Effects of joint distraction exercises on selected motor parameters in male football players

Efectos de los ejercicios de distracción de cadera sobre el rendimiento físico en futbolistas recreativos

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Abstract

Introduction: Warm-up strategies to enhance joint mobility and motor performance have gained increasing attention in football. However, evidence on the acute effects of joint-distraction exercises remains limited.
Objective: Therefore, this study aimed to investigate the acute effects of joint distraction exercises on selected motor performance parameters in male football players.
Methodology: Twenty-four male university football players (age 22.2 ± 1.4 years) were randomly assigned to a joint-distraction group (n = 12) or a control group (n = 12). Participants completed flexibility, bilateral hip ROM, CMJ, 505 agility, and 30-m sprint tests before and after the intervention.
Results: Significant group × time interaction effects were observed for flexibility ($p = .001$, $\eta p^2 = .386$), right hip ROM ($p = .041$, $\eta p^2 = .177$), left hip ROM ($p = .011$, $\eta p^2 = .257$), CMJ performance ($p = .005$, $\eta p^2 = .302$), and sprint performance ($p = .049$, $\eta p^2 = .164$). No significant interaction effect was found for agility performance ($p > .05$). The joint-distraction group demonstrated superior improvements in ROM and explosive performance parameters compared with the control group.
Discussion: The findings were consistent with previous studies, although agility performance remained unchanged.
Conclusions: These findings suggest that hip joint-distraction exercises may acutely enhance lower-body performance and sprint ability in recreational football players, while having limited influence on change-of-direction performance.

Keywords

Hip distraction; range of motion; countermovement jump; sprint performance; change of direction

Resumen

Introducción: Las estrategias de calentamiento para mejorar la movilidad articular y el rendimiento motor han recibido una atención creciente en el fútbol. Sin embargo, la evidencia sobre los efectos agudos de los ejercicios de distracción articular sigue siendo limitada.
Objetivo: El objetivo de este estudio fue investigar los efectos agudos de los ejercicios de distracción articular sobre determinados parámetros del rendimiento motor en futbolistas masculinos. Metodología: Veinticuatro futbolistas universitarios varones (edad: 22.2 ± 1.4 años) fueron asignados aleatoriamente a un grupo de distracción articular (n = 12) o a un grupo control (n = 12). Los participantes realizaron pruebas de flexibilidad, rango de movimiento bilateral de la cadera, salto con contramovimiento (CMJ), prueba de agilidad 505 y sprint de 30 m antes y después de la intervención. Resultados: Se observaron efectos de interacción significativos grupo × tiempo para la flexibilidad ($p = .001$, $\eta p^2 = .386$), el ROM de cadera derecha ($p = .041$, $\eta p^2 = .177$), el ROM de cadera izquierda ($p = .011$, $\eta p^2 = .257$), el rendimiento en CMJ ($p = .005$, $\eta p^2 = .302$) y el rendimiento en sprint ($p = .049$, $\eta p^2 = .164$). No se encontró un efecto de interacción significativo para el rendimiento en agilidad ($p > .05$). El grupo de distracción articular mostró mejoras superiores en el ROM y en los parámetros de rendimiento explosivo en comparación con el grupo control. Discusión: Los hallazgos fueron consistentes con estudios previos, aunque el rendimiento en la agilidad permaneció sin cambios.
Conclusiones: Estos hallazgos sugieren que los ejercicios de distracción de la articulación de la cadera pueden mejorar de forma aguda el rendimiento del tren inferior y la capacidad de sprint en futbolistas recreativos, mientras que su influencia sobre el rendimiento en cambios de dirección es limitada.

Palabras clave

Distracción articular de la cadera; rango de movimiento; salto con contramovimiento; rendimiento en sprint; rendimiento en cambios de dirección

Introduction

Optimizing warm-up strategies to acutely improve motor performance is an important objective in football, as even small improvements may influence athletic performance. However, despite the growing interest in different warm-up approaches, the acute effects of joint distraction exercises on motor performance in healthy football players remain insufficiently understood. This gap in the current literature provides the rationale for the present study.

