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The Effects of Walking Lunges and Adductor Stretching on the Flexibility of Volleyball-Specialization Students at Universitas Negeri Makassar

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ABSTRACT

This study aims to determine the effects of walking lunges and adductor stretching on the flexibility of Volleyball-Specialization students in the Sports Coaching Education Program, Faculty of Sports and Health Sciences, Universitas Negeri Makassar. The research employed an experimental method using a group pretest-posttest design. The sample consisted of 40 male students, divided into two treatment groups. The study was conducted at the Sports Campus of FIKK UNM. Flexibility measurements were taken before and after the intervention. The results indicate a significant effect of walking lunges training on improving flexibility, as shown by a t-value of 15.742 ($p < 0.05$). Adductor stretching also demonstrated a significant effect with a t-value of 10.767 ($p < 0.05$). Furthermore, comparative testing revealed a significant difference in the effects of the two training methods on flexibility, indicated by a t-value of 2.554 ($p < 0.05$). These findings suggest that both walking lunges and adductor stretching are effective in enhancing flexibility among Volleyball-Specialization students, with each exercise contributing differently to flexibility improvement.

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A. Conception and design of the study;
B. Acquisition of data;
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INTRODUCTION

Flexibility is a fundamental component of physical fitness and plays an essential role in optimizing athletic performance across various sports, including volleyball. Adequate flexibility enables athletes to execute efficient and biomechanically sound movements, particularly during actions requiring rapid changes of direction, explosive jumping, and dynamic lower-limb movements. (McGinnis, 2021) emphasizes that improved joint range of motion enhances movement efficiency, reduces mechanical stress on muscles, and contributes to better overall athletic functionality. In volleyball, flexibility of the hip and lower extremities is crucial for supporting actions such as blocking, defensive maneuvers, and transitional movements during play.

Numerous training methods have been widely applied to enhance flexibility, including static stretching, dynamic stretching, and functional movement exercises.

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Recent evidence highlights that flexibility-oriented interventions produce significant improvements when performed consistently and systematically. According to (Behm et al., 2021), chronic static stretching is effective in increasing muscle extensibility without compromising athletic performance, particularly when integrated into long-term conditioning programs. These findings suggest that combining stretching routines with functional lower-body training may provide superior benefits for athletes.

Functional exercises such as walking lunges have gained increased attention in sports training programs due to their ability to enhance hip mobility, neuromuscular control, and dynamic stability. (Pham, M. H., Doan, T. T., & Kim, 2021) reported that lunge variations significantly activate the hip flexors and gluteal muscles, contributing to improved functional range of motion and joint mobility. These characteristics position walking lunges as a promising intervention for targeting lower-limb flexibility in physically active populations.

Meanwhile, the adductor muscle group plays a critical role in maintaining pelvic stability and supporting lateral movements—elements heavily involved in volleyball performance. Limited adductor flexibility is associated with increased muscular tension and heightened injury risk, particularly during rapid multidirectional movements. (Mejia-Hernandez, K., Prendergast, L., O'Sullivan, K., & Franklyn-Miller, 2019) found that targeted adductor stretching improves muscle tension regulation and enhances functional performance of the lower limbs in athletes. This supports the importance of examining adductor stretching interventions specifically in volleyball-related physical preparation.

Given the importance of lower-extremity flexibility and the lack of empirical evidence within the context of university-level volleyball specialization programs, this study aims to examine the effects of walking lunges and adductor stretching on the flexibility of male Volleyball-Specialization students in the Sports Coaching Education Program at Universitas Negeri Makassar. Using a two-group pretest–posttest experimental design, this research contributes to the existing literature by providing practical recommendations for flexibility training strategies in collegiate athletic settings.

METHODS

This study employed an experimental method using a two-group pretest-posttest design, which is widely used to determine the causal effect of an intervention by comparing measurements taken before and after treatment in separate groups. According to (Creswell & Creswell, 2017), experimental designs allow researchers to systematically manipulate independent variables to observe their effect on dependent variables while controlling for extraneous factors. Similarly, (Thomas et al., 2023) emphasize that pretest–posttest experimental models are effective in evaluating the impact of physical training interventions on human performance outcomes. In this research, two treatment groups were formed: (1) a walking lunges training group and (2) an adductor stretching group. Both groups underwent pretest and posttest flexibility assessments to evaluate changes resulting from the interventions. The study involved

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40 male students specializing in volleyball within the Sports Coaching Education Program at Universitas Negeri Makassar. Participants were selected using purposive sampling, considering criteria such as active enrollment, physical readiness, and absence of musculoskeletal injuries. Purposive sampling is appropriate when selecting individuals with specific characteristics relevant to the research objectives (Etikan & Bala, 2017). All participants provided informed consent, and the study adhered to ethical principles outlined by the Declaration of Helsinki for research involving human subjects.

