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Enhancing Agility in Young Tennis Athletes: The Impact of Holistic Forehand Groundstroke Training for Ages 16 to 18

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Abstract Training models commonly used by athletes can sometimes lead to boredom and a decrease in motivation, which in turn affects their performance. Therefore, it is crucial to implement training variations that not only provide physical benefits but also enhance technical skills. This study aims to explore the impact of forehand training with a holistic approach on improving agility in tennis athletes over a period of six weeks. The research utilized a quasi-experimental design featuring a pre-test and post-test control group model, allowing for a comprehensive analysis of the intervention's effectiveness. The sample consisted of 11 tennis athletes in the experimental group and 11 in the control group, selected through purposive sampling based on criteria of age (14-18 years) and technical proficiency. The forehand training program included 10 models with a holistic approach, which were certified as suitable for use in training programs. The tool used to measure agility was the shuttle run test (4 x 10 meters), effective for assessing improvements in motor capacity. Data analysis involved descriptive statistics, tests for normality and homogeneity, and the Mann-Whitney test comparing the *Post-Test* results between the experimental and control groups. The results indicate that the forehand training model with a holistic approach significantly improved agility in tennis athletes aged 14-18 after six weeks of training, with a p-value <0.05. The Mann-Whitney test comparing the *Post-Test* results between the experimental and control groups yielded U = 20.5 and p-value = 0.009 ($p < 0.05$). This indicates a significant difference between the *Post-Test* results of the experimental group, which used the holistic approach, and the control group, which used standard training. The significant difference in *Post-Test* scores between the two groups suggests that the holistic training approach had a significantly different effect on agility improvement compared to the standard training approach applied in the control group.

Keywords Forehand, Holistic Approach, Agility

1. Introduction

Tennis is a sport that can be played solo or with a partner, where the main goal is to hit the ball over the net in a way that prevents the opponent from returning it. Although the objective of the game appears straightforward, tennis is

highly complex in terms of its physical demands. The sport has evolved into one of the most physically demanding in terms of fitness conditioning. In addition to requiring advanced technical skills, tennis also demands a range of other physical components, including strength, endurance, speed, agility, the ability to perform repetitive sprints, and robust aerobic and anaerobic metabolism [1], [2].

This research seeks to bridge the gaps in tennis training by creating a comprehensive model that incorporates all key components necessary for peak performance [3], [4]. The primary focus is on creating a comprehensive training model for the forehand stroke, exploring how physical conditioning can be effectively merged with technical training to boost agility, speed, and overall performance [3], [5], [6], [7]. The primary focus is on creating a comprehensive training model for the forehand stroke, examining how physical conditioning can be successfully combined with technical training to improve agility, speed, and overall performance [8], [9], [10].

Even though there has been extensive research on the physical and technical requirements of tennis, there is a notable gap in studies focusing on a holistic training approach that integrates all aspects of optimal performance [11], [12], [13]. Many existing studies emphasize either physical conditioning or kinematic aspects of sports, frequently overlooking the integration of these elements into a cohesive training model [14], [15], [16]. There is a pressing need for improved integration between physical and technical training to support the holistic development of athletes. Furthermore, more in-depth research is needed to evaluate the impact of specific training models, such as those targeting the forehand stroke, on enhancing the physical and technical abilities of junior athletes.

This research highlights the significance of creating a holistic approach to forehand training, with a particular emphasis on enhancing athletes' agility and responsiveness during matches. This emphasis is increasingly relevant given the recent decline in performance observed among athletes from Nusalima Tennis Academy Pekanbaru. This decline is evident from their low national rankings and the difficulties they face in the early stages of tournaments, indicating an urgent need for improvement. One major contributing factor may be the athletes' limited agility, particularly in their ability to respond quickly and effectively to balls coming from various directions on the court.

In this context, a holistic approach is viewed as a comprehensive solution to address these issues. The training model developed in this research aims to integrate various physical and technical aspects into forehand training, including strength, speed, and coordination. This training is designed not only to enhance the forehand technique but also to improve the athletes' ability to handle dynamic and fast-paced situations on the court.