Participation in football demands a broad array of motor abilities, encompassing strength, balance, jumping capacity, and the ability to execute swift directional changes. Furthermore, players require sufficient flexibility to bend, turn, and move efficiently during gameplay. These factors are of paramount importance for maintaining optimal health and preventing injuries. Research indicates that 49.3% of football injuries occur when players are not in physical contact with each other. The likelihood of sustaining such injuries is positively correlated with the degree of bodily immobility (Klein et al., 2021; Witvrouw et al., 2003).

The repetitive strain on joints and tendons can result in a decline in physical functionality and overall health. Rather than being directly proportional to joint mobility, injury risk may be influenced by deviations from optimal functional mobility, as both excessive joint laxity and restricted range of motion may adversely affect movement quality and joint function. Researchers have posited that joints become less flexible as training intensifies during the season (Moreno-Pérez et al., 2022; Mosler et al., 2024; Tak et al., 2016) and that excessive mechanical stress on joint surfaces can lead to problems from overuse (Krivickas, 1997). The biomechanics of tendons are of particular significance due to their design to withstand tensile forces (Cook & Purdam, 2009). However, prolonged exposure to compressive loads has the potential to adversely affect the tendon matrix. Such stress can also impede ambulatory function by causing collagen fibers to disengage from their alignment, resulting in the proliferation of cysts, the formation of spurs at bone-tendon junctions, and the stiffness of tendons. These pathophysiological mechanisms also hasten the advancement of overuse tendinopathies (Cook & Purdam, 2009). Given the considerable stress that football exerts on the joints and tendons through repetitive movement, it is imperative to engage in proper warm-up routines. These routines are designed to maintain joint mobility, regulate stress levels on tendons, and enhance performance.

A body of research has previously indicated that the application of warmth to the body prior to engaging in football-related activities has the potential to mitigate the risk of injury by increasing body temperature and decreasing muscle stiffness. Furthermore, the implementation of meticulously designed warm-up regimens has been demonstrated to facilitate enhancements in explosive actions, including jumping, sprinting, and agility (Ayala et al., 2016; Soligard et al., 2018; Silva et al., 2018; Jamshidi et al., 2016; León Muñoz et al., 2024; Firmansyah et al., 2024). Consequently, the scientific community has identified the necessity to identify novel methodologies that would enhance the flexibility and range of motion during training and competition. Joint distraction is a treatment that is gaining popularity. This process facilitates the mobility of the synovial fluid, reduces friction, and enhances joint movement (Prentice, 2024). As reported by Jansen and Mastbergen (2022) the application of joint distraction has been demonstrated to reduce pain, control inflammation by increasing the amount of synovial fluid, and improve mobility by stretching the connective tissues around the joint. These factors may contribute to the maintenance of equilibrium between anabolic and catabolic processes within the cartilage that connects the bones. Although these mechanisms have primarily been described in rehabilitation settings, the resulting temporary improvements in joint mobility may also be beneficial during warm-up in healthy athletes by facilitating movement preparation before sport-specific activities (Jansen & Mastbergen, 2022; Guillot et al., 2019; Taş et al., 2024). These approaches hold particular utility for athletes who prioritize performance enhancement, as they facilitate reduced joint stress and enhance movement efficiency. A significant number of rehabilitation programs incorporate joint distraction exercises; however, there is a paucity of research on their impact on athletes, particularly during the warm-up phase (Guillot et al., 2019; Çağlın et al., 2023; Taş et al., 2024).

Athletes frequently face the expectation of regularly monitoring sport-specific applications and observing changes in motor performance parameters to support optimal performance. In this context, the present study investigated the effects of joint distraction exercises on flexibility, hip flexion range of motion (ROM), countermovement jump (CMJ), 505 change-of-direction performance, and 30-m sprint performance in male soccer players. To the best of our knowledge, this study is among the first to comprehensively examine the acute effects of joint distraction exercises on multiple motor performance parameters in healthy male soccer players, thereby contributing to the current understanding of warm-up strategies in football. It was hypothesized that performing joint-distraction exercises during the warm-up would acutely improve flexibility, hip flexion range of motion, countermovement jump performance, 505 change-of-direction performance, and 30-m sprint performance in healthy male football players compared with a standard warm-up alone.

