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The Effect of Leg Muscle Training Using Rubber Bands on The Kinematic Parameters of Shooting Techniques in Female Soccer Athletes

Intan Anggraini[1]✉, Tono Haryono[2], Iwa Ikhwan Hidayat[3]

Department of Sports Science, Faculty of Sports and Health Education, Universitas Pendidikan Indonesia, Jl.Dr. Setiabudhi No 229 Bandung, 40154, Indonesia[123]

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Abstract

This study aims to analyze the effect of lower body exercises using rubber bands on the kinematic parameters of kicking technique in female soccer players. The method used is a single-group quasi-experimental design with pretest-posttest, involving 10 female soccer players from the Universitas Pendidikan Indonesia who participated in a six-week training program. This design is useful for determining the effect of rubber bands on the lower leg muscles after treatment. Kinematic data were analyzed using Skillspector 1.3, while kicking speed was tested using a paired sample t-test. The results showed an increase in several joint angles, particularly an increase in hip and ankle movement during the preparation and impact phases, as well as a more controlled and efficient follow-through pattern. Joint movements that changed angle a values indicated that treatment with rubber bands affected muscle reactions. An significant increase in kicking speed was also found, rising from 54.71 ± 6.86 km/h to 59.86 ± 8.63 km/h ($p = 0.024$), indicating increased strength and force transfer after training. These findings suggest that rubber band training effectively improves biomechanical efficiency and kicking speed, making it a recommended method for developing kicking skills and treating kicking injuries in female soccer players in Indonesia.

How to Cite

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✉ Correspondence Author:
E-mail: intanggrain21@student.upi.edu

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INTRODUCTION

Shooting is one of the most important basic techniques in soccer that directly determines the outcome of a match. This technique requires good coordination between leg muscle strength, body balance, and movement precision to produce fast, directed, and accurate kicks (Kamaluddin & Abdul Ropi, 2024). To support optimal shooting performance, various training methods have been developed, including the use of tools such as resistance bands, which aim to increase muscle strength and body stability (Ginting et al., 2023). However, the success of shooting is not only determined by the final result in terms of accuracy or kicking power, but also by how efficiently the body moves, which can be analyzed through kinematic parameters (Ekst et al., 2023). A number of studies have proven the effectiveness of training using resistance bands or elastic bands in increasing muscle strength and shooting performance (Pamuk et al., 2022). For example, a study by (Gaamouri et al., 2024) shows that training using elastic bands can increase leg muscle power, which supports the ability to kick a ball. Another study by (Fitriani et al., 2023) concluded that resistance bands can improve physical performance such as balance, agility, and speed. In addition, (Gaamouri et al., 2023) reported a significant increase in futsal shooting results after training with resistance bands. Similar findings were reinforced by Núñez-González et al., (2025), who showed that training with TRX bands for eight weeks improved shooting accuracy and physical strength in youth soccer players (Coşkun et al., 2025). Although many studies have examined the effectiveness of resistance bands in improving physical performance and basic shooting techniques, these studies have focused more on end results, such as kicking accuracy, muscle strength, or performance (Loud et al., 2024). Furthermore, there have been few studies specifically examining how training with rubber bands affects the biomechanical aspects of movement, particularly kinematic parameters such as leg swing angle, movement speed, and body coordination during shooting (Febrianto & Ismalasari, 2018). This gap is important because understanding kinematic parameters can provide a more in-depth picture of the overall efficiency of shooting techniques, not just in terms of final results (Kaya et al., 2025). Therefore, this study aims to explore the effect of shooting training using rubber bands on kinematic parameters as a more innovative approach to effectively developing ball kicking performance (Marzuki & Soemardiawan, 2020).

METHOD

This study applied a quantitative method with a quasi-experimental design of the one-group pretest posttest type (Miller et al., 2020). This design was chosen based on the use of a single experimental group without a control group, so that measurements were made by comparing the results of tests before (pretest) and after (posttest) the treatment. Through this approach, it can be determined to what extent training using rubber bands affects the kinematic parameters of shooting techniques in female soccer athletes. The research sample consisted of 10 athletes from the Indonesian University of Education Women's Soccer Student Activity Unit (UKM) who were selected using purposive sampling. The sample criteria included: (1) aged 18–21 years, (2) actively participating in soccer training for at least the last six months, (3) in good physical condition with no history of lower limb injuries in the last six months, and (4) willing to participate in the entire research process. These characteristics were established to ensure that the respondents involved had relatively the same level of fitness, adequate training experience, and physical conditions that allowed them to safely undergo the research procedures. The research instruments used included a Sony HDR-CX405 handycam, Skillspector software version 1.3, a level 3 rubber band (600 x 50 x 0.7 mm) with a strength of 15-20 lbs, and a variety of shooting exercises. The camera was used to record shooting movements from various angles for kinematic analysis. Skillspector was used to measure and analyze movements by utilizing coordinates extracted from video data. Meanwhile, the Rubber Band was used as an aid during leg muscle training with variations of the Loop-band warm-up program, such as Front, Inside, Side, and Back.