By implementing this training model, it is hoped that athletes will improve their reaction speed, shot accuracy, and overall agility across the court. This research will also assess the effectiveness of this training model in enhancing athletes' performance in actual match conditions, with the expectation that the results will contribute significantly to better tennis training strategies in the future.

2. Materials and Methods

This study introduces seven forehand training models based on a basic holistic approach specifically designed for tennis courts. The study utilizes shuttle run4x10 M Agility Test to measure agility. Below is an outline of the forehand training program with a holistic approach, featuring 10 training models.

This program aims to improve forehand technique while enhancing agility and physical conditioning through a holistic approach over a 6-week period. Key elements such as intensity, volume, repetitions, and rest are progressively structured, following established training principles to promote comprehensive athletic development.

Holistic Elements in the Training Program

1. Intensity and Volume: Intensity and volume are gradually increased to build technical skill and physical conditioning. The program begins with lower intensity (40-50%) in the initial weeks, providing a technical foundation and minimizing fatigue risk. By the final weeks, intensity reaches up to 70%, challenging the athlete to maintain consistent forehand technique under increased demands. This progression aligns with the progressive overload principle [17], which advocates for incremental load increases to optimize physical adaptation.
2. Rest and Density: Each set includes a 1-2 minute rest interval with a 5-minute break between sessions, maintaining balanced training density. This approach allows athletes to perform with maximum energy and precision. As recommended by the American College of Sports Medicine [18], structured rest intervals based on intensity and volume are essential for optimal recovery and performance.
3. Agility Development through Forehand Technique: Combining forehand drills with lateral and transitional movements enhances agility as a natural result of technical training. This program reflects a holistic approach to improving both technical ability and agility, as supported by Fleck, et al. [19] in their Skill-Based Training framework.
4. 6-Week Training Structure.

Table 1. Groundstroke Forehand with Holistic Approach

Week	Session	Drill Type	Sets	Repetitions	Intensity	Rest Between Sets
1-2	01-Jun	Forehand Drill: Low/High Balls, Cross/Straight	3	8-10	40-50%	1-2 minutes
3-4	07-Dec	Forehand Drill: Across Net, Baseline, Return	03-Apr	10-12	50-60%	1-2 minutes
5-6	13-16	Forehand & Backhand Drill: Moving Forward, Evaluation	4	12-15	60-70%	1-2 minutes

This holistic approach enables simultaneous improvements in forehand technique and agility over a 6-week training period. The program's progressive increase in intensity and volume, combined with structured rest, supports both physical conditioning and skill development, reflecting principles endorsed by experts like [20] for effective, sustainable training

This research utilizes an experimental method with a one-group pretest-posttest design. This approach is employed to examine cause-and-effect relationships or to assess the impact of an intervention and effect or the influence of other variables [21].

Table 2. Research Design

	Pre Test	Exercise	Post Test
Experiment	O1	X1	O2
Control	O2	X2	O4

The population for this study consisted of eleven tennis athletes from the Academy tennis Nusalima Pekanbaru; the Experiment group training model forehand with holistic approach consists of 1) Forehand Drill: Low/High Balls, Cross/Straight, 2) Forehand Drill: Cones, One Direction, Left Side, Low/High, 3) Forehand Drill: Cones, Left/Right, Low/High, 4) Forehand Drill: Across Net, Cones, Baseline, Right Side, 5) Forehand Drill: Across Net, Cones, Return, Baseline, Left Side, 6) Forehand Drill: Across Net, Cones, Return, Baseline, Left Side, 7) Forehand Drill: Across Net, Cones, Baseline, Left Side, 8) Forehand & Backhand Drill: Baseline, Moving Forward, Straight/Cross, 9) Forehand & Backhand Basket Drill: Baseline, Straight Balls, Moving Forward, 10) Forehand & Backhand Drill: Left/Right, Close/Distant Balls. Eka Tennis Club Pekanbaru for control group uses traditional training model. The entire population was sampled using a total sampling technique. The research instrument employed which quantitatively measures agility, alongside the shuttle run4x10 M Agility Test.

