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Effects of Nordic Hamstring Exercise on Hamstring Flexibility and Muscle Strength in Futsal Players

I Made Dhita Prianthara, I Putu Astrawan, I Putu Prisa Jaya, Komang Gde Arjuna Surya Negara, I Gusti Made Suandinata Yoga, I.A Pascha Paramurthi

Universitas Bali Internasional, Indonesia
*Correspondence: E-mail: dhitaprianthara@gmail.com

ABSTRACT

Poor hamstring muscle flexibility and strength is one of the most common risk factors for hamstring injuries. The purpose of this study was to determine the Effect of Nordic Hamstring Exercise on hamstring flexibility and strength in futsal players. This study employed experimental method with a one group pre and post-test design. The research sample consisted of 35 people who were given Nordic Hamstring Exercise. Measurement of hamstring flexibility was carried out by using the active knee extension test while the measurement of hamstring muscle strength used a leg dynamometer measured before and after exercise. The results of analysis obtained the mean of flexibility before exercise of 124.74, while the mean after the exercise was 145.94. The hypothesis testing using a paired sample t-test obtained a p value = 0.000. Meanwhile, in terms of hamstring muscle strength, the average flexibility before exercise was 167.63 and after exercise was 184.40 with a p value of 0.000. It can be concluded that Nordic hamstring exercise can increase hamstring flexibility and strength in futsal players in Denpasar city. This study contributes to knowledge regarding increasing hamstring muscle flexibility and strength. Regular implementation of Nordic Hamstring Exercise can serve as an effective strategy to enhance performance of futsal players.

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INTRODUCTION

Sport is an organized physical activity that is carried out to improve a person fitness and physical ability. In its development, sports can be carried out as an entertaining and fun activity as well as a mean of improving achievement. One of the popular sports among teenagers is futsal (Hidayat et al., 2022). Futsal is one of the popular sports for the general public. Each futsal team consists of five players and several regulation variations that are almost identical to football. Futsal is a dynamic sport where players must always move, sprint, and dribble and shoot the ball into the opponent goal (Khurrohman et al., 2021). Because of these elements and the fact that futsal players have to make fast movements on a small, hard, and slippery indoor field, the risk of injury to futsal players is higher than other sports (Bekris et al., 2020).

The injury rate in futsal players is high and the risk increases in futsal players when playing. Futsal has twice injury rates compared to football (J. P. Oliveira et al., 2024). The non-contact trauma is the main cause of the majority of injuries experienced by futsal players (Yoshida et al., 2023). The lower extremities were the most frequently injured area, namely 72.4% of injuries (Yoshida et al., 2023). Leg muscle injuries, knee ligament injuries, toe fractures, and thigh muscle injuries were the most common injuries during matches (Ahmad-Shushami & Abdul-Karim, 2020). Rough playing surfaces and the game-related aspects are the main causes of knee injuries (Ahmad-Shushami & Abdul-Karim, 2020). Lack of warm-up and cool-down exercises before the match causes injuries. As a result, the body muscles stretch. Improper warming can cause injury to the muscles, especially the thighs and calves due to the sudden heavy physical activity because the muscles are not ready to receive the load (Gene-Morales et al., 2021).

There are several methods used in futsal, including running, kicking, heading, dribbling, and holding the ball (Khurrohman et al., 2021) These movements require good supporting elements, especially from skeletal muscles. Skeletal muscles have the extensibility, flexibility, and contractility capacity. Skeletal muscles have the strength to move skeletal elements, and when the strength is reduced, the obstacles will occur when trying to move (Méndez-Dominguez et al., 2022). Hamstring flexibility is essential to carry out daily activities efficiently, especially for athletes who need maximum speed, strength, and flexibility in the hamstring muscles such as futsal players. The hamstring muscles cannot stretch as far as their resting length when their flexibility is reduced. This will cause a decrease in ROM, making the range of motion of the hamstring muscles more limited, thus limiting the movement of futsal players and making it difficult to perform various functional tasks (Saryono et al., 2022).

Nordic hamstring exercise is an exercise to increase the length and tension of the hamstring muscles through the use of eccentric principles (de Oliveira et al., 2020). Nordic hamstring exercise allows the best possible muscle stretching because the hamstring muscles are stretched a little longer and do not encounter resistance from the quadriceps muscles as their antagonists. As the result, the hamstring muscles are more flexible and the range of motion of the joints increases. In addition to increasing flexibility, this exercise can also increase the strength of the hamstring muscles. The increase in flexibility and strength of the hamstring muscles is hoped to prevent the hamstring muscle injury when playing futsal (Patel & Barot, 2022).

