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The Effect of Jack Knife Stretching and Nordic Hamstring Exercise on The Hamstring Muscle Flexibility of Futsal Athletes

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Abstract

The purpose of this study is to examine whether there is a significant effect of jack knife stretching and Nordic hamstring exercise on the hamstring muscle flexibility of futsal extracurricular students at state junior high school 7 Cimahi, and to determine whether there is a significant difference in the effects between jack knife stretching and Nordic hamstring exercise on the hamstring muscle flexibility of these students. The method used in this study is an experimental method with a Two Groups Pretest and Posttest Design. The population in this study consisted of 22 male students from state junior high school 7 Cimahi who participated in the futsal extracurricular program. The sample also consisted of 22 students, selected using the total sampling technique, which means the entire population was used as the sample. The sample was then divided into two groups using the ABBA formula. The treatment was conducted over 15 sessions (3 times per week). To measure hamstring muscle flexibility, the researcher used the Sit and Reach Test instrument. The Shapiro-Wilk test was used to test data normality, the Paired t-test was used to test the effect, and the Independent t-test was used to compare the effects. The results after the data analysis, a significance value of 0.000 was obtained, indicating that there is a significant effect from the treatment of jack knife stretching and nordic hamstring exercise. Data analysis showed that there was no significant difference in the effects between jack knife stretching and Nordic hamstring exercise. It can be concluded that both jack knife stretching and Nordic hamstring exercise have an effect on hamstring muscle flexibility.

How to Cite

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INTRODUCTION

Futsal athletes require significant hamstring flexibility because they often need to move quickly and agilely. Many athletes suffer injuries due to a lack of muscle flexibility. For example, hamstring strains, quadriceps injuries, and many other injuries occur as a result of inadequate muscle flexibility. The hamstring muscles, which function as the primary movers for knee flexion, are at risk of tearing if they lack sufficient flexibility during knee extension movements, such as when powerfully kicking a ball. Therefore, insufficient hamstring flexibility in futsal can lead to slower movements and increase the risk of injuries to muscles, ligaments, and other tissues (Herstiani-S & Anam, 2024). Hamstring injuries are among the most common injuries that occur on the field. In futsal athletes, the percentage of injuries affecting the thighs and lower legs is 12.8%. These injuries can occur due to several risk factors. In addition to muscle weakness, one important factor that must be considered is the lack of muscle flexibility (Ribeiro-Alvares et al., 2020).

Physical components such as flexibility can enhance a player›s ability in technical and tactical training. However, many coaches focus solely on technical and tactical exercises, which leads to less effective training because the physical components that support those aspects are undertrained. Therefore, the coach›s role in designing training programs to reduce the risk of injury is very important. Furthermore, the training process should be carried out consistently among coaches, as many coaches deliver training materials that are not aligned with what has been presented or recommended (Komarrudin & Sartono, 2016).

Although there are various studies on hamstring flexibility training, few have directly compared the effectiveness of jack-knife stretching and the Nordic hamstring exercise. Therefore, this study aims to compare the effects of jack-knife stretching and the Nordic hamstring exercise on hamstring muscle flexibility. In a study by (Oh & Kang, 2021) titled ‹The Effectiveness of Hamstring Stretching with Proprioceptive Neuromuscular Facilitation versus Stretching for Jack-Knife Individuals with Hamstring Tightness›, it was found that proprioceptive neuromuscular facilitation and jack-knife stretching both provided similar improvements in hamstring flexibility. This study offers novelty by comparing two different training methods for hamstring flexibility, so that readers can later identify which training method is more effective for improving hamstring flexibility.

Futsal in Spanish is ‹fútbol sala,› which means indoor football. The game of futsal is similar to soccer; however, the differences lie in the number of players, the size of the ball, the dimensions of the court, and some variations in basic techniques (Moore et al., 2014). Futsal today is a dynamic game that requires playing quickly and with precise timing. In other words, the fast pace of the game is a deliberate process created by the team to achieve the objectives of the game (Saputra et al., 2023).

Extracurricular activities in schools are additional programs held outside regular school hours, aimed at helping shape students› character according to their individual interests and talents. Many aspects can be developed through extracurricular activities from physical development through sports, fostering creativity and emotional expression through arts and skills, to building and developing students› mentality through religious or spiritual activities and other similar programs (Heksa, 2021).