Data collection utilized both pretest and posttest methods, with the pretest conducted at the beginning of the intervention period and the posttest at the end, specifically after the 16th session. Quantitative analysis was performed using statistical tests. The procedure involved calculating the mean and standard deviation for each test, conducting the Lilliefors normality test, and performing a t-test to assess differences in sample means. The following outlines the research procedure.

3. Results

After selecting the sample for this study, an initial test (pre-test) was conducted using agility tests. This pre-test aimed to gather baseline data to assess whether there was any improvement in agility after the training program. The training was carried out over 16 sessions (6 weeks), with sessions occurring three times a week—on Wednesdays, Saturdays, and Sundays. The training was followed by a final test (post-test). The data from both the initial and final tests for the experimental group are summarized below:

Table 3. Distribution Frequency Data Recapitulation Pre Test and Post Test Agility Experiment Group

Agility (s)	Frequency pre test		Frequency post test		Category
	(Fi)	(%)	(Fi)	(%)	
< 12,10 S	0	0,00%	1	9	Excellent
12,11 - 13,53 S	5	45,45	6	55	Good
13,54 - 14,96 S	5	45,45	4	36	Satisfactory
14,97 - 16,39 S	1	9,09	0	0	Fair
> 16,40 S	0	0,00%	0	0	Poor
Total	11	100%	11	100%	

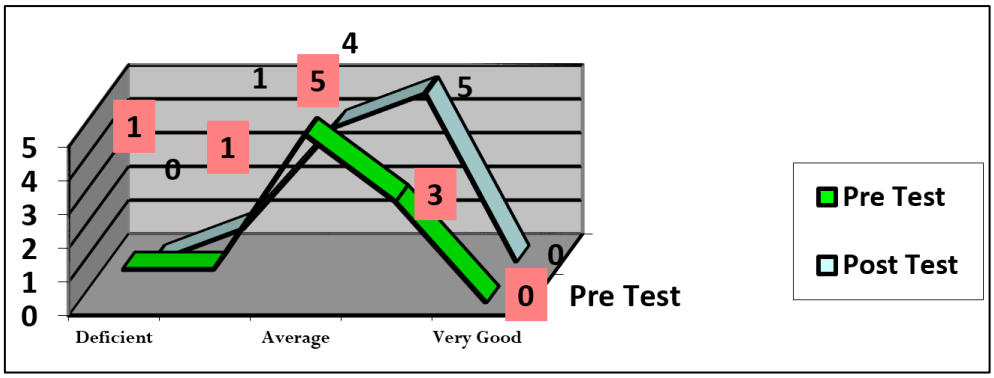

Figure 1. Pretest and Posttest Agility Experiment Group

Table 4. Distribution Frequency Data Recapitulation Pre Test and Post Test Agility Control Group

Agility (s)	Frequency pre test		Frequency post test		Category
	(Fi)	(%)	(Fi)	(%)	
< 12,10 S	0	0,00%	0	0	Excellent
12,11 - 13,53 S	2	18,18	3	27	Good
13,54 - 14,96 S	8	72,73	8	73	Average
14,97 - 16,39 S	1	9,09	0	0	Fair
> 16,40 S	0	0,00%	0	0	Poor
Total	11	100%	11	100%	

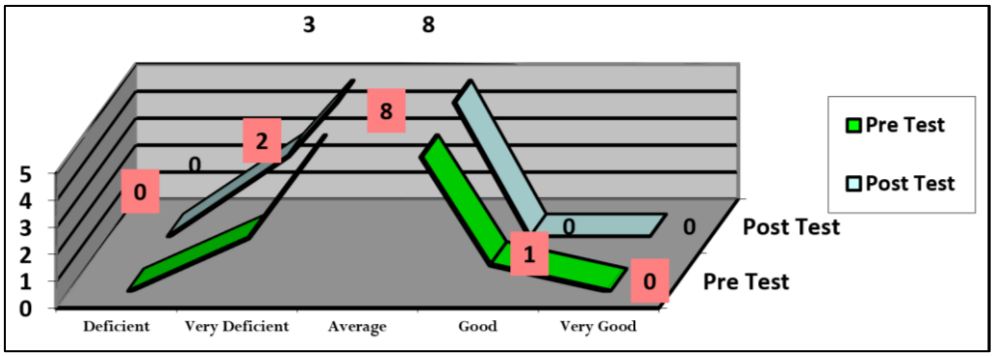

Figure 2. Pretest and Posttest Agility Control Group

Before testing the proposed hypothesis, the data analysis requirements are first evaluated, starting with the assessment of data normality for each variable using the Liliefors test. For further details, refer to Table 5.

