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The Effect of Core Stability Training on Dynamic Balance in Taekwondo Athletes

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ABSTRACT

Introducing. Dynamic balance is an important ability in sports. In Taekwondo, movement control and changes in direction require strong postural stability. Core stability training aims to improve trunk stability through strengthening exercises that enhance neuromuscular control. However, its effectiveness needs to be empirically proven in Taekwondo athletes.

Methods. This study used a quasi-experimental method with a one-group pre-test and post-test design. The sample consisted of 6 Taekwondo athletes selected using purposive sampling. The instrument used to measure dynamic balance was the Stork Test. The core stability training program was implemented over several sessions. Data were analyzed using descriptive statistics and an inferential test to determine differences between pre-test and post-test.

Result. The results showed a significant improvement in dynamic balance after participating in the core stability training program, as indicated by differences between pre-test and post-test scores with a significance value of $p < 0.05$.

Conclusion. Core stability training has a significant effect on improving dynamic balance in Taekwondo athletes. This program can be used as part of training to support technical performance, movement efficiency, and injury prevention. Further studies are recommended to use larger samples and longer training durations to strengthen the generalization of the findings.

1. Introduction

Dynamic balance is one of the essential components in enhancing Taekwondo athletic performance. As a martial art that emphasizes kicking techniques, rotations, jumps, and rapid changes of direction, Taekwondo athletes must be able to maintain optimal body stability while performing movements. The ability to maintain balance when the body is in unstable positions is a determining factor in the successful execution of kicking techniques such as dollyo chagi, yeop chagi, and tornado kick, which require good postural control. Hidayat (2019) explained that balance is the ability to maintain body position to avoid falling in both static and dynamic conditions and is strongly influenced by sensory function, somatosensory input, and postural muscle strength.

In the world of competitive sports, particularly martial arts, dynamic balance not only determines technical accuracy but also affects energy efficiency and injury prevention. For

example, insufficient stability during kicking movements can cause uncontrolled body rotation and increase the risk of ankle, knee, and hip injuries. Therefore, the development of training programs focused on improving body stability is urgently needed in the training of Taekwondo athletes.

One effective form of exercise to improve body stability is core stability training. The concept of core stability refers to the ability of the core muscles, which include the abdominal muscles, lower back muscles, pelvic muscles, and muscles surrounding the spine, to control posture and trunk movement (Kibler, Press, & Sciascia, 2006). The core functions as the center of stabilization that connects upper and lower limb movements, thus influencing balance, strength, and coordination simultaneously. When the core muscles are weak, the body has difficulty maintaining its center of gravity in an effective position, which can disrupt dynamic balance.

Biomechanical mechanisms of core stability training indicate that strengthening the core muscles can enhance the body's ability to withstand disturbances (perturbations) during fast and explosive movements. During kicking and rotational movements, body stability largely depends on the core muscles' ability to maintain body orientation so that movements remain controlled. This is consistent with the explanation by Kibler et al. (2006), who stated that core stability plays a fundamental role in distributing force, maintaining pelvic stability, and helping the body preserve balance during rapid changes in body position.

Previous studies have shown that core stability training can improve various aspects of physical performance, such as postural strength, coordination, and balance. Putri (2021) found that core stability training significantly improved dynamic balance in pencak silat athletes. Rahman (2020) also reported that core muscle training had a positive effect on body stability in volleyball athletes, particularly during jumping and landing movements. However, there is still limited research that specifically examines Taekwondo athletes, who have movement characteristics different from other martial arts.

The movement characteristics in Taekwondo tend to be more explosive and require greater rotational forces compared to other martial arts. Many kicking techniques in Taekwondo require athletes to lift one leg high while maintaining balance on the supporting leg. This condition increases the demand for core stability, as the core muscles play a vital role in maintaining body position, preventing falls, and avoiding loss of control. Therefore, limited research examining the relationship between core stability training and dynamic balance in Taekwondo athletes provides The limitation of previous studies regarding the specific relationship between core stability training and dynamic balance in Taekwondo athletes provides an important basis for conducting this research.

In addition, current youth athlete development programs still tend to focus primarily on technical training and training intensity without adequately considering supporting components such as core stability. In fact, the quality of kicking techniques and the ability to maintain balance are strongly influenced by the strength and coordination of the core muscles. If coaches emphasize technical training without strengthening the core, athletes are more likely to experience postural instability, faster muscle fatigue, and an increased risk of recurrent injuries.