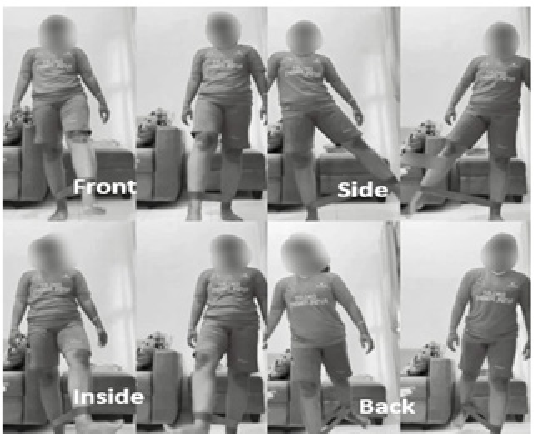

Figure 1. Front, Inside, Side, and Back Movements

The research procedure began with an explanation of the research procedures and obtaining consent from the sample participants. Next, a warm-up was conducted to minimize the risk of injury, followed by a pretest consisting of shooting movements that were recorded using a camera and extracted to Skillspector. After that, the subjects underwent the Loop-band warm-up program treatment, such as Front, Inside, Side, and Back, for 6 weeks (3 times/week), totaling 16 sessions. Immediately after the training, the subjects were asked to perform the landing test (posttest) again using the same procedure as in the pretest.

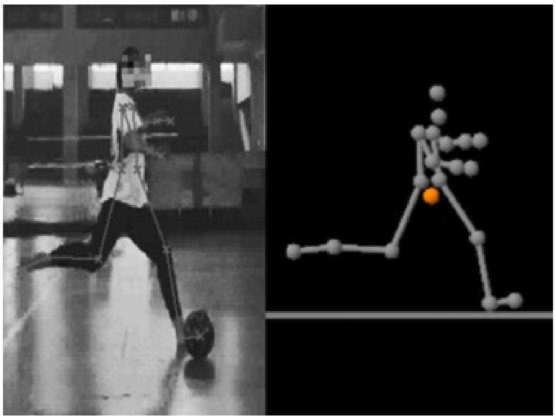

Figure 2. Skill Spector Analysis

The data obtained was analyzed using Skillspector Software version 1.3. The analysis process was carried out by utilizing coordinates extracted from video data to produce numerical outputs from various coordinate angles. Then, descriptive statistical tests were performed using IBM SPSS Statistics software version 22 to calculate the mean, standard deviation (SD), and the difference in scores between the pretest and posttest results for each kinematic variable studied. Furthermore, to determine whether there were significant differences between before and after the treatment, a paired sample t-test with a significance level of 0.05 was used.

RESULTS AND DISCUSSION

Table 1. Anthropometric Data of the Sample

Subject	Height (m)	Body Mass (kg)	BMI (kg/m2)
Average	158	51	20.67
Standard Deviation	3.64	8.16	0.5

Based on the **Table 1**, the data shows the physical characteristics of the ten research subjects, consisting of height, body mass, and body mass index (BMI). The average height of the subjects was 158 cm, with an average body mass of 51 kg and an average BMI of 20.67 kg/m², which is classified as normal according to WHO standards. The height ranged from 150 to 163 cm, while body mass varied from 41 to 69 kg. The lowest BMI value recorded was 15.4 kg/m² and the highest was 29.5 kg/m², indicating variations in nutritional status among subjects ranging from underweight to overweight. In general, these data illustrate that most subjects were in a proportional condition between their height and weight.

Table 2. Address Angle, Impact, and Follow through in Relation to Y (Position)

Variabel	Average Pre-test ± SD	Average Post-test ± SD	Sig. (Pre-Post)
Approach Angle			
Hip Ancang-ancang [Degree]	0.75 ± 0.229	0.76 ± 0.241	+0.01
Knee Ancang-ancang [Degree]	0.45 ± 0.064	0.45 ± 0.071	0.00
Ankle Ancang-ancang [degree]	0.49 ± 0.205	0.52 ± 0.218	+0.03
Impact			
Hip Impact [Degree]	0.74 ± 0.247	0.76 ± 0.236	+0.02
Knee Impact [Degree]	0.51 ± 0.061	0.51 ± 0.090	0.00
Ankle Impact [degree]	0.13 ± 0.078	0.14 ± 0.066	+0.01*
Follow Through			
Hip Follow Through [Degree]	0.68 ± 0.317	0.78 ± 0.237	+0.10*
Knee Follow Through [Degree]	0.66 ± 0.251	0.56 ± 0.291	-0.10*
Ankle Follow Through [degree]	0.65 ± 0.239	0.51 ± 0.310	-0.14*