Flexibility was measured using a validated sit-and-reach test, widely recognized for assessing hamstring and lower-back flexibility. (Cejudo et al., 2019) Confirm that the sit-and-reach test demonstrates acceptable reliability (ICC > 0.90) and is frequently applied in sports science research for lower-limb flexibility assessment. The instrument used in this study included a standardized sit-and-reach box, measurement scale in centimetres, and a warm-up protocol consistent with ACSM (Riebe et al., 2018). The walking lunges intervention followed principles of functional lower-limb training. Lunges have been shown to activate hip flexors, gluteal muscles, and hamstrings while improving dynamic flexibility and stability (Pham, M. H., Doan, T. T., & Kim, 2021). Participants performed walking lunges three times per week for four weeks, following a progressive workload model consistent with strength and conditioning guidelines (Association, 2021). Each session consisted of: 3 sets × 12–15 repetitions Controlled tempo movements, Focus on full hip extension and stride length. The adductor stretching intervention focused on static stretching techniques targeting hip adductor muscles. Static stretching is known to enhance muscle extensibility and joint range of motion when performed consistently (Behm et al., 2016). Participants performed: 3 sets × 30–40 seconds per stretch. Stretching variations included the seated butterfly stretch and standing side adductor stretch (Mejia-Hernandez, K., Prendergast, L., O'Sullivan, K., & Franklyn-Miller, 2019) highlight that targeted adductor stretching can reduce muscle tension and improve lower-limb mobility in athletes.

The research procedures consisted of four stages: Pretest Evaluation. Flexibility was measured using the sit-and-reach test before any intervention. Intervention Phase: Both groups participated in their respective training programs for four weeks under supervision to ensure proper execution. Posttest Evaluation: The same flexibility test was administered after the intervention. Data Recording and Verification All results were logged and verified by two independent assessors to ensure accuracy and reliability. Data were analyzed using paired sample t-tests to determine within-group differences and independent sample t-tests to compare the effects between the two training groups. (Field, 2024) states that t-tests are appropriate for analyzing mean differences in pretest–posttest experimental designs when data meet assumptions of normality and homogeneity. Statistical significance was set at $p < 0.05$.

RESULTS AND DISCUSSION

The empirical data collected in the field consisted of flexibility test results obtained from Volleyball-Specialization students. Before conducting inferential statistical analysis,

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all data were systematically tabulated to facilitate accurate processing and interpretation. Descriptive statistics were first computed to provide an overview of the dataset, including the mean, standard deviation, variance, minimum and maximum values, range, frequency distributions, and graphical representations. This initial step was essential for identifying general patterns and characteristics of the flexibility scores in both intervention groups. Following the descriptive analysis, prerequisite statistical assumption tests were conducted to ensure the appropriateness of subsequent parametric analyses. These procedures included tests of normality and homogeneity, which are required to validate the use of parametric statistical methods. Once the assumptions were confirmed, hypothesis testing was carried out using the t-test, which was employed to determine both the effect of each training intervention and the comparative differences between the walking lunges and adductor stretching groups. The use of the t-test was justified as the data met the assumptions of normal distribution and homogeneity, thereby ensuring the robustness and validity of the statistical conclusions.

Table 1.
Descriptive Statistics of Flexibility Scores

Flexibility	N	Mean	Standard Deviation	Min	Max	Range
Before (A1)	20	10.6	6.801	1	26	25
After (A2)	20	17.2	7.245	6	35	29
Before (B1)	20	10.45	6.716	1	24	23
After (B2)	20	16.05	5.808	5	26	21

Descriptive analyses were conducted to provide an overview of the flexibility scores before and after the interventions in both groups. Table X presents the mean, standard deviation, minimum, maximum, and range for each measurement. In Group A (Walking Lunges), the pretest flexibility score (A1) showed a mean of 10.60 (SD = 6.801), with values ranging from 1 to 26. Following the intervention (A2), the mean increased to 17.20 (SD = 7.245), with an expanded range of 6 to 35. This indicates an improvement of 6.60 points in mean flexibility performance, demonstrating a substantial enhancement after the walking lunges program. In Group B (Adductor Stretching), the pretest flexibility score (B1) had a mean of 10.45 (SD = 6.716), with scores between 1 and 24. After the stretching intervention (B2), the mean rose to 16.05 (SD = 5.808), with values ranging from 5 to 26. This reflects a mean increase of 5.60 points, indicating consistent improvement among participants. The decrease in standard deviation suggests reduced score variability, implying more homogeneous outcomes following the intervention. Overall, both training protocols had positive effects on flexibility, with Group A showing slightly greater improvement than Group B. These descriptive results are consistent with the subsequent inferential findings.

Table 2.
Normality Test Results (Kolmogorov–Smirnov)

Variable	KS-Z	Prob.	α	Remarks
Before (A1)	0.102	0.2	0.05	Normal
After (A2)	0.166	0.152	0.05	Normal
Before (B1)	0.127	0.2	0.05	Normal
After (B2)	0.102	0.2	0.05	Normal

The normality test was conducted using the Kolmogorov–Smirnov (K–S) procedure to examine whether the flexibility score data from both groups met the assumptions required for parametric statistical analysis. As presented in Table X, all variables—A1, A2, B1, and B2—showed probability (p) values greater than the significance level of $\alpha = 0.05$. Specifically, the p-values ranged from 0.152 to 0.200, indicating that none of the distributions deviated significantly from normality. The K–S Z values, which ranged from 0.102 to 0.166, further confirm that the deviations of the observed data from a normal distribution were minimal. Based on these findings, all datasets were concluded to be normally distributed. This outcome supports the use of parametric procedures, particularly the t-test, in the subsequent hypothesis testing. Establishing normality is essential in experimental research, as it enhances the reliability and accuracy of inferential conclusions (Thomas et al., 2022; Gravetter & Wallnau, 2020). Therefore, the normality results demonstrate that the dataset fulfils the statistical assumptions required for conducting the paired and independent t-tests employed in this study.