Based on the above explanation, this study is important to fill the knowledge gap regarding the effectiveness of core stability training in improving the dynamic balance of Taekwondo athletes. This study aims to analyze the effect of core stability training on improving dynamic balance, so that the results can be used as a reference for designing more comprehensive training programs for Taekwondo athletes. The findings of this study are expected to contribute to the development of sports science, particularly in the context of physical training oriented toward improving body stability, movement technique performance, and injury prevention in martial arts athletes.

2. Methods

This study employed a quantitative approach using a quasi-experimental design with a one-group pre-test and post-test model. This design was selected because it allows researchers to compare changes in dynamic balance ability before and after the intervention in the form of core stability training. The study was conducted at the Atma Jaya Taekwondo Club over one week, consisting of three training sessions, each lasting 45–60 minutes. The selection of this location was based on the availability of adequate training facilities and a training schedule compatible with the implementation of the intervention program. The research sample was selected using a purposive sampling technique with criteria including athletes aged 14–20 years, actively participating in training, not currently experiencing any injuries, and willing to participate in the entire intervention program. Based on these criteria, six Taekwondo athletes were selected as research subjects.

The instrument used In this study was the Boat Position Test, which is a core endurance test performed in a seated position with the body forming an angle of approximately 45 degrees while lifting both legs. This test was used to measure core stability and dynamic balance ability. Endurance time was measured using a digital stopwatch, and the testing procedure was conducted twice, namely before and after the intervention. The study began with a preparation phase consisting of an explanation of the research objectives, initial data collection through a pre-test, and preparation of training equipment. Subsequently, the researchers administered a core stability training intervention that included plank series, dead bug, boat pose hold, bird-dog, and bridge variations. Each exercise was performed for 30–45 seconds with three to four sets and short rest intervals between exercises. All exercises were designed to increase core muscle strength and activation, with the expectation of improving athletes' dynamic balance.

After the training program was completed, all participants retook the Boat Position Test using the same procedures. The test results were then analyzed using a Paired Sample T-Test to determine the significance of differences between pre-test and post-test scores.

Data were analyzed by calculating the mean and standard deviation, followed by a normality test to ensure that the assumptions of parametric statistics were met. The results of the analysis were used to draw conclusions regarding the effectiveness of core stability training in improving the dynamic balance of Taekwondo athletes.

3. Results

The results showed significant improvements in both technical skills and physical fitness after the implementation of core stability training. Descriptive analysis indicated an increase in the dynamic balance ability of Taekwondo athletes following participation in the core stability training program. The mean pre-test value represented the athletes' initial dynamic balance ability prior to the intervention, while the post-test mean value reflected dynamic balance ability after the intervention period. This analysis was conducted to observe overall changes in performance before proceeding to inferential statistical testing. The following section presents the descriptive statistical results, including the mean, standard deviation, and p-value, as indicators of the significance of improvements in dynamic balance performance.

Table 1. Pre test and Post test results

Variabel	Mean (detik)	SD (Seconds)	p-value
Pre-Test	**34,67**	**2,16**	***(not applicable)***
Post-Test	**51,33**	**2,94**	**p < 0,0000001**

Based on Table 1, there was a substantial increase in the mean dynamic balance score from 34.67 seconds during the pre-test to 51.33 seconds during the post-test. The relatively small standard deviations in both conditions indicate that the data were homogeneous and that the improvements were consistent across participants. The statistical results demonstrate that core stability training had a highly significant effect on improving dynamic balance, as indicated by a p-value of < 0.000001. These findings confirm that the core stability training program was effective in enhancing body stability, postural control, and dynamic balance ability in Taekwondo athletes.