*Significantly influential

Changes in position angles during the preparatory, impact, and follow-through phases show variations in increase and decrease between the pre-test and post-test. In the preparatory phase, the hip and ankle angles experienced a small increase of +0.01 and +0.03, respectively, indicating an improvement in the initial position of the movement. Meanwhile, the knee angle remained stable without change, and the toe angle actually decreased by –0.02, indicating a slightly lower position at the post-test. In the impact phase, a similar pattern of change was observed, where the hip and ankle angles increased slightly by +0.02 and +0.01, while the knee angle remained unchanged. However, the toe angle decreased slightly by –0.01. The most noticeable change occurred in the follow-through phase. The hip angle experienced the largest increase, namely +0.10, indicating a significant improvement in final motion control. Conversely, the knee, ankle, and toe angles decreased by –0.10, –0.14, and –0.05, respectively, indicating a change in the direction of movement or a technical adjustment that placed these segments in a lower position during the post test.The systematics of the writing section or sequence of results and discussion can be written based on the research questions posed, the findings of the research, or according to the research procedure, especially when the research is in the form of development, for example, using a Research & Development (R&D) model. Information in the form of a table without a direct number is preceded by a description of the table. The following is an example.

Table 3. Analysis of Pre-test and Post-test Shooting Speed

Subject	Pre-test speed (km/h)	Post-test speed (km/h)	Significant
Average ± SD	54,711 ± 6.86	59,862 ± 8.63	0.024*

*Significantly influential

Based on the research results **Table 3**, the data shows a comparison of kicking speed values before and after training using rubber bands on ten female soccer athletes. The average kicking speed value in the pre-test was 54.71 ± 6.86 km/h, while in the post-test it increased to 59.86 ± 8.63 km/h. This increase illustrates an improvement in shooting speed performance after participating in a four-week leg muscle training program using rubber bands. Individually, most subjects experienced an increase in speed, although some showed minimal changes.

The results of the paired sample t-test with a significance value of 0.024 ($p < 0.05$) showed that there was a significant difference between the pre test and post-test results, so it can be concluded that leg muscle training using rubber bands has a significant effect on improving kicking speed parameters in female soccer players.

Leg muscle training using rubber bands has been proven to contribute positively to the quality of shooting technique movements, especially in the preparation phase. Muscle adaptation that occurs after the training program enables athletes to place body segments in a more efficient starting position, especially in the hip and ankle areas, which play a major role in initiating leg swings. This improvement in postural readiness indicates that athletes experience improved neuromuscular control, resulting in better coordination between muscles and joints when initiating the shooting sequence (Ningsih & Hasanudin, 2023). This change reflects improved body stability, which directly affects the quality of subsequent movements.

In the impact phase, the strengthening of the leg muscles from rubber band training appears to help improve stability and body position accuracy when the foot makes contact with the ball. Neuromuscular system adaptation makes athletes better able to maintain balance and optimal position, making the transfer of force from the foot to the ball more effective. The ability to maintain better joint alignment in this phase also indicates that athletes' bodies are becoming more efficient in controlling movements at moments that are crucial in determining the direction and quality of shots (Suryadi, 2022). Increased stability in this phase is very important because it is a crucial point in producing strong and accurate kicks.

In the follow-through phase, the changes observed reflect technical adjustments made after training. Some body segments exhibit a greater range of motion, while others show more concise movement patterns. These changes can be understood as adaptations toward more efficient final movements, where athletes reduce unnecessary compensatory movements after the ball is released. With increased leg muscle strength and stability, the final movement tends to be more controlled and directed (Rovendra, 2020). The efficiency of the follow through is closely related to the body's mechanism of maintaining balance after shooting, enabling athletes to maintain stability and reduce the risk of injury.

Changes in kicking speed reinforce the finding that rubber band- s not only affect movement patterns but also significantly improve functional performance. Increased shooting speed reflects that the transfer of power from the leg muscles to the ball is more optimal after training. This may occur because increased muscle strength promotes more explosive contractions, while improved body coordination allows athletes to direct force more efficiently. Additionally, the increased kicking speed indicates that all phases of the movement from the approach, impact, to the follow-through become more synchronized and integrated, resulting in higher performance output. Thus, rubber band training can be considered effective in enhancing both biomechanical capabilities and shooting performance in female soccer athletes.

CONCLUSION

Based on the results of kinematic analysis in the preparation, impact, and follow-through phases, as well as increased shooting speed, it can be concluded that leg muscle training using rubber bands has a positive effect on the shooting technique of female soccer players. Changes in several joint angle variables indicate improved motion control, body stability, and movement pattern efficiency after participating in a six-week training program. These findings indicate that resistance-based training, particularly with rubber bands, can improve neuromuscular coordination and postural readiness, which play an important role in effective shooting. In addition, the marked increase in kicking speed reinforces that rubber band training not only affects biomechanical aspects but also has a direct impact on the functional performance of athletes. Adaptations in leg muscle strength and stability have been shown to optimize power transfer during kicking, resulting in faster and more powerful kicks. Overall, this study confirms that the use of rubber bands can be an effective and practical training method for improving kinematic parameters and shooting performance in female soccer athletes.

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