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THE EFFECT OF STATIC STRETCHING EXERCISES ON IMPROVING FLEXIBILITY AND SQUAT-JUMP HEIGHT IN UNDER-19 FOOTBALL PLAYERS

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Abstract: This study investigated the effects of static stretching exercises (SSE) on flexibility and squat- jump height in under- 19 football players. A two- group pre- test- post-test experimental design was used. The research population comprised players of Chabab Kais Football Club, affiliated with the Regional Football League of Batna. The study sample consisted of 16 under- 19 football players, equally divided into an experimental group (n = 8) and a control group (n = 8). The experimental group performed SSE, whereas the control group engaged in small games. The intervention was implemented for about 10 min per session, three times per week, over twelve weeks during the main part of the training session. Flexibility and squat- jump height were assessed before and after the intervention. Data were analyzed using analysis of covariance (ANCOVA), with the corresponding pre- test score entered as a covariate. Adjusted means, adjusted mean differences with 95% confidence intervals (CI), F statistics, p values, and partial eta squared (ηp^2) were reported. Both groups improved from pre- test to post- test. For squat- jump height, the experimental group increased from 13. 13.85 ± 1. 24 to 16. 16.73 ± 1. 21, whereas the control group increased from 12. 12.88 ± 0. 95 to 14. 15 ± 0. 87. After adjustment for baseline scores, ANCOVA revealed a significant effect of group on post- test squat- jump height, F(1, 13) = 47.73. 73, p <. .001, ηp^2 =. .786. The adjusted means were 16. 31 for the experimental group and 14. 57 for the control group, with an adjusted mean difference of 1. 74 units (95% CI [1. 12, 2. 35]). For flexibility, the experimental group improved from 19. 19.38 ± 3. 74 to 26. 26.50 ± 4. 17, whereas the control group improved from 19. 19.00 ± 2. 39 to 20. 20.75 ± 2. 60. The ANCOVA showed a significant effect of group on post- test flexibility, F(1, 13) = 283. 04, p <. .001, ηp^2 =. .956. The adjusted means were 26. 30 for the experimental group and 20. 95 for the control group, with an adjusted mean difference of 5. 34 units (95% CI [4. 65, 6. 03]). Under the conditions of the present study, the experimental group performing static stretching demonstrated significantly greater improvements in flexibility and squat- jump height than the control group performing small games. These findings suggest that incorporating static stretching into the main part of the training session may contribute to improvements in flexibility and squat- jump height in under- 19 football players.

Key words: Static Stretching; Flexibility; Squat-Jump Height; Football.

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INTRODUCTION

Football is one of the complex sports that requires the integration of various abilities and qualities. Among the most important abilities that football players must possess is flexibility, which involves the athlete's ability to perform movements within the full range of motion of the body's joints and muscles (Jothi & Jose, 2015; Ștef et al., 2026).

Physical preparation in football is of great importance, as it represents the foundation upon which the other aspects of athletic preparation for achieving sporting excellence are built. Improving physical attributes in football is one of the fundamental principles that does not focus solely on developing one or two qualities, nor does it prioritize them over other attributes. A balanced approach to optimal physical preparation leads to improvements in overall performance, which positively affects other performance factors (Al-Jamili, 2014).

There are many well-known methods to enhance various physical capabilities in football players, whether through training specifically targeted at these abilities or by improving the performance of these components without direct training. This approach is often due to a lack of sufficient time or to avoid the high risk of injuries in football, along with the resulting consequences of injuries and the loss of gains (Cheriet et al., 2023).

Flexibility plays a significant role in enabling the body to respond to various physical effort stimuli, allowing the movement and bending of joints through the full range of motion (ROM). Flexibility of a particular joint reduces the danger of injury, improves performance, and diminishes resistance in the surrounding muscle tissue of a joint, allowing for a decrease in energy use during the muscle-stretching process. Furthermore, the speed of the nerve impulses increases as a result of stretching, which improves the coordination of the muscles because it affects the number, arrangement, and functioning of the fibers (Jason et al., 2024).