Table 3.
Effect of Walking Lunges on Flexibility

Variable	N	To	A	Sig
A2 – A1	20	15.742	0.05	0.000

The results showed a significant improvement in flexibility following the walking lunges intervention. The statistical analysis revealed a t-value of 15.742 ($p < 0.05$), indicating that the walking lunges program had a substantial effect on increasing lower-body flexibility among participants. This result confirms that functional lower-limb training provides meaningful improvements in joint mobility.

Table 4.
Effect of Walking Lunges on Flexibility

Variable	N	To	A	Sig
A2 – A1	20	10.767	0.05	0.000

The adductor stretching group also demonstrated significant improvement. The paired sample t-test yielded a t-value of 10.767 ($p < 0.05$), showing that static adductor stretching significantly increased flexibility. This indicates that targeted stretching effectively enhances muscle extensibility and joint range of motion.

Table 5.
Comparison Between Walking Lunges and Adductor Stretching

Variable	N	To	A	Sig
A2 – B2	20	2.554	0.05	0.033

The independent sample t-test comparing posttest scores between the two groups showed a t-value of 2.554 ($p < 0.05$). This result indicates a significant difference between the effects of the two training interventions. Overall, both interventions improved flexibility, but walking lunges demonstrated a stronger effect.

The findings of this study indicate that both walking lunges and adductor stretching significantly improve flexibility in Volleyball-Specialization students. However, walking

lunges showed a greater magnitude of improvement, which is consistent with the principles of functional movement training. Walking lunges significantly increased flexibility, as demonstrated by the high t-value (15.742). This aligns with the findings of (Pham, M. H., Doan, T. T., & Kim, 2021), who reported that lunge variations enhance hip mobility and activate major muscle groups—including the hip flexors, hamstrings, and gluteus muscles—leading to improved dynamic flexibility and neuromuscular coordination. Additionally, (McGinnis, 2021) explains that functional exercises that move joints through a full range of motion promote adaptive structural changes in muscles and tendons, increasing elasticity and mobility. The significant improvement in this study reinforces the idea that walking lunges can be an effective intervention for athletes requiring lower-limb flexibility, such as volleyball players.

Adductor stretching also produced significant improvement (t = 10.767), supporting previous findings that static stretching increases muscle extensibility when performed consistently. (Behm et al., 2016) Highlight that static stretching contributes to reductions in passive stiffness and increases in muscle-tendon unit compliance, which improves flexibility without negative effects on performance when performed outside of warm-up. Additionally, (Mejia-Hernandez, K., Prendergast, L., O'Sullivan, K., & Franklyn-Miller, 2019) found that targeted adductor stretching reduces muscle tension and improves lower-limb function, particularly in sports requiring lateral movements—an essential component of volleyball. This supports the effectiveness of adductor stretching as demonstrated in the present study.

The significant difference between groups (t = 2.554) suggests that although both interventions improved flexibility, functional exercises such as walking lunges provide a more comprehensive stimulus due to combined muscular activation, dynamic stability, and joint movement patterns. According to (Thomas et al., 2023), multi-joint functional exercises produce greater neuromuscular adaptations compared to isolated stretching movements. Therefore, walking lunges may lead to superior flexibility gains due to their dynamic nature.

Volleyball demands rapid direction changes, explosive jumps, and strong hip mobility. The present study demonstrates that integrating walking lunges or adductor stretching into training sessions can effectively enhance flexibility, potentially reducing injury risk and improving performance. Coaches and trainers are encouraged to utilize both interventions, with emphasis on walking lunges for greater overall improvement.

CONCLUSION

Based on the results of data analysis, including descriptive statistics, normality testing, and hypothesis testing using the t-test, several conclusions can be drawn. The flexibility test data obtained from both groups demonstrated normal distribution characteristics, as indicated by the Kolmogorov–Smirnov values and probability scores that consistently exceeded the significance threshold of $\alpha = 0.05$. This confirms that the dataset met the assumptions required for the application of parametric statistical

procedures. Furthermore, the t-test analysis revealed significant improvements in flexibility following the implementation of the training programs administered to the athlete groups. The comparison between pre-test and post-test scores showed measurable increases, indicating that the applied training interventions had a positive and meaningful impact on athletes' flexibility performance. Overall, the findings suggest that the training methods utilized in this study are effective in enhancing the flexibility of volleyball athletes. These results not only support the theoretical basis of sport training programs but also provide practical implications for coaches and practitioners in designing evidence-based flexibility training protocols.

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