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The Effect Of 8 Repetition Badminton Footwork Training In Increasing Leg Muscle Flexibility And Endurance

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Abstract

The basic movements of badminton are directed at footwork. The research aims to prove the effect of 8 repetitions of footwork training on flexibility and leg muscle endurance. Experimental research with a pre and post test control group design. The research sample consisted of 30 people divided into 2 groups. KI footwork training 8 repetitions and KII control. The results of the data normality and homogeneity tests show that the data distribution is normal and homogeneous. The test results for differences in mean flexibility and endurance of leg muscles using the t-paired test between groups were significantly different ($p<0.05$). KI flexibility, the pre test mean 3.33 and the post test 11.93, the difference 8.60. KII, the pre test mean 3.86 and the post test 5.06, a difference 1.20. In KI leg muscle endurance, the pre test average 16.86 and the post test 28.53, the difference 11.66. KII, mean pre test 17.06 and post test 18.33, difference 1.26. It was concluded that 8 repetitions of badminton footwork training increased flexibility and leg muscle endurance.

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INTRODUCTION

Footwork, or the movement of the feet, is fundamental to delivering quality shots. This is achieved when performed from the correct position according to the proper technique. To hit the shuttlecock effectively, an athlete must possess the ability to move quickly. Speed in foot movement cannot be achieved if the footwork is not well-coordinated (Yoniel, 2013). Performing footwork with flexibility and good muscle endurance requires excellent physical ability. The earlier a badminton athlete can master agile footwork, the better they will be at anticipating incoming shuttlecocks. In addition to physical condition, mastering good footwork technique requires the ability to control the movements of the lower body parts as well as the overall body movement. In other words, good automatic movement is necessary for effective footwork.

Footwork is a foot movement exercise based on concentric and eccentric training principles, aimed at enhancing muscle flexibility and increasing leg muscle endurance. The purpose of this study is to determine the effectiveness of an 8-repetition badminton footwork training program in improving flexibility and leg muscle endurance among female students participating in extracurricular badminton activities.

In a study conducted by Junge and Dvorak in 2010, it was stated that the lower extremities are the most common site of injuries, accounting for 85.2% of all injuries (Junge & Dvorak, 2010). This is because badminton players frequently engage in activities such as hitting the shuttlecock, stepping, jumping, and leaping, which require good muscle endurance and flexibility. These movements necessitate strong supportive elements, especially from skeletal muscles. The lower extremities often experience injuries in the leg muscles, particularly the hamstrings. If there is weakness in the skeletal muscles and a decrease in muscle flexibility, the muscles become more susceptible to injury. Therefore, efforts to prevent leg muscle injuries are needed, such as exercises to improve muscle flexibility and endurance. One exercise that can enhance leg muscle flexibility and endurance is footwork training. Each player, when attempting to hit the shuttlecock, must chase it with strong footwork that can withstand muscle strain in all corners of the court. Badminton players need resilient and flexible leg muscles to jump and move back and forth, side to side, and laterally. Athletic performance is closely linked to the physical condition of the athlete, aiming to achieve optimal physical capabilities to support sports activities and attain peak performance. To achieve high performance, it should be supported by physical conditions such as agility, speed, explosive power, coordination, endurance, reaction time, flexibility, and strength, all of which are essential for badminton players (Astrawan, 2019).

Physical fitness is essential in everyday life. Physically fit people are more likely to have good health. Those with poor physical fitness are more susceptible to chronic diseases such as heart attacks, diabetes, fatigue, and muscle weakness (Tisna, 2015). Physical ability is one of the most dominant components in achieving success in badminton. Badminton performance is influenced by tactical, technical, and physical condition elements. Badminton players require quality strength, endurance, flexibility, speed, agility, and good coordination. These aspects are essential for moving and reacting effectively to cover every corner of the court during a match. The physical requirements to become a good badminton player include the ability to run or spring quickly in all directions, maintain a fast running or springing rhythm throughout the match, and be agile. A player's hands must be strong enough for powerful smashes, able to perform multiple smashes with maximum strength without fatigue, and capable of jumping to execute smashes. The entire body must have strong muscles, especially flexible leg muscles (Karyono, 2011).