Table 5. Summary of Data Distribution Normality Test

No	Variable	N	Lh	Ltab	Distribution
1	Pre test Experiment	11	0,1245	0,249	Normal
2	Pre test Control	11	0,1085	0,249	Normal
3	Post test Experiment	11	0,1596	0,249	Normal
4	Post test Control	11	0,1188	0,249	Normal

Table 5 indicates that the normality test results for the post-test data reveal that the sample group, which received Forehand Drive training, is drawn from a normally distributed population. After performing a normality test on the data, the next analytical requirement is to conduct a test for homogeneity of variance. In this study, the homogeneity of variance test is applied to the forehand ability data from two different sample groups: the experimental group and the control group. The homogeneity of variance between the two sample groups is assessed by calculating the F-Ratio, which is the ratio of the largest variance to the smallest variance of the groups by dividing the largest variance by the smallest variance. The result is then compared with the F-table value at a significance level of $\alpha = 0.05$. Details of the results from the homogeneity of variance test can be seen in the following Table 6:

Table 6. Homogeneity of Variance Test for 22 Sample

Group	Mean	Varian	F Hitung	α	F tabel	Test Results
Pre test	14,19	0,649	1,45			Sig.
Post Test	13,85	0,539		0,05	2,35	

The homogeneity of variance index between the tested groups (Fh) is 1.45, while the F-table value (Ft) at a significance level of $\alpha = 0.05$ is 2.98. Therefore, Fh < Ft, which means that the two variances are homogeneous. It means that both groups come from homogeneous groups.

Statistical Description for Experimental and Control Groups

This study aims to analyze the effectiveness of a holistic approach in improving agility by comparing the *Post-Test* results between the experimental and control groups.

Experimental Group: *Pre-Test* mean score: 13.56 with a standard deviation of 0.737, *Post-Test* mean score: 13.11 with a standard deviation of 0.630. Control Group: *Pre-Test* mean score: 14.19 with a standard deviation of 0.649. *Post-Test* mean score: 13.85 with a standard deviation of 0.539. From these results, it is observed that both the experimental and control groups experienced a slight decrease in average agility scores from *Pre-Test* to *Post-Test*. However, to determine if this decrease is significant in terms of improving agility, further statistical tests were conducted.

Intra-Group Mann-Whitney Test (Pre-Test vs. Post-Test): In the experimental group, the Mann-Whitney test results between *Pre-Test* and *Post-Test* yielded U = 82.0 and p-value = 0.168 ($p > 0.05$). This indicates that there was no significant difference between *Pre-Test* and *Post-Test* scores within the experimental group. Therefore, the holistic approach has not shown a significant improvement in agility within the experimental group when compared internally. In the control group, the Mann-Whitney test results between *Pre-Test* and *Post-Test* yielded U = 79.5 and p-value = 0.224 ($p > 0.05$). Similar to the experimental group, this result indicates no significant difference between *Pre-Test* and *Post-Test* scores in the control group.

Inter-Group Mann-Whitney Test (Post-Test Experimental Group vs. Post-Test Control Group): The Mann-Whitney test comparing the *Post-Test* results between the experimental and control groups yielded U = 20.5 and p-value = 0.009 ($p < 0.05$). This indicates a significant difference between the *Post-Test* results of the experimental group, which used the holistic approach, and the control group, which used standard training. The significant difference in *Post-Test* scores between the two groups suggests that the holistic training approach had a significantly different effect on agility improvement compared to the standard training approach applied in the control group.

Interpretation of Results: Although no significant difference was found between *Pre-Test* and *Post-Test* within each group independently, the comparison between the *Post-Test* results of the two groups shows a significant difference. This finding suggests that the holistic approach has a distinct effect on improving agility compared to the standard training applied to the control group. The significant difference in the inter-group test shows that the experimental group, which received the holistic approach, demonstrated better performance improvement compared to the control group.