Method

Study Design

This study was designed as a randomized, single-blind, parallel two-group pretest–posttest experimental trial, in which participants were randomly allocated to either the joint-distraction group or the control group. The study investigated the acute effects of banded hip joint-distraction exercises, performed following a standardized warm-up protocol, on selected motor performance parameters. All measurements were conducted under standardized environmental conditions, and performance assessments were carried out by investigators blinded to group allocation. Written informed consent was obtained from all participants prior to participation. This study was approved by the Ethics Committee of İstanbul Gelişim University (Decision No: 2025-01-07, dated January 10, 2025) and was conducted in accordance with the principles of the Declaration of Helsinki.

Participants

A total of 24 recreational male football players voluntarily participated in the study and were randomly assigned to either the joint-distraction group (n = 12; age 22.50 ± 1.09 years; height 177.17 ± 5.49 cm; body mass 76.31 ± 11.01 kg; BMI 24.85 ± 4.60 kg/m^2) or the control group (n = 12; age 21.92 ± 1.68 years; height 179.08 ± 6.47 cm; body mass 73.27 ± 10.24 kg; BMI 22.50 ± 2.79 kg/m^2). All participants were university students with a minimum of five years of football experience and engaged in regular football training at least three times per week. Inclusion criteria required the absence of lower extremity injury within the previous six months and no history of chronic musculoskeletal or neuromuscular disorders. Exclusion criteria included any acute injury or medical condition that could affect physical performance, as well as smoking, the use of dietary supplements, or medications that could influence physical performance.

Procedure

All procedures were conducted during the spring semester under standardized field conditions. To ensure data reliability, participants were instructed to refrain from alcohol, caffeine, and any performance-enhancing substances for at least 24 hours prior to each testing session.

During the first session, all participants completed a standardized 15-minute routine warm-up. Following the warm-up, baseline (pre-test) measurements were obtained in a participant-level randomized order and included anthropometric measurements, flexibility, hip flexion range of motion (ROM), countermovement jump (CMJ), 505 agility test, and 30-m sprint performance. Each test was performed twice, and the best value was retained for statistical analysis.

Rest intervals were standardized as follows: 4–5 minutes between different test modalities; 2–3 minutes between repeated CMJ and 505 trials; 4–5 minutes between 30-m sprint trials; and at least 2 minutes between the remaining measurements.

After 48 hours, participants returned for the post-test session and repeated the same standardized 15-minute warm-up protocol. Immediately thereafter, the joint-distraction group performed the joint-distraction protocol consisting of quadruped posterior hip distraction, half-kneeling anterior hip distraction, and quadruped lateral hip distraction exercises (2 × 30 s per exercise, 15 s inter-set rest, bilateral application). Following a standardized 5-minute passive recovery period, the full test battery was repeated in the same randomized order. The control group did not perform the joint-distraction protocol and instead remained seated in passive rest for an equivalent duration before repeating the same post-test battery.

Assessors responsible for performance measurements were blinded to group allocation (single-blind design). Group allocation was performed using block randomization. All sessions were conducted at the same time of day under standardized environmental conditions (22–24°C) using the same field and equipment to minimize circadian and environmental variability.