Although futsal players also require a high degree of hamstring muscle strength and flexibility to support their ability to play the game, there are currently only few studies on nordic hamstring exercises on futsal players. For example, the study involving athletes from various sports, including soccer, basketball, and athletics, which demonstrated an increase in

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absolute strength following the implementation of nordic hamstring exercise from (Potosí-Moya et al., 2025). However, the study did not specifically investigate futsal players, indicating a gap in the literature regarding the application of nordic hamstring exercise within this population. Furthermore, studies rarely evaluate muscle strength. They, instead, solely focus on flexibility. The study of Sulaiman et al. (2024) compared the effects of nordic hamstring exercise and static stretching on hamstring flexibility, reporting that both interventions were equally effective in enhancing flexibility. The findings indicate that certain studies have primarily focused on flexibility outcomes without incorporating assessments of muscle strength. Thus, researchers aimed to find out the efficacy of nordic hamstring exercise on hamstring flexibility and muscle strength of futsal players.

METHODS

This study used an experimental method with a one group pre-test and post-test design. The sampling method used in this research was the purposive sampling technique according to inclusion and exclusion criteria. The study was conducted on futsal players in Denpasar City. The research and data collection was carried out from February 2024 - April 2024.

Participants

The target population of this study were all futsal players in Denpasar City indicated to have decreased flexibility and strength of the hamstring muscles. The reachable population for this study were futsal players in Denpasar City with complaints of poor hamstring flexibility and strength based on the physiotherapy assessment. The samples of this study were 35 people selected based on the inclusion and exclusion criteria and physiotherapy assessments.

Sampling Procedures

The sample selection in this study used the Pocock formula and was carried out based on the inclusion and exclusion criteria, obtaining 35 people as samples. The inclusion criteria for this study involved futsal players aged 18-25 years, male gender, and having hamstring muscle flexibility of less than 160o. Exclusion criteria included samples with cardiovascular, neurological, and musculoskeletal conditions, having a history of impaired mobility and knee and ankle pain according to the inspection examination, having a history of cardiovascular disorders according to the doctor statement, and were receiving other interventions. The samples were given the nordic hamstring exercise intervention performed three times a week for four weeks.

Materials and Apparatus

The measurement of hamstring flexibility was carried out by using the active knee extension, while the hamstring muscle strength was measured by using leg dynamometer.

Procedures

Before collecting the data, the researcher explained the purpose and the procedures of the research and provided an opportunity for respondents to ask questions if there were aspects they did not understand. Furthermore, the researcher asked for approval from the subject regarding the research to be carried out. After approval, the researcher handed over the informed consent sheet to the subject and asked for the subject signature on the sheet. Then, interviews and examinations were conducted to obtain data on the subject characteristics regarding age. Next, the examinations of the flexibility and strength of the hamstring muscles were carried out by using AKE test and leg dynamometer. After examining and measuring hamstring muscle flexibility and strength, the samples who met the inclusion and exclusion criteria were given nordic hamstring exercises. At the end of the training session, the flexibility and strength were measured by using the AKE test and leg dynamometer.

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Data Analysis

The data obtained were analyzed by using the SPSS Version 25.0 application. Descriptive data were used to analyze age, educational background, and hamstring flexibility and strength data. The normality test used the Shapiro-wilk test, while the hypothesis testing used paired sample t-test.

RESULTS

To present complete research results and strengthen the interpretation of hypothesis testing, a description of the data in the form of the characteristics of the research sample. The characteristics of the samples, including gender, age, and educational history. The sample characteristics comprised gender, age, and educational background. The mean age of the participants was 21.11 ± 1.38 years. In terms of educational background, 14.3% of the participants had completed senior high school, whereas 85.7% held a bachelor's degree.