The injury rate among badminton players is very high, and this risk increases while playing. In a study conducted by Junge and Dvorak in 2010, it was shown that the lower extremities are the most common site of injuries, accounting for 85.2% of all injuries. According to Nemcic et al. (2016), injuries to the leg muscles, knee ligament injuries, toe fractures, and thigh muscle injuries are the most common injuries during matches. Insufficient warming-up and cooling down before and after training or matches lead to these injuries. Improper warm-up can cause injuries to the body's muscles, particularly the thighs and calves, due to sudden heavy physical activity, as the muscles are not yet ready to bear the load (Nemčić et al., 2016).

Every player preparing to make a shot must chase the shuttlecock with strong and fast footwork (muscular power) to cover every corner of the court. Specific training principles tailored to the respective sports discipline, in this case badminton, require players to have strong legs for jumping and moving back and forth (Nala, 2011). Sporting achievements are inseparable from the physical condition of athletes, aiming to achieve optimal physical capabilities that support athletic activities in pursuit of excellence. To attain high performance, athletes should focus on physical aspects such as strength, agility, speed, explosive power, coordination, endurance, reaction time, flexibility, and muscle endurance, all crucial in badminton gameplay.

Therefore, it is important for a badminton player to have flexible muscles and good muscle endurance. Injuries can be not only treated but also prevented through preventive measures and specific training. Injuries to leg muscles can be avoided by maintaining and improving their flexibility and endurance. According to a study by

Tantowi in 2017, out of a total of 472 physiotherapy students at Muhammadiyah University of Malang, it was found that among 174 students measured for hamstring muscle flexibility, 48 students experienced hamstring muscle tightness, equivalent to 28% of the students. The majority of students with hamstring muscle tightness complained of quick fatigue during activities such as stair climbing and walking, as well as morning stiffness. Additionally, some reported lower back pain with prolonged activity. Typically, they only rested to alleviate their symptoms, but the complaints returned upon exertion (Tantowi, 2017).

The flexibility of the hamstring muscles, a major part of the leg muscles, significantly impacts a person's daily life. These muscles function in hip flexion and knee extension, so reduced hamstring flexibility can lead to compensation by other muscles. Increased workload on muscles surrounding the hamstrings can result in movement and functional impairments, as the hamstrings serve as stabilizing muscles, particularly in supporting a person's body mass (Dwidhya, 2019).

The physical fitness components in badminton are closely tied to muscle strength, as it involves powerful strokes and maximal energy output derived from the muscles throughout the body. This allows players to control body movements and footwork, engaging various muscle segments in a sequence of motions during badminton gameplay (Ishak, 2011). Motor components are fundamental physical movement abilities or bodily activities that help protect against injury and maintain homeostasis. Motor components influencing the achievement of physical fitness goals include flexibility and muscle endurance.

Based on the issue, the researcher conducted a study aimed at enhancing the flexibility and endurance of leg muscles in badminton players through an 8-repetition badminton footwork training program. This study examined various footwork training methods and compared them with regular badminton play to improve gameplay skills, support student achievements, and determine which training method is more effective in enhancing the flexibility and endurance of leg muscles. The training provided in footwork exercises emphasizes the impact of an 8-repetition badminton footwork training program on leg muscle development.

METHODS

Experimental research is a type of study aimed at exploring potential cause-and-effect relationships by administering one or more treatments to one or more experimental groups and comparing them with one or more control groups that do not receive the treatment (Kanca, 2010). This research employs a quantitative method with an experimental approach. The research design is a plan on collecting, presenting, and analyzing data effectively and efficiently to give meaning to the data (Kanca, 2010). The research design used is The Randomized

Pre and Post Test Control Group Design, which aims to determine the effectiveness of training in improving flexibility and endurance of leg muscles in extracurricular badminton participants. The sampling technique employed in this study is simple random sampling. The research was conducted from June to August 2023. The target population for the study includes female students participating in extracurricular badminton, based on inclusion and exclusion criteria. Total sampling was used with a population size of 30 individuals. The inclusion criteria are: 1) aged 16-20 years; 2) female; 3) willing to participate as respondents in the study. The exclusion criteria are: 1) respondents undergoing intensive medical treatment for conditions such as cardiovascular, neurological, and musculoskeletal disorders; 2) respondents withdrawing from the study; 3) respondents receiving other interventions. The badminton footwork training consisting of 8 repetitions was conducted over 8 weeks, twice a week, with training intensity increasing progressively: weeks I & II at 50% of Maximum Heart Rate (MHR), weeks III & IV at 60% MHR, weeks V & VI at 70% MHR, and weeks VII & VIII at 80% MHR. Before training, respondents were required to warm up with static and dynamic stretching. The core badminton footwork exercises followed, and after training, respondents performed cooling down exercises.