Training is a structured and planned activity aimed at improving bodily functions. In the context of sports, training plays a vital role in skill development. It is a systematic process of practicing or working, carried out repeatedly, with a gradual increase in training load or intensity over time. The goal of training is to help athletes enhance their skills and performance to the fullest extent possible (Harsono, 2018). Therefore the role of a coach as a leader is an interesting subject to examine and evaluate, as there are various positive and negative paradigms to be discussed. It is widely understood that one of the key factors in an athlete's success lies in how the coach leads both in terms of self-leadership and in leading others, particularly their athletes (Novian & Noors, 2020).

According to (Harsono, 1988), flexibility is the ability to perform movements within the widest possible range of motion of a joint. Flexibility is defined as the ability of the human body›s muscles to stretch within a range of motion that occurs in various joints throughout the body. Human flexibility is influenced by muscles, ligaments, bones, and other skeletal structures. Flexibility provides the body with freedom and ease in performing certain movements and helps protect it from various types of injuries (Thakur & Motimath, 2014).

Jack-knife stretching is categorized as active static stretching because it combines both static and dynamic techniques. During the

stretch, the contraction of the antagonist muscle results in relaxation of the agonist muscle due to reciprocal inhibition a process in which muscles function in pairs, where the contraction of one muscle is accompanied by the relaxation of its opposing muscle across the joint. In this case, when the quadriceps muscle contracts, it causes relaxation in the hamstring muscle, leading to an adaptive increase in hamstring length (Sairyo et al., 2013). This movement begins in a squatting position with both hands holding the back of the ankles. Then, the knees are straightened, and the position is held for 5 seconds. This is repeated 5 times for one set (Kabra et al., 2020).

The Nordic hamstring exercise is an eccentric exercise performed at the knee, with the ankles held or secured while the subject lowers their upper body into a prone position as slowly as possible. The exercise is performed with the subject kneeling, hips and back straight, and arms at their sides. Another person should sit behind the subject to hold their ankles. The subject is then instructed to slowly lower themselves toward the ground. In this position, the hamstring muscles are activated as soon as the subject begins to lower, working eccentrically. The gluteus maximus, lower back extensors, and gastrocnemius also assist in preventing the subject from collapsing onto their chest (Putri et al., 2023). The Nordic hamstring exercise is a dynamic lengthening training method that uses the principle of eccentric contraction, which involves increasing the length and tension of the hamstring muscles. When the hamstring muscles are lengthened eccentrically, the muscles undergo a stronger stretch, enhancing the flexibility and strength of the hamstrings (Dwidhya et al., 2019).

The objectives of this study are:

Examine whether there is a significant effect of jack knife stretching exercise on the hamstring muscle flexibility of futsal athletes.

Examine whether there is a significant effect of Nordic hamstring exercises on the hamstring muscle flexibility of futsal athletes.

Examine whether there is a significant difference in the effects between jack-knife stretching and Nordic hamstring exercises on the hamstring muscle flexibility of futsal athletes.

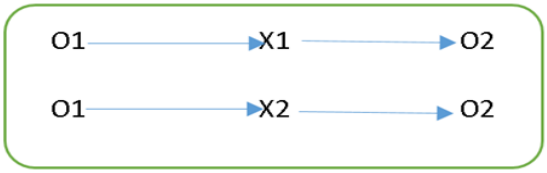
According to (Wiguna et al., 2014), human body flexibility develops significantly during childhood and reaches its peak during adolescence; therefore, selecting junior high school students as samples is highly appropriate for improving hamstring muscle flexibility.

This study offers novelty by comparing two different training methods for hamstring muscle flexibility, so that readers will be able to identify which training method is more effective in improving hamstring flexibility.