Table 1. Subject Flexibility Frequency Distributions Before Trainings

Category	N	Percentage (%)
100° – 120°	13	37.1
121° – 130°	12	34.3
131° – 140°	9	25.7
141° – 150°	1	2.9
151° – 160°	0	0
Total	35	100

Table 2. Subject Flexibility Frequency Distributions After Trainings

Category	N	Percentage (%)
100° – 120°	1	2.9
121° – 130°	1	2.9
131° – 140°	8	22.9
141° – 150°	20	57.1
151° – 160°	5	14.3
Total	35	100

Based on Table 1, the number of subjects whose hamstring flexibility at 100° – 120° before the intervention were 13 (37.1%), at 121° – 130° were 12 (34.3%), at 131° – 140° were 9 (25.7%), and at 141° – 150° was 1 (2.9%). Based on Table 2, the number of subjects whose hamstring flexibility at 100° – 120° after the intervention was 1 (2.9%), at 121° – 130° was 1 (2.9%), at 131° – 140° were 8 (22.9%), at 141° – 150° were 20 (2.9%), and at 151° – 160° were 5 (14.3%).

Table 3. Subject Leg Strength Frequency Distributions Before Trainings

Category	N	Percent (%)
Moderate	24	68.6
Good	11	31.4
Total	35	100

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Table 4. Subject Leg Strength Frequency Distributions After Trainings

Category	N	Percent (%)
Moderate	18	51.4
Good	17	48.6
Total	35	100

Table 3 shows that subjects who had moderate category in leg strength before the intervention were 24 people (68.6%), while other 11 people (31.4%) were at the good category. Based on Table 4, the subjects who had moderate category in leg strength after the intervention were 18 people (51.4%), while other 17 people (48.6%) were at the good category.

The results of the normality test using the Shapiro Wilk Test, obtaining a probability value of p = 0.752 (p >0.05) for the flexibility data group before the intervention and the value of p = 0.204 (p >0.05) after the intervention. The strength data group gained the value of p = 0.114 (p >0.05) before the intervention and the value of p = 0.202 (p >0.05) after the intervention. These results indicate that the data were not normally distributed.

Table 5. Differences in Improved Hamstring Muscle Flexibility Before and After Exercises

Category	Before Training	After Training	p
Flexibility			
100° – 120°	13	1	0.000
121° – 130°	12	1	
131° – 140°	9	8	
141° – 150°	1	20	
151° – 160°	0	5	
Mean	124.74	145.94	
Standard Deviation	10.424	8.815	
Total Sample	35	35	

Table 5 presents the results of the mean difference analysis in hamstring muscle flexibility improvement by using the paired sample T-test before and after exercises, obtaining a value of p = 0.000 (p <0.05), indicating that there was a significant difference in the increase of the hamstring muscle flexibility before and after the exercise.

Table 6. Differences in Improved Lower Limb Muscle Strength Before and After Exercises

Category	Before Training	After Training	p
Strength			
Moderate	24	18	0.000
Good	11	17	
Mean	167.63	184.40	
Standard Deviation	17.184	18.606	
Total Sample	35	35	

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Table 6 shows that the analysis of the mean difference in lower limb muscle strength improvement, using the paired sample T-test before and after exercises, gained a value of p = 0.000 (p <0.05). It indicates that there was a significant difference in the increase in the leg strength before and after the exercise.

DISCUSSION

Identification of Sample Characteristics

Based on the results of the study, the research subjects had an average age of 21.11±1.38 years. Subjects who had hamstring flexibility 100o – 120o before the intervention were 13 (37.1%) and subjects who had moderate category in leg strength before the intervention were 24 (68.6%). According to a cross-sectional study employing the active knee extension test, 82% of research participants were younger and the prevalence rate of hamstring tightness was higher among those aged 18 to 25 years (Mbada et al., 2021). Meanwhile, in our study, the widespread age of the research participants with hamstring tightness was found in the 21.11±1.38 years. Trauma, extended sitting, and biomechanically unbalanced posture could cause the tight around the back of the leg hamstring muscle group. This study is consistent with Liyanage et al. (2024) research, which indicated that 68% of students between the ages of 18 and 25 had hamstring tightness. One of the risk factors for tight hamstrings is the prolonged sitting. Student activities may be hindered by hamstring strains and other problems caused by hamstring tightness. This study found that 24 (68.6%) players had moderate lower limb muscle strength. In futsal, a high-intensity sport that involves several sprints and frequent direction changes with a dominant lower extremity, lower limb muscle strength is crucial. Strengthening the muscles in the lower limbs would improve the performance and lower the risk of injury (Saryono et al., 2022).

The Effectiveness of Nordic Hamstring Exercise on Hamstring Muscle Flexibility

The analysis results of the mean difference in Hamstring Muscle Flexibility improvement, analyzed by using the paired sample t-test before and after exercises, gained a value of p = 0.000 (p <0.05), meaning that there was a significant difference in the increase of the hamstring muscle flexibility before and after the exercise.