The flexibility of muscle is measured using the sit and reach test, while leg muscle endurance is measured using the squat test instrument. Data analysis for this study utilizes SPSS software version 16.0. Descriptive statistics are employed to analyze age data collected before the initial training. The normality of data is assessed using the Shapiro-Wilk test to determine whether the data follow a normal distribution. The homogeneity of data is tested using Levene's Test to assess whether data variances are homogeneous or not. If the data are normally distributed and homogeneous, further analysis employs parametric statistical tests, specifically the Paired Samples T-test. Independent T-tests are conducted to examine differences between pre-and post-treatment results with a significance level of $\alpha = 0.05$.

In cases where data are not normally distributed and not homogeneous, non-parametric statistical analysis is employed. The Wilcoxon Signed Rank Test is used to compare pre- and post-treatment results for paired samples, while the Mann-Whitney U Test is utilized to compare results between independent samples.

RESULT

The study was conducted at the Gumuhsari Darmasaba Badminton Court involving female students participating in the extracurricular badminton program at SMK Kesehatan Bali Khresna Medika. The experimental research spanned 8 weeks from June to August 2023, comprising one treatment group and one control group. The research sample consisted of 30 participants, divided equally into two groups of 15. Group 1 received badminton footwork training, while Group 2 served as the control group. Data collected from the study included characteristics of the research sample and measurements of flexibility and leg muscle endurance from both study groups. Analysis of sample characteristics focused on the age range of 16 to 20 years and all participants being female. The data indicated that there were no significant differences in age and gender characteristics between the two groups before training, ensuring both groups had similar characteristics and capabilities.

1. Data Normality and Homogeneity Test

To determine the distribution of data in the research sample, normality tests using the Shapiro-Wilk Test and homogeneity tests using Levene's Test were conducted. The tests were performed on the data obtained from both groups, both before and after the training. The variables tested were the dependent variables before and after training in each research group. Table 1.

Table 1. Results Normality and Homogenity Tests Of Data Before and After Training

Variable	**Training**	**(p) Normality (*Shapiro Wilk Test*)**		**(p) Homogenity (*Levene Test*)**
		Grup I	**Grup II**	
Flexibility	*Pretest*	0,25	0,22	0,34
	Posttest	0,09	0,68	0,45
Leg Muscle Endurance	*Pretest*	0,80	0,81	0,92
	Posttest	0,67	0,26	0,28

Table 1 shows that the data analysis using normality and homogeneity tests for the results before and after training indicates that both groups have p-values greater than 0.05 ($p > 0.05$). This suggests that the variable data before and after training are normally distributed and the data variances are homogeneous. Therefore, further analysis will utilize parametric statistical tests.

2. Test Results for Average Differences in Intra-Group Research Results

The results of the difference test are used to determine and compare the mean scores of flexibility and leg muscle endurance before and after training between Group I and Group II, namely between badminton footwork training and the control group. The significance analysis results using paired t-tests for intra-group, Table 2 and Table 3.

Table 2. Results of the Average Difference Test Before and After Intra-Group Training

Flexibility		**n**	**Average**	**p**
Grup I	before training	15	3,33	0,00
	after training		11,93	
Grup II	before training	15	3,86	0,00
	after training		5,06	

Table 3. Results of the Average Difference Test Before and After Intra-Group Training

Leg Muscle Endurance		**n**	**Average**	**p**
Grup I	before training	15	16,86	0,00
	after training		28,53	
Grup II	before training	15	17,06	0,00
	after training		18,33	

Table 2 and Table 3 show that the mean scores of the dependent variables before and after training between the two groups have p-values less than 0.05. This indicates that there is a significant difference in the mean scores after training within each group ($p < 0.05$). Thus, the difference in mean scores of the variables before training between Group 1 and Group 2 is comparable. The difference in the variables after training is statistically significant.

3. Before and After Difference Test Results Between Groups

To determine the differences between the two groups both before and after training, the significance analysis was conducted using an independent t-test. Tables 4 and 5..