METHOD

This study uses an experimental method, as the researcher conducts a pre-test, treatment, and post-test. The experimental research method can be defined as a method used to determine the effect of a particular treatment on another variable under controlled conditions. The "Two Groups Pretest and Posttest Design" is used in this study. In this design, a pretest is conducted before the treatment is given, allowing the results of the treatment to be determined more accurately by comparing them to the pre-treatment condition. The experimental group 1 and experimental group 2 were selected through non-random sampling (Sugiyono, 2017). The design is illustrated in the following **Figure 1.**

Figure 1. Research Design



(Sugiyono, 2017)
Explanation:
O1:Pretest using the sit and reach test
X1:Treatment with jack-knife stretching exercises
X2:Treatment with Nordic hamstring exercises
O2: Posttest using the sit and reach test

The population used in this study consists of 22 students from state junior high school 7 Cimahi who participate in the futsal extracurricular activity. The sampling technique applied is total sampling, in which the entire population is taken as the sample in this case, 22 students. These students were then divided into two groups, each receiving a different treatment. The sample was divided into two groups after the pretest results were obtained, ranked from the highest to the lowest. In this study, the subjects were grouped using the "ABBA" formula. The instrument used to measure flexibility in this study is the sit and reach test The sample sits and leans on a flat surface with both legs straight and spread as wide as possible, then slowly bends the body forward with the arms extended as far as possible until both arms reach their farthest point. To measure the farthest reach in centimeters, two trials are conducted (Berliana, 2024).The training program was conducted over 15 sessions across 5 weeks, adapted from

a previous study. The training was given with a frequency of 3 times per week for 5 weeks, carried out progressively with increasing intensity each week. In the first week, 5 repetitions for 2 sets were performed; in the second week, 6 repetitions for 2 sets; in the third week, 6 repetitions for 3 sets; in the fourth week, 8 repetitions for 3 sets; and in the fifth week, 12 repetitions for 3 sets (Babu & Paul, 2018). The consistent and continuous implementation of a training program will improve its effectiveness and the quality of the results. The training program should be applied systematically and in a measurable way. In this study, the researcher conducted the training or treatment three times a week. The stages included administering the jack-knife stretching and Nordic hamstring exercise treatments during a 10 minute warm-up session, followed by 50 minutes of core training focused on basic futsal techniques. After the main session, a 10 minute coolingdown was carried out.

RESULTS AND DISCUSSION

The purpose of this study is to determine the effect of jack-knife stretching and Nordic hamstring exercises on the hamstring muscle flexibility of futsal extracurricular students at state junior high school 7 Cimahi. The data in this study were processed based on the test results from the research samples. A pretest was conducted to assess the initial flexibility condition of the samples. The samples were then divided into two groups based on the pretest results using the ABBA technique.

Table 1. Pretest and Posttest Data Results of the Jack Knife Stretching Treatment Group

Pretest	Posttest	Difference
24,4	29,1	4,7
20,7	25,4	4,7
20,5	24,8	4,3
17,8	21,8	4
16,8	20,9	4,1
15,5	20,7	5,2
15,3	20,4	5,1
12,9	19,7	6,8
12,3	18,9	6,6
9,8	17,1	7,3
9,3	16,9	7,6

From **Table 1**, the average increase was 5.49 cm, with the highest improvement being 7.6 cm and the lowest improvement being 4 cm after receiving jack-knife stretching treatment over 15 sessions

Table 2. Pretest and Posttest Data Results of the Nordic Hamstring Exercise Treatment Group

Pretest	Posttest	Difference
23,7	28,1	4,4
21,6	27,6	6
19,7	25,4	5,7
17,4	23,5	6,1
16,7	22,4	5,7
15,6	21,2	5,6
15,3	20,7	5,4
13,8	18,7	4,9
11,8	18,6	6,8
11,5	17,9	6,4
9,6	16,1	6,5

From **Table 2**, the average increase was 5.77 cm, with the highest improvement being 6.8 cm and the lowest improvement being 4.4 cm after receiving Nordic hamstring exercise treatment over 15 sessions.

After the measurements were conducted, the data were processed and analyzed using a statistical approach. Initially, the researcher collected raw data using Microsoft Excel, which was then converted into standardized data. The subsequent analysis was carried out using statistical software, namely Statistical Product and Service Solution (SPSS) version 25.

