 0.5659) in the post-test measurements. Statistical analysis yielded a t-value of -7.862, with a significance level of $p < 0.001$, indicating a highly significant improvement in backhand stroke performance. The mean difference of -0.6950 represents a substantial enhancement in technical execution and accuracy. The larger improvement margin in backhand compared to forehand suggests differential training effects of the tennis ball dropping machine on different stroke types.

Table 2.
Backhand Performance Comparison

Measurement	Mean	Standard Deviation	t-value	Significance
Pre-test	1.840	0.4272	-7.862	$p < 0.001$
Post-test	2.535	0.5659		
Mean Difference	-0.6950			

The N-Gain analysis for backhand performance showed an average improvement of 0.22 with a percentage gain of 22.34%, slightly higher than forehand improvements but still categorized as low improvement. The highest individual improvement was achieved by M. Ade Jafriyadi L (0.42, moderate category, 42.1% improvement), while Xena showed no improvement (0.00, 0% improvement). The results indicate that 19 out of 20 participants demonstrated improvement in backhand performance. The overall improvement trend confirms the effectiveness of the tennis ball dropping machine in enhancing backhand stroke technique among the study participants.

Discussion

Effectiveness of Tennis Ball Dropping Machine Training

The effectiveness of the tennis ball dropping machine can be attributed to several key factors that differentiate it from traditional manual training methods, as described in previous research (Evita, 2020). The device provides consistent ball delivery at

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predetermined intervals and heights, eliminating variability in ball trajectory and timing that characterizes manual feeding. This consistency allows athletes to develop muscle memory and proper technique execution through repetitive practice under controlled conditions. Additionally, the machine enables higher training intensity with minimal rest periods between ball deliveries, maximizing practice efficiency and skill development opportunities within limited training sessions (Nurhidayat, 2012). The systematic approach provided by the machine creates optimal conditions for motor learning and skill acquisition.

The research findings align with motor learning principles that emphasize the importance of consistent practice conditions for skill acquisition. According to Kovacs et al. (2020), consistent ball delivery systems enhance the development of proper movement patterns and timing in tennis stroke execution. The tennis ball dropping machine creates an optimal learning environment by providing predictable stimulus patterns that allow athletes to focus on technique refinement rather than ball anticipation. This controlled environment facilitates the development of proper movement patterns and timing, which are essential components of effective tennis stroke execution as noted by Sukadiyanto (2005). Furthermore, the device enables independent practice sessions, allowing athletes to engage in self-directed training that complements coach-supervised instruction and accelerates skill development processes.

Comparative Analysis of Stroke Development

The differential improvement between forehand and backhand strokes provides important insights into the specific benefits of tennis ball dropping machine training. The greater improvement observed in backhand performance (22.34%) compared to forehand (20.64%) may be attributed to the inherent complexity and difficulty of backhand stroke execution. Williams and Hodges (2020) suggest that more complex motor skills tend to show greater improvement when practice conditions are optimized and variability is reduced. The tennis ball dropping machine appears to address specific challenges in backhand development by eliminating timing uncertainties and allowing focused attention on technique refinement (Universitas Muhammadiyah Surakarta et al., 2021). The consistent ball placement enables athletes to concentrate on proper grip, body positioning, and follow-through execution without the additional cognitive load of anticipating ball trajectory variations.

The individual variation in improvement rates observed across participants reflects the multifactorial nature of skill acquisition in tennis as discussed by Zemková and Hamar (2021). Individual differences in initial skill level, learning capacity, and adaptation rate significantly influence training outcomes. Athletes with lower initial performance levels demonstrated greater improvement potential, while those with higher baseline skills showed more modest gains. This pattern is consistent with the ceiling effect commonly observed in skill acquisition research, where highly skilled individuals require more intensive or specialized interventions to achieve measurable improvements. The tennis ball dropping machine proves particularly beneficial for intermediate-level players

who have mastered basic techniques but require consistent practice conditions to refine their stroke mechanics.

Implications for Tennis Training Methodology

The significant improvements observed in both forehand and backhand performance support the integration of technology-assisted training devices in tennis coaching programs as advocated by modern sports education approaches (Marisyah & Firman, 2019). The tennis ball dropping machine offers several advantages over traditional manual feeding methods, including consistency, repeatability, and the ability to maintain high training intensity throughout practice sessions. These benefits align with contemporary sports training principles that emphasize deliberate practice and systematic skill development. Coaches can utilize this technology to create structured training environments that complement traditional coaching methods and enhance overall training effectiveness, particularly in regions where access to advanced training facilities may be limited.

The research findings also highlight the importance of individualized training approaches that consider the specific needs and skill levels of different athletes, supporting the educational philosophy that recognizes individual differences in learning and development. While the overall results demonstrate positive training effects, the variation in individual responses suggests that optimal training protocols may need to be customized based on athlete characteristics and performance goals. Future implementations of tennis ball dropping machine training should consider factors such as training frequency, session duration, and integration with other training modalities to maximize effectiveness. Additionally, the technology should be viewed as a supplementary tool that enhances rather than replaces traditional coaching methods, maintaining the essential human element in tennis instruction and development as emphasized in sports coaching literature.

CONCLUSION

This research demonstrates that the tennis ball dropping machine effectively improves forehand and backhand training performance among tennis athletes in West Tanjung Jabung Regency. Statistical analysis revealed significant improvements in both stroke techniques, with forehand performance increasing from 2.065 to 2.670 ($p < 0.001$) and backhand performance improving from 1.840 to 2.535 ($p < 0.001$). Although N-Gain analysis indicated low-category improvements (20.64% for forehand, 22.34% for backhand), the statistical significance demonstrates the device's effectiveness in enhancing technical skill development. The research confirms that technology-assisted training methods can provide superior outcomes compared to traditional manual training approaches through consistent practice conditions and structured skill development opportunities.

The findings have important implications for tennis coaching and training program development. Coaches and tennis facilities should consider integrating tennis ball

dropping machines into their training protocols to enhance skill acquisition and practice efficiency. However, the research limitations include the relatively short intervention period and small sample size, suggesting that future studies should examine longer-term effects and include larger, more diverse populations. Additionally, research comparing different types of training devices and their specific applications for various skill levels would provide valuable insights for optimizing technology-assisted tennis training programs.

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