4. Discussion

The findings of this study support the theory that forehand drive training can markedly improve both the technical and physical abilities of tennis players. According to Dufresne [22] in his book *"The Science of Tennis,"* specific drills like the forehand drive are designed to improve neuromuscular adaptations, which are crucial for increasing the speed and efficiency of the forehand stroke. This training, which involves repetitive movements, strengthens the muscles involved in the forehand stroke while enhancing overall coordination and reaction time. Reid, et al. [3] emphasize that a holistic approach, which integrates both physical and technical aspects, not only boosts performance but also reduces the risk of injury by ensuring a balance between strength training and technical skill development.

The study by Selmi, et al. [23] also demonstrates that intensive and focused training can significantly impact physical parameters such as speed, agility, and endurance in tennis players. This aligns with the training periodization theory proposed by Bompa, et al. [20], which highlights the importance of a structured training approach to achieve optimal adaptation and performance. By incorporating periodization principles, forehand drive training can be integrated into a continuous training program to support long-term athlete development. Dom ńguez, et al. [10] highlight that a comprehensive training approach, which includes periodization and ongoing adaptation, supports the overall development of athletes by addressing strength, coordination, and game strategies simultaneously.

Additionally, Pluim, et al. [24] in *"Health Benefits of Tennis"* outline how regular tennis practice, including forehand drive training, can improve aerobic and anaerobic capacity and strengthen the cardiovascular system. This suggests that tennis training, in general, contributes to better heart and lung health, beyond just technical and

physical benefits. Fleming, et al. [9] stress the importance of tailoring training to the individual needs of athletes, particularly junior players who are still in developmental stages. This approach ensures that training is not only beneficial for general health but also effective in addressing the specific needs of each athlete.

Brown, et al. [25] note that specialized forehand training can enhance hand-eye coordination and stroke efficiency, which in turn reduces the likelihood of technical errors and injuries. This focus on refining technique is crucial for minimizing injury risk associated with technical mistakes and improving overall performance. This research also supports the findings of Elliott, et al. [26] in *"Biomechanics of Tennis,"* which emphasize that biomechanically focused training can optimize movement efficiency, shot accuracy, and power. By integrating biomechanical principles into forehand drive training programs, athletes can improve their technique and reduce unnecessary stress on their bodies.

Overall, the research confirms that forehand drive training offers significant benefits in enhancing the technical and physical abilities of tennis players. Improvements in speed, agility, stroke efficiency, and accuracy demonstrate the effectiveness of this method. With consistent evidence supporting the broad benefits of this training, it is highly recommended to incorporate it as a core component of tennis training programs to enhance athlete performance and reduce injury risks. A holistic and comprehensive approach, as suggested by experts, can further enhance the effectiveness of training and support successful long-term development on the tennis court.

5. Conclusions

The statistical test results support the hypothesis that the holistic approach has a significant effect on improving agility compared to the standard training method. The holistic approach can be considered more effective in enhancing agility within the experimental group, although this impact is more evident when directly compared with the control group.

This study provides a basis for implementing the holistic approach in agility training programs, showing that this method can offer more substantial benefits than conventional approaches.

In conclusion, adopting a holistic approach to tennis training offers significant benefits. Integrating physical and technical aspects into tennis practice not only enhances player performance but also reduces the risk of injury by ensuring a balance between physical conditioning and technical skill development. A comprehensive training model supports overall player development by addressing crucial elements such as agility, coordination, and game strategy, while also tailoring training to individual needs, especially for players still in their developmental stages.

Recent findings indicate that a six-week holistic forehand training program significantly improves agility in tennis players aged 14-18. This program, which includes ten training models, effectively enhances both technical skills and physical conditioning, including quick movement and responsiveness on the court. The success of this approach highlights the importance of a thorough training model in improving technical abilities and physical fitness, ultimately providing a competitive edge on the court.

Overall, this research provides valuable insights for optimizing tennis training programs. Future research could explore combining forehand training with other techniques or assess its impact on various aspects of tennis skills to further refine player performance.

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