Nordic hamstring exercise is a type of training that helps build and stretch muscle tissues. This is because the weight of the body mass against gravity causes the physiological reaction allowing the muscle fibres to be maximally stretched. Reciprocal inhibition is the process where the antagonist muscular contraction causes agonist muscle relaxation in this active-static stretching process (Nunes et al., 2024). Static muscular stretching exercises are performed gradually until the muscles become tense and uncomfortable, at which point the position is held. When a muscle is stretched, its length is preserved and the muscle spindles adjust to the new variations in the muscle length (Vatovec et al., 2021).

Muscle stretching most effectively performed with nordic hamstring exercises because the hamstring muscles are stretched for a little longer period of time and are not subjected to the resistance from the quadriceps muscles, which act as antagonists. This allows the hamstring muscles to become more flexible and the joints to move more freely (Liang et al., 2024). Muscle tension is increased when the muscle is stretched rapidly because the primary afferent fibers trigger the spinal cord alpha motor neurons and help the extrafusal fibers contract. Nevertheless, if the muscle is stretched gradually, the Golgi tendon organ is activated, which reduces muscle tensions and causes the muscle elastic components to extend. The muscle spindle will adjust to the new muscle length if stretching is performed for a little longer (Raya-González et al., 2023).

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The Effectiveness of Nordic Hamstring Exercise on Lower Limb Muscle Strength

One eccentric exercise that targets hamstring muscle strength is the Nordic Hamstring Exercise. Athletes frequently utilize this workout to enhance their performance and avoid hamstring issues. This workout focuses on the hamstring eccentric contractions, which allow the muscles to extend while staying tensed to regulate movements. Mechanical adaptations, such as enhanced muscle strength and endurance, are triggered by eccentric contractions, which stretch the muscle fibers while maintaining high tensions (Alonso-Fernandez et al., 2018).

Muscle fibers experience microtrauma from the eccentric exercise, which is followed by adaptation and repair processes. To make the hamstring muscles bigger and more resilient to increased workloads, these microtraumas cause muscle hypertrophy, an increase in the size of muscle fibers through increased muscle protein synthesis (Lauersen et al., 2018). Exercises with eccentric movement mechanisms, where the hamstring muscles are perfectly stretched and the tendons respond by lengthening due to the stimulus from the Golgi tendon organs, are designed to have no resistance from the antagonist muscles, specifically the quadriceps. Gravity plays a part in this process. Muscle strength may also be impacted by the force of gravity if the antagonist muscles do not resist when the agonist is stretched (Patel & Barot, 2022).

Nordic hamstring exercises improve the nervous system ability to recruit muscle fibers in the most efficient way, which boosts eccentric strength and endurance. Stronger knees and hip joint stabilization are other ways where the improved neuromuscular activation aids in injury preventions (Cuthbert et al., 2020). Furthermore, this eccentric exercise promotes the production of collagen in muscle and tendon tissues, strengthening connective tissue structures. Since type II muscle fibers, or fast-twitch fibers, are involved in creating and sustaining the stress during the eccentric phase, they are highly stimulated during the nordic hamstring exercise. When subjected to increasing stresses, these fibers are known to have a significant capability for hypertrophy. Overall, this makes the muscles stronger (Medeiros et al., 2021). Nordic hamstring exercises lengthen the hamstring muscular fascicles, particularly the biceps femoris. Because it increases the muscle capacity to stretch without sustaining harms, the increase in fascicle length is crucial for injury preventions (Bautista et al., 2021). Additionally, this activity stimulates the synthesis of metabolic marker molecules including insulin-like growth factor-1 (IGF-1), which aids in the muscle adaptation and repair. The muscle ability to generate forces is increased when the mechanical and metabolic stresses are combined (Borba et al., 2020).

CONCLUSION

Based on the research analysis and discussion, the nordic hamstring exercise could effectively increase the hamstring flexibility and muscle strength of futsal players in Denpasar. The improvement in the muscle strength may contribute to the enhanced performance, particularly in sprinting, kicking, and sudden directional changes that require strong and flexible hamstring muscles. Furthermore, regular implementations of nordic hamstring exercises can serve as a preventive strategy to reduce the risk of hamstring injuries, thereby supporting the overall physical readiness and performance of futsal players.

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AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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