Researchers have found that the most common static stretching technique among various stretching methods used in the sports environment involves the elongation of soft tissues beyond the point of tissue resistance, which is maintained in an extended position with continuous stretching force over a specified period.

Moreover, flexibility is related to speed and power, as an athlete cannot fully utilize their maximum speed without the elasticity of the muscles and the complete range of motion of their limbs. This also contributes to easier control of the body and smooth, fluid changes in direction during maximum-speed running (Mehimdat & Loukia, 2018).

Many studies show that a muscle generates higher force if it is stretched just before contraction, as this stretching helps achieve several benefits in terms of relaxation, maximum strength, energy storage, and thus works to increase the speed and efficiency of contraction and its effectiveness (Jason et al., 2014; Hindle et al., 2012; Caplan et al., 2009).

During static stretching, the stretch placed on the muscle-tendon unit triggers the Golgi tendon organ (GTO) to perceive the tension present, as it supersedes the excitatory impulses from the source of the muscle spindle. This causes muscle relaxation as it inhibits the tension in the contracting component of the muscle stretched through autogenic inhibition. Consequently, the collective neurophysiological responses lead to better muscle elongation (Jayaram & Mallikarjunaiah, 2015).

The goals of stretching typically include improving muscle and connective tissue flexibility and reducing resistance. However, intense stretching exercises, when used as a warm-up immediately before athletic performance, may impair coordination and reduce the potential for maximum contraction force, thereby increasing the risk of injury (Ylinen, 2008, p.21).

Performing both passive and active flexibility exercises allows for an increase in the elastic properties of ligaments and muscles, leading to optimal utilization of the range of motion, which reflects on the efficiency of motor performance through both the amplitude and ease of movement (Salama, 2000). Additionally, Mustafa (2002) notes a close relationship between joint flexibility and the muscle fibers' ability to stretch. Therefore, when there is a limitation in the full range of motion, the range of muscle fiber extension may be limited.

Based on the previous observations, although acute stretching protocols have been extensively investigated in the context of warm-up and immediate athletic performance, fewer studies have examined the effects of systematically repeated static stretching interventions implemented over several weeks, particularly among youth football players. This distinction is especially important because the present study applied stretching repeatedly during a defined training period rather than immediately before a single performance test. Therefore, the present study addresses a different research question from studies examining the immediate effects of static stretching during pre-performance warm-up routines (Gliga et al., 2026).

Accordingly, the purpose of the present study was to investigate the effects of a repeated static stretching program implemented over several weeks on jump performance among youth football players. By focusing on the potential long-term adaptations associated with systematic stretching, the study aims to provide further evidence regarding the role of chronic static stretching within the physical preparation of young football players.

METHODOLOGY

Objective: The impact of static stretching exercises, performed after physical exercises, on flexibility and squat-jump height.

Hypothesis: There are statistically significant differences that would exist in post-test flexibility and squat-jump height between the experimental group performing SSE and the control group performing small games, after controlling for pre-test scores, in favor of the experimental group.

Participants: All participants were recruited from a single youth football club (Chabab Kais, aged 17-19 years) registered in the Batna Regional Football League. Before participant selection, players with injuries or health conditions that could interfere with participation were excluded. Players who were not regularly compliant with the club's training program were also excluded before the study began. Following the application of these eligibility criteria, 16 players out of 30 players were randomly selected using a lottery procedure. After sample selection, the 16 participants were randomly allocated to either the experimental group (n = 8) or the control group (n = 8) using a separate lottery procedure. Thus, participant selection and group allocation were conducted as distinct stages. All participants completed the study, and no player withdrew after group allocation or during the intervention period.