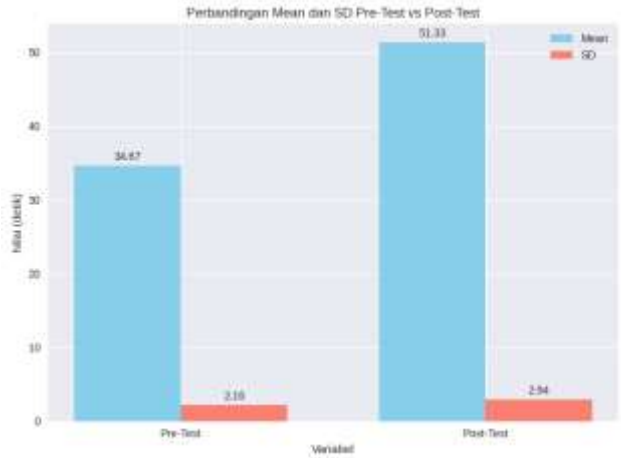

Figure 1. Comparison of Mean and Standard Deviation of Pre-Test and Post-Test

The results of the study revealed a very noticeable difference between the mean time values obtained in the Pre-Test and Post-Test stages. In the Pre-Test, participants recorded an average time of 34.67 seconds with a standard deviation of 2.16. This value indicates that the participants' performance was relatively consistent, with not too large variance among individuals. After the intervention was administered, the Post-Test results showed an increase in the average time to 51.33 seconds with a standard deviation of 2.94. The improvement of 16.66 seconds is not only practically meaningful but is also statistically significant, with a p-value < 0.000001. This very small p-value indicates that the probability of this difference occurring by chance is almost zero, ensuring that the treatment provided truly had an impact on participants' performance.

In addition to the increase in the mean score, the rise in standard deviation from 2.16 to 2.94 shows that Post-Test results were more varied compared to the Pre-Test. This suggests that, although overall performance levels increased, the improvement among participants was not uniform. Some

participants experienced very substantial improvement, while others experienced moderate gains. This variation may be influenced by various factors, such as physical fitness, motivation, previous experience, and the level of understanding of the treatment provided. Therefore, although the trend shows good success of the intervention, further research is needed to identify the factors that influence differences in participant responses.

Overall, these findings provide strong evidence that the intervention was effective in improving participants' performance. The significant improvement, both statistically and practically, shows that the treatment delivered not only affected the average score but also has real implications in field application. However, considering individual variation, it is important for future researchers or practitioners to consider a more personalized approach in implementing similar interventions. Thus, this study not only confirms the effectiveness of the treatment but also opens opportunities for further exploration regarding the factors contributing to individual success in responding to the intervention.

4. Discussion

The findings of this study indicate that core stability exercises have a significant effect on improving dynamic balance in Taekwondo athletes. The increase in average time from 34.67 seconds in the Pre-Test to 51.33 seconds in the Post-Test is an indicator that the ability to maintain body position more stably experienced substantial improvement after the intervention was given. This aligns with the basic concept of core stability, which is the strengthening of the core muscles of the body to improve postural control, balance, and movement efficiency during physical activity.

Physiologically, core stability training works by increasing the activation of major core muscles such as the transverse abdominis, erector spine, internal and external oblique muscles, and pelvic floor muscles, which function as stabilizers of the spine. Optimal activation of these core muscles produces better ability to maintain balance when the body experiences sudden or unexpected disturbances, which frequently occur in Taekwondo. The improvements seen across participants reinforce that the intervention enhanced muscular strength and neuromuscular coordination of the core stabilization system.

The overall increase in performance observed throughout the test period further emphasizes that the intervention effectively improved athletes' physical capabilities. This improvement supports the conclusion that the exercises given successfully increased the stability, strength, and coordination of the core, thereby enhancing dynamic balance in Taekwondo athletes. These findings strengthen the understanding that core stability plays an essential role in achieving optimal performance and minimizing the risk of injury during dynamic movements often performed in

Several factors play an important role in determining improvements in balance. This significant increase has the potential to positively impact athletic performance and reduce the risk of injury, as good balance helps athletes maintain body control when performing complex movements in Taekwondo.

However, the study also shows that the intervention did not have uniform effects on all participants. The presence of individual variation suggests that a more personalized approach may be needed in designing future training programs. Adjustments in intensity, frequency, and training duration based on the characteristics and needs of each athlete may produce more optimal outcomes.

Overall, this study emphasizes that core stability training is effective in improving the dynamic balance of Taekwondo athletes. The improvements observed, both statistically and practically, indicate that the training program can serve as an important method to be applied in athlete development. Further research is recommended to examine the long-term impact of the training program, compare

responses between groups, and evaluate the factors influencing individual levels of response to the intervention.

5. Research Contribution

Muh Said Ramadhan and Muhammad Yusuf Faizal Putra Anas conducted the experiments and developed the research design. Lurjin and Muhammad Aldi were responsible for data collection. Muh. Rizky Bahar was responsible for the analysis and interpretation of the results. All authors participated in the writing and preparation of the final manuscript.

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