Table 4. Difference Test Results Before and After Training Between Groups

Variable	Training	Average		p
		Grup I	Grup II	
Flexibility	Before	3,33	3,86	0,60
	After	11,93	5,06	0,00

Table 5. Difference Test Results Before and After Training Between Groups

Variabel	Training	Average		p
		Grup I	Grup II	
Leg Mucle Endurance	Before	16,86	17,06	0,88
	After	28,53	18,33	0,00

From Table 4 and Table 5, it can be observed that the mean scores of the research variables before training between the two training groups have p-values greater than 0.05, whereas after training, the p-values are less than 0.05. This indicates that the mean scores of the variables before training between the two groups are not significantly different ($p > 0.05$). Thus, the mean scores before training are comparable. However, the difference in variables after training is statistically significant ($p < 0.05$), suggesting that the final outcomes differ due to the differences in the treatments administered.

4. Percentage Improvement in Both Groups

After 8 weeks of training, there were differences in improvement and percentage. The percentage increase in flexibility for both groups is calculated using the following formula: percentage = part amount / total amount x 100. The percentage results are shown in Table 6 and 7 below.

After 8 weeks of training, there were differences in improvement and percentage. The percentage increase in lower limb muscle endurance for both groups is calculated using the formula Arikunto (2004): $P = \frac{T2 - T1}{T1} x(100\%)$

Table 6. Percentage of Flexibility Results in Each Group

Flexibility	Average Grup I (*Footwork*)	Average Grup II (Control)
Before Training (T1)	3,33	3,86
After Training (T2)	11,93	5,06
Difference in Improvement (T2–T1)	8,60	1,20
Persentage (%)	72,08	23,71

Table 7. Percentage of Leg Muscle Endurance Results in Each Group

Leg Muscle Endurance	Average Grup I (*Footwork*)	Average Grup II (Control)
Before Training (T1)	16,86	17,06
After Training (T2)	28,53	18,33
Difference in Improvement (T2–T1)	11,66	1,26
Persentage (%)	69,15	7,38

DISCUSSION

The percentage increase in flexibility and lower limb muscle endurance for both groups during training is shown in Tables 6 and 7. These tables indicate that the increase in flexibility and lower limb muscle endurance after training in Group I is greater than in Group II. This suggests that both groups experienced improvements after the research data was obtained. The percentage increase in flexibility and lower limb muscle endurance in Group I is higher than in Group II. Physiologically, during footwork training in badminton, the muscle response, particularly in the lower limb muscles, adapts to the footstep movements towards various court angles. This adaptation activates the muscle spindle and Golgi tendon organ. When the hamstring muscle is quickly stretched, the primary afferent fibers stimulate alpha motor neurons in the spinal cord, facilitating the contraction of extrafusal fibers to increase muscle tension. This process is known as the monosynaptic stretch reflex. Conversely, slow stretching of the muscle stimulates the Golgi tendon organ, inhibiting muscle tension and allowing the muscle to elongate through the elastic components. The goal of maintaining prolonged stretching is to allow the muscle spindle to adapt to the new muscle length. Gradually, this trains the muscle response to achieve greater lengthening of the muscle over time (Jumharyati, 2020).

The effect on muscles trained with footwork focuses on the theory that correct technique or good coordination in stepping triggers neurophysiological responses that affect muscle stretching tolerance. Neurophysiological responses can assist shortened muscles in tolerating stretching and directly influence the flexibility of the lower limb muscles after treatment (Kalanekar, 2020).

The increase in lower limb muscle endurance in each group is attributed to the footwork training consisting of 8 repetitions in badminton. This has a significant impact because the training spanned eight weeks, conducted at a frequency of two to three times per week, by recommended training doses. This regimen potentially benefits the leg muscles by facilitating adaptation to the muscular contractions induced by the training loads. Training over a period of 6-8 weeks typically yields consistent results, as the body adapts to the training regimen during this time (Nala, 2011).

Footwork training prepares the leg and foot muscles to work more effectively and efficiently. Strong muscle activity leads to increased muscle capability. Muscles undergo hypertrophy, enhancing muscle strength and the nutritional mechanisms to sustain increased mobility. Even brief, intense muscle activity occurring daily facilitates muscle strength and endurance adaptation. Prolonged muscle activity enhances muscle endurance, leading to increased oxidative enzymes, myoglobin, and crucial blood capillaries for improved muscle metabolism (Syaifuddin, 2012).