Measures:

Flexibility Test (Sit and Reach): Purpose of the test: To measure the flexibility of the lower limbs; Required tools: Measuring tape, flexibility box, ruler; Procedure: The participant sits on the floor and places their feet on the flexibility box, which is secured to a wall to prevent movement. The participant places their hands on the ruler, which is placed on the measuring tape fixed on the box, attempting to reach as far as possible without bending the knees. Each player is allowed two attempts with a 05 minute interval between them; the best attempt counts; Scoring method: The distance achieved in the best attempt is measured in centimeters (Miñarro et al., 2009).

Squat-Jump Test (Squat-Jump Height): Purpose of the test: The purpose of this measurement is to assess the height achieved during a squat jump with the lower limbs; Required tools: Measuring tape, whistle, My Jump 2 application; Procedure: The participant stands in a bent-knee position (90-degree knee flexion) with their hands on their hips. Upon hearing the signal, they perform the maximum push with their legs (knees extended) to jump upward and maintain their hands on their hips. Upon landing, the knees should remain extended, landing on the balls of the feet first; Each participant performed three maximal jump attempts following a standardized warm-up and familiarization procedure. The smartphone camera was positioned on a stable support in the sagittal plane, at an appropriate distance to ensure clear visualization of the participant throughout the jumping movement. Videos were recorded using the highest available frame rate supported by an iPhone 13 Pro Max (240 fps). A standardized rest period was provided between consecutive attempts to minimize the influence of fatigue. All videos were subsequently analyzed using the My Jump 2 application by the researcher. The relevant video frames corresponding to take-off and landing were identified according to the application's analysis procedure. The best performance, represented by the highest recorded jump value among the three attempts, was retained for subsequent statistical analysis; Scoring method: Several measurements are taken (the length of the lower limbs with extended toes, the length of the lower limbs in the bent-knee position at 90 degrees), in addition to calculating the body weight with an electronic scale (Anker Smart Scale P1 with Bluetooth). The photography was done with an iPhone 13 Pro Max; The results are then calculated using the My Jump 2 application; many studies have proven the reliability of this application in calculating different types of jumps (Stojiljković et al. 2024; Olmedo et al. 2022; Bogataj et al. 2020; Haynes et al. 2019; Ciacci & Bartolomei, 2017).

Procedure:

The study was conducted between 04/11/2022 and 22/04/2023. November and December were dedicated to preparations, securing approval from the club, players, and their parents, and preparing to administer the pre-tests. On 28/01/2023, pre-tests were administered to both the experimental and control groups. The SSE program was implemented from 29/01/2023 through 20/04/2023. Post-tests were conducted for both groups on 22/04/2023. (The pre- and post-tests) were administered under the same conditions regarding timing and order.

A program comprising 24 SSE for lower-limb muscles (quadriceps, hamstrings, adductors, abductors, and calf muscles) was implemented. The program involved performing two exercises per session, with each exercise repeated three times over the course of the program, with an experimental group of eight players during the competitive season. Training sessions were conducted three times a week (Sundays, Tuesdays, and Thursdays) over twelve weeks, totaling 36 sessions. Each session lasted 90 minutes; the SSE were performed during the final part of the main training phase for about 10 minutes (immediately preceding the cool-down). These exercises were administered only to the experimental group, while the control group engaged in small games during the same period (both groups followed the same physical, plyometric, technical, and tactical training regimen throughout the program). Exercise intensity was consistently set at 100% (The players stretched as far as possible until they felt the onset of stretching pain), achieved by progressively increasing the load to surpass the previous range of motion with each repetition. Although the study did not obtain approval from a human research ethics committee, consent was secured from players over the age of 18; for the five players under 18, both their personal consent and that of their parents or guardians were obtained. The following table outlines the training load (Table 1.)

Table 1. Characteristics of the training load for static stretching exercises

SSE	Intensity	N.E	S.T	N.R	R.B.R	N.S	R.B.S	T.K
The fisrt month	100%	2	10"	04	15"	04	20"	400"
The second month	100%	2	12"	04	15"	04	20"	432"
The thirth month	100%	2	15"	04	15"	04	20"	480"

Note: N.E: Number of Exercises; S.T: Stretching Time; N.R: Number of Repetitions; R.B.R: Rest between Repetitions; N.S: Number of Sets; R.B.S: Rest between Sets; T.K: Time of Work.