Jack-knife stretching is categorized as active-static stretching because it combines both static and dynamic techniques. Active-static stretching exercises performed for a certain duration can increase flexibility. This occurs because, during the stretching process, there is a response from two receptors located in the muscles—muscle spindles and Golgi tendon organs, each of which plays a different role. When the muscle is stretched slowly, the Golgi tendon organs are optimally stimulated, leading to the elongation of muscle fibers and fascia. On the other hand, muscle spindles, which are receptors within the muscle, play a role in detecting changes in the length of muscle fibers. The muscle spindle reports changes in length and how fast those changes occur, sending signals to the spinal cord to forward the information to the central nervous system. The muscle spindle responds by triggering a stretch reflex, an unconscious response that causes the muscle to contract through neural stimulation, re-

sulting in muscle elongation. When the stretched muscle length is maintained, the muscle spindle gradually adapts to the new muscle length, training the receptor to allow for greater muscle extension (Yaqin et al., 2019).

The Nordic hamstring exercise has a muscle-stretching nature. It is an eccentric exercise in which muscle elongation results in increased muscle tension (Ferdian et al., 2016). Eccentric exercises produce more muscle tension than concentric exercises, as they involve lengthening muscle contractions. The number of sarcomeres arranged in series and in parallel can increase with this type of eccentric training. The active elongation of muscles performed during the Nordic hamstring exercise causes the myofilaments and several sarcomeres in the muscles to stretch. These sarcomeres become weaker to the point where the myofilaments no longer overlap. However, when the exercise is performed continuously, these initially weak sarcomeres adapt and become stronger, and they do not return to their original state at the end of the contraction. The increase in passive muscle tension following eccentric contractions is the reason for the improvement in flexibility after repeated Nordic hamstring exercises (Babu & Paul, 2018).

The effects of the two treatments jack knife stretching and nordic hamstring exercise were achieved through different physiological processes. In jack knife stretching, which is a form of static stretching, the activation of the knee extensor muscles is followed by relaxation of the knee flexor muscles due to the occurrence of reciprocal inhibition (Babu & Paul, 2018). In this study, both methods produced equally beneficial effects on improving muscle flexibility. This finding is consistent with (Askar, 2015), who conducted a study comparing three interventions: eccentric training, static training, and dynamic stretching, and found that there was no significant difference between eccentric and static stretching in terms of improving muscle flexibility.

CONCLUSION

Based on the results of the study, it can be concluded that the jack knife stretching exercise program has a highly significant effect on improving the hamstring flexibility of futsal athletes. This is evidenced by an increase of 5.49 cm in hamstring flexibility, and the statistical test shows a highly significant inferential difference. This improvement reflects the effectiveness of jack knife stretching in enhancing the hamstring flexibility of futsal athletes. Jack knife stretching is also categorized as an active static stretching movement, in which static stretching is performed by lengthening the muscle fibers as well as connective tissues such as tendons and ligaments. This activity helps the muscles move within a wider range of motion. When the muscles are stretched, the microscopic structures in the muscle fibers and connective tissues undergo changes that increase their elasticity. If performed consistently over the long term, the muscles become more flexible and are able to stretch more optimally. Therefore, jack knife stretching, as a form of static stretching, is effective in reducing muscle tension after physical activity and in improving muscle flexibility.

Nordic hamstring exercise has a significant effect on increasing hamstring muscle flexibility of futsal atheletes. This is evidenced by an increase of 5.77 cm in hamstring flexibility, and the statistical test shows a highly significant inferential difference. This improvement reflects the effectiveness of Nordic hamstring exercise in enhancing the hamstring flexibility of futsal athletes. Nordic hamstring exercise is an eccentric type of training in which muscle lengthening is accompanied by an increase in muscle tension. Eccentric training involves performing repeated eccentric muscle contractions. Such training can slow down the muscle lengthening process under resistance, thereby increasing muscle strength, accelerating muscle recovery, and improving the metabolic rate. Therefore, Nordic hamstring exercise can effectively increase the flexibility and length of the hamstring muscles.

There is no difference in the effect between jack-knife stretching and Nordic hamstring exercise. The effects of the two treatments, jack knife stretching and Nordic hamstring exercise, are achieved through different physiological processes, where jack knife stretching is classified as an active static stretching movement, while Nordic hamstring exercise is classified as an eccentric training movement. Based on the data analysis, both methods were found to have a significant effect on the hamstring flexibility of futsal athletes.

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