Based on research, to effectively increase muscle strength, using a volume of 2–10 repetitions maximum (RM) within 1–3 sets, with a frequency of 2–4 times per week, yields better results. The recommended training dosage for optimal muscle strength improvement includes high intensity (70–100%) combined with low-volume training (6–10 repetitions per set and 3–5 sets) and a frequency of 2–3 times per week. In this context, the footwork training with 8 repetitions, conducted twice a week, aligns well with these principles. With low intensity and high volume (repetitions & sets), this regimen effectively enhances muscle endurance (Nala, 2011).

Flexibility is the capacity of muscles to move lengthwise or contract according to the Range Of Motion (ROM) with sufficient comfort and endurance (Kisner, C. & Colby, 2016). Flexibility is important in supporting physical activity in performing ideal performance movements. Movement and function disorders in the structures around the lower back can be side effects due to decreased lumbar/lower back flexibility (Sudaryanto & Anshar, 2011). Factors that influence flexibility are internal factors including joint structure, tendons, muscle tone, muscle strength, body temperature, age and gender, while external factors include psychological conditions, stress levels, sports activities and fatigue conditions in this case related to work patterns (Vitalistyawati et al., 2019) in (Aprilyanti *et al.*, 2022)

Lack of hamstring flexibility is associated with susceptibility to musculoskeletal injuries such as low back pain. Because the origin of the hamstring muscles is located in the ischiadicus tuberosity of the pelvis, hamstring flexibility can affect pelvic rotation (Naufal, 2019) in (Pradipta *et al.*, 2021). Poor hamstring muscle flexibility or commonly called hamstring tightness can cause pelvic tilt to the posterior so that the lumbar spine becomes hypolordosis. This can increase pressure on the anterior structures of the spine including the intervertebral discs. Repeated and continuous pressure will cause disc degeneration, causing complaints of low back pain and even decreased muscle strength and endurance in the legs.

According to (Hasyim, 2022) in 2018 in his research stated that leg muscle flexibility in sports has several benefits, including: 1) Facilitating mastery of high techniques, 2) Reducing injuries to athletes, 3) The art of movement 29 is reflected in high flexibility, 4) Helping in developing speed, coordination and agility, 5) Saving energy expenditure (efficient) when performing movements. Muscle flexibility is the maximum ability of muscles to move joints within the range of motion. Lack of muscle flexibility can result in limited joint range of motion (LGS) caused by muscle and tendon stiffness, causing joint contractures. Back flexibility often causes decreased daily living activities and causes chronic lower back disease. An adequate level of flexibility will increase an individual's functional ability (bending and turning) and reduce the likelihood of injury (risk of muscle tension and lower back problems). These parameters depend on a number of specific variables including the distensibility of the joint capsule, muscle temperature and in addition the tightness of tissues such as ligaments, tendons and their flexibility.

Good physical condition is very much needed and must be possessed by athletes, therefore in maintaining physical condition, athletes must always train continuously, progressively, and systematically so that the results obtained have a physical appearance that is always good (Wibowo et al., 2019), and one of the physical conditions in this study is leg muscle endurance for futsal players. Muscle endurance is one of the components of physical condition that is very much needed by badminton players in addition to other physical condition components such as strength, speed, power, cardiovascular endurance, coordination agility and many more. Endurance is a movement that is carried out repeatedly for a long time, but the athlete's condition must be seen and adjusted to the needs of the sport (Suryawan et al., 2019). Another opinion says that endurance is the ability of the body's muscles to exert energy and try not to get tired quickly during sports (Rustiawan, 2020). This means that endurance is very much needed in every sport, especially sports games such as football, futsal, basketball, and many more sports games that require endurance (Warni et al., 2017). Based on explanations from several references, the author concludes that endurance is one of the components of physical condition needed for sports, especially game sports such as football and futsal for a fairly long period of time continuously without experiencing severe fatigue (Armawijaya, Rustiawan and Sudrazat, 2021).

CONCLUSION

Based on the hypothesis and research results, it can be concluded that: (1) Badminton Footwork Training with 8 Repetitions Can Improve Flexibility in Students of Bali Khresna Medika Health Vocational High School Badminton Extracurricular Participants. (2) Badminton Footwork Training with 8 Repetitions Can Improve Leg Muscle Endurance in Students of Bali Khresna Medika Health Vocational High School Badminton Extracurricular Participants.

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