Statistical Analysis: All statistical analyses were performed using SPSS version 26. Continuous variables were summarized as means and standard deviations (M ± SD). Before conducting the primary analyses, the assumptions of analysis of covariance (ANCOVA) were assessed. The normality of ANCOVA residuals was evaluated using the Shapiro–Wilk test, and homogeneity of variance was assessed with Levene's test. Baseline differences between the experimental and control groups were examined using independent-samples t-tests. The assumption of homogeneity of regression slopes was tested via the Group × pre-test interaction. As no significant interaction was detected, ANCOVA was deemed appropriate. Separate ANCOVA models were conducted for post-test performance jump and flexibility, with the corresponding pre-test score included as a covariate. For each outcome, adjusted means ± standard error (SE), adjusted mean differences with 95% confidence intervals (CIs), F statistics, degrees of freedom, and p-values were reported. Statistical significance was defined as $p < .05$. Effect sizes were reported as partial eta squared (ηp^2) for the Group × Time interaction and Cohen's d for the between-group difference in change scores. All statistical tests were two-tailed, with significance set at $p < .05$.

RESULTS

Table 2. Descriptive statistics by group and time

Variables	Group	Pre-test M ± SD	Post-test M ± SD	Change M ± SD
Flexibility	Experimental	19.38 ± 3.74	26.50 ± 4.17	7.12 ± 0.83
	Control	19.00 ± 2.39	20.75 ± 2.60	1.75 ± 0.46
Squat-Jump Height	Experimental	13.85 ± 1.24	16.73 ± 1.21	2.88 ± 0.56
	Control	12.88 ± 0.95	14.15 ± 0.87	1.27 ± 0.34
Note. Change = post-test − pre-test. Values are mean ± standard deviation				

Table 2 showed descriptive statistics improvements in both groups from pre-test to post-test. For flexibility, the experimental group increased from 19.38 ± 3.74 to 26.50 ± 4.17, compared with an increase from 19.00 ± 2.39 to 20.75 ± 2.60 in the control group. For squat-jump height, the experimental group increased from 13.85 ± 1.24 to 16.73 ± 1.21, whereas the control group increased from 12.88 ± 0.95 to 14.15 ± 0.87.

Table 3. Assumption checks and baseline comparability

Outcome	Test	Statistic	df	p
Flexibility/normality	Shapiro–Wilk	0.952	—	0.521
Squat-Jump Height /normality	Shapiro–Wilk	0.954	—	0.558
Flexibility/pre-t variance	Levene	0.683	1,14	0.422
Flexibility/pos-t variance	Levene	1.215	1,14	0.289
Squat-Jump Height / pre-t variance	Levene	1.940	1,14	0.185
Squat-Jump Height / pos-t variance	Levene	2.624	1,14	0.128
Flexibility/regression slope	Group × pre-test	0.002	1,12	0.969
Squat-Jump Height / regression slope	Group × pre-test	0.036	1,12	0.853
Flexibility/baseline	Independent t	1.760	14	0.100
Squat-Jump Height /baseline	Independent t	0.239	14	0.815

Table 3 show the assumptions for ANCOVA were adequately met. Shapiro–Wilk tests indicated no significant deviation from normality for the residuals of flexibility (W = 0.952, p = .521) and squat-jump height (W = 0.954, p = .558). Levene's tests were non-significant for both pre- and post-test strength and flexibility scores (all p > .05), indicating homogeneity of variance. The Group × pre-test interaction was also non-significant for flexibility (F(1,12) = 0.002, p = .969) and squat-jump height (F(1,12) = 0.036, p = .853), supporting the assumption of homogeneous regression slopes. Baseline comparisons revealed no significant between-group differences for flexibility (t(14) = 1.760, p = .100) or squat-jump height (t(14) = 0.239, p = .815).

Table 4. ANCOVA results with adjusted group comparisons

Variable	E.G adjusted M ± SE	C.G adjusted M ± SE	Adjusted difference	95% CI	F(1,13)	p	Partial η^2
Flexibility	26.30 ± 0.317	20.95 ± 0.317	5.34	[4.65, 6.03]	283.04	<.001	0.956
Squat-Jump Height	16.31 ± 0.251	14.57 ± 0.251	1.74	[1.19, 2.28]	47.73	<.001	0.786
Note. adjusted mean difference (EG − CG); CI = 95% confidence interval; ηp^2 = partial eta squared.							

Table 4 show after adjustment for pre-test scores, ANCOVA revealed a significant between-group effect in squat-jump height, with higher adjusted scores in the experimental group (M = 16.31, SE = 0.251) than in the control group (M = 14.57, SE = 0.251), yielding an adjusted mean difference of 1.74 (95% CI [1.19, 2.28], p < .001). Similarly, for flexibility, the experimental group demonstrated a higher adjusted mean (M = 26.30, SE = 0.317) than the control group (M = 20.95, SE = 0.317), with an adjusted mean difference of 5.34 (95% CI [4.69, 6.03], p < .001). ANCOVA showed significant group effects for flexibility, F(1,13)=283.04, p<.001, partial η^2=0.956, and squat-jump height, F(1,13)=47.73, p<.001, partial η^2=0.786, with higher adjusted post-test values in the experimental group than in the control group. Within-group paired comparisons also showed significant pre-to-post improvements in both outcomes in both groups (all p<.001). These findings indicate that, after controlling for baseline performance, the experimental group produced significantly greater improvements in both flexibility and performance jump than the control group.

DISCUSSION

The results of the present study demonstrated a clear positive effect of the applied intervention on flexibility in the experimental group compared with the control group, after controlling for baseline differences using analysis of covariance (ANCOVA). The adjusted mean for performance jump was 26.30 ± 0.317 in the experimental group, compared with 20.95 ± 0.317 in the control group, yielding an adjusted mean difference of 1.74 units in favor of the experimental group. The ANCOVA revealed a statistically significant difference between the two groups, F(1,13) = 283.04, p < .001, with a 95% confidence interval for the adjusted mean difference ranging from 4.65 to 6.03. Furthermore, the effect size η^2 = .956 indicated a very large group effect on flexibility after statistically controlling for baseline performance.

The present findings are consistent with those reported by Kataura et al. (2017), which found that static stretching with higher intensity is more effective in increasing the range of motion (ROM) and reducing passive muscle tendon stiffness. The findings of this study also agree with the study by Hirata & Akagi (2024), which aimed to study the acute effects of static stretching on the stiffness of non-muscle tissues in older adults and young adults and whether decreasing the stiffness can improve flexibility of the joints. The results showed that stretching the non-muscle tissues increased ROME and decreased joint stiffness.

The researchers attribute these results to static stretching, which led to increased flexibility of the lower limbs and enhanced joint range of motion. Bacurau et al. (2009) further supported this finding by reporting that static stretching produces greater flexibility improvements than ballistic stretching exercises. Additionally, Mohamed et al. (2016) found that muscle stretching exercises positively influence explosive strength, while Al-Khazraji (2017) observed improvements in shoulder and trunk flexibility resulting from such exercises.

Bryant et al. (2023) aimed to conduct a systematic review of evidence regarding the effects of using different intensities of static stretching on range of motion (ROM) and strength. All studies indicated that static stretching only increases the range of motion; however, eight studies showed that higher intensity of static stretching led to higher increases in range of motion. Arntz et al. (2023) pointed out that chronic SSE leads to significant improvements in flexibility, with more substantial effects for passive exercises. They also noted higher benefits with a higher number of repetitions per exercise and longer stretch durations in each session, as well as a higher total duration of stretching. Železnik et al. (2023) Compared the acute effects of static stretching and proprioceptive neuromuscular facilitation on hamstring stiffness and range of motion. Participants performed the physical activity designed to fatigue hamstring muscles and to measure the length of the muscles. Both SS and PNF increased the ROM, and no significant difference was seen between the two. The conclusion was drawn that both SS and PNF techniques can effectively increase hamstring flexibility.

The results of the present study demonstrated a clear positive effect of the applied intervention on squat-jump height in the experimental group compared with the control group, after controlling for baseline differences using analysis of covariance (ANCOVA). The adjusted mean for squat-jump height was 16.31 ± 0.251 in the experimental group, compared with 14.57 ± 0.251 in the control group, yielding an adjusted mean difference of 1.74 units in favor of the experimental group. The ANCOVA revealed a statistically significant difference between the two groups, $F(1,13) = 47.73$, $p < .001$, with a 95% confidence interval for the adjusted mean difference ranging from 1.19 to 2.28. Furthermore, the effect size $\eta^2 = .786$ indicated a very large group effect on squat-jump height after statistically controlling for baseline performance.

The improvement in squat-jump height may be explained by the characteristics of the intervention program, which may have contributed to improving the ability of the muscles and joints to operate through a more appropriate range of motion, in addition to neuromuscular adaptations associated with movement performance. From a mechanical perspective, improvements in flexibility and range of motion may contribute to the propulsive phase of the jump, thereby potentially enhancing the efficiency of force production during explosive movement. However, these mechanisms should be considered potential explanations, as the present study did not directly assess neural adaptations, muscle architecture, or tendon properties. This is confirmed by Al-Hawari (2021), who states that there is a direct relationship between strengthening muscles and achieving the natural range of motion in joints; the higher the joint's range of motion, the higher the strength of the muscles acting on that joint. Basir (1999) emphasizes the importance of considering the relationship between flexibility development and strength, as there is a strong correlation between stretching exercises and muscular strength.

The present findings are partially consistent with those reported by Kokkonen et al. (2007), who found that a 10-week program of chronic static stretching resulted in improvements in vertical jump and standing long-jump performance, with a notable improvement in vertical jump performance in the stretching group. Similarly, the findings of Donti et al. (2021) suggest that improvements in vertical jump performance may occur during prolonged stretching programs, although the improvement in their study was not independently attributable to the stretching group.

This indicates that the relationship between chronic stretching and jump performance may be influenced by the characteristics of the training program, participants, and performance test employed. Arntz et al. (2023), which indicated that chronic SSE has the potential to enhance muscle strength and power. Al-Khazraji (2017) also adds that muscle stretching exercises improved explosive strength. Palaniappan et al. (2013) found that for enhancing vertical jump performance during explosive-type activities, passive static stretching may be helpful.

In contrast, the present findings are not fully consistent with those of some previous studies. Bazett-Jones et al. (2008) reported that six weeks of static stretching of the hamstrings did not result in significant changes in vertical jump performance. Similarly, Yuktasir and Kaya (2009) found no significant changes in drop-jump performance following six weeks of static stretching, despite significant improvements in range of motion.

These discrepancies among studies may be attributable to several methodological factors, including the duration of the intervention, frequency of stretching sessions, stretching intensity, muscles targeted, participants' characteristics, type of jump test, and method used to assess performance. In addition, chronic responses to static stretching may differ according to the participants' training status and the nature of the sport in which they are engaged. This interpretation is supported by the systematic review and multilevel meta-analysis conducted by Warneke et al. (2024), which reported that the overall effect of chronic static stretching on jumping performance was trivial, while considerable variability was observed across studies according to the type of jump and stretching protocol.

CONCLUSIONS

The present study showed that the SSE produced significant improvements in both flexibility and squat-jump height among under-19 football players. After adjustment for pre-test scores using ANCOVA, the experimental group demonstrated significantly greater post-test values than the control group performing small games. These findings suggest that incorporating SSE into the main part of training may be an effective strategy for improving selected physical performance variables in youth football players.

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