Figure. 1 Research procedure

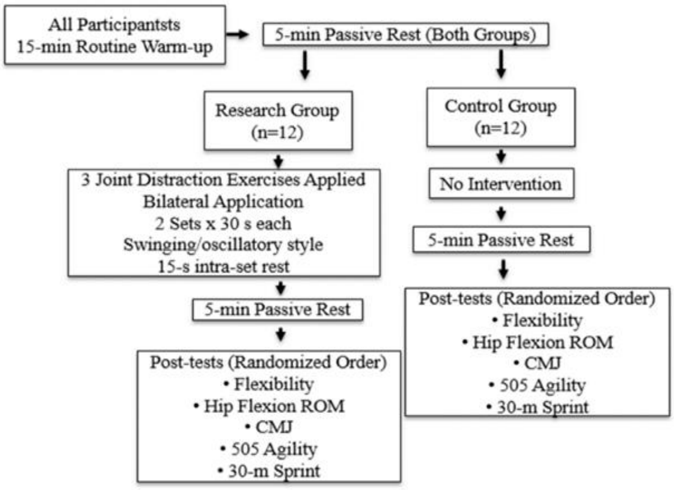
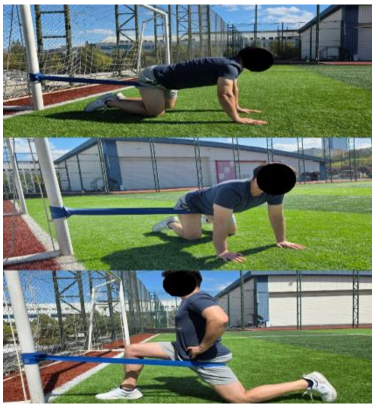


Table 1. Banded hip distraction exercises and set–rest parameters.

Exercise	Distraction direction	Sets	Duration per set	Rest between sets
Quadruped Posterior Hip Distraction	Posterior pull	2	30 s per set	15 s between sets
Half-Kneeling Anterior Hip Distraction	Anterior pull	2	30 s per set	15 s between sets
Quadruped Lateral Hip Distraction	Lateral pull	2	30 s per set	15 s between sets

Figure 2. Joint distraction exercises



Instrument

Anthropometrics

Body mass was measured using a calibrated digital scale (Tanita HD 366, Tanita Corp., Tokyo, Japan) with a precision of 0.1 kg, and standing height was assessed using a telescopic stadiometer (ADE-MZ10023, ADE Germany GmbH, Germany) with a precision of 0.1 cm. All measurements were performed with participants barefoot and wearing light sports clothing. Height was measured with participants standing upright, head positioned in the Frankfurt plane, and body mass was recorded with participants standing still at the center of the scale platform.

Flexibility

Hamstring and lower-back flexibility were assessed using the sit-and-reach test with a standardized flexibility box (Model 01285A, Lafayette Instrument Company, Lafayette, USA; sensitivity 0.1 cm). The testing protocol followed standardized procedures commonly used in sports science research. Evidence from a recent meta-analysis indicates that sit-and-reach tests have moderate criterion-related validity for estimating hamstring extensibility when compared with criterion measures (e.g., passive straight-leg raise) in adult populations (Mayorga-Vega et al.,2014).

Participants were seated on the floor with knees fully extended, feet placed flat against the testing box, and heels aligned at the 23 cm reference mark. The 23 cm offset corresponds to the standardized zero point of the sit-and-reach apparatus, allowing both negative and positive scoring relative to anatomical reference positions. Participants slowly reached forward with both hands placed one over the other, pushing the sliding ruler as far as possible without flexing the knees. The final position was maintained for approximately two seconds. Each participant performed two trials separated by a brief recovery period, and the highest value (cm) was retained for analysis (Mayorga-Vega et al.,2014).

Hip Flexion Range of Motion (ROM)

Bilateral hip flexion range of motion (ROM) was assessed using the MyROM feature of the MyJump Lab mobile application (iPhone 15 Pro, Apple Inc., Cupertino, CA, USA). Recent research provides evidence that smartphone-based goniometric measurements are valid and reliable alternatives to traditional universal goniometers for joint ROM assessment in healthy populations (Keogh et.al., 2019; Shimizu et al., 2022; Saraç et al., 2022).

Participants were positioned supine on a firm surface with the contralateral limb extended. The smartphone was placed superior to the patella of the examined limb and aligned longitudinally with the femur. Participants were instructed to perform a controlled active hip flexion movement to the end of their available range while maintaining knee extension and pelvic stability. The terminal position was held for 1–2 seconds, and the angle was recorded in degrees (°). Each participant performed two trials for each limb, and the highest value was retained for statistical analysis.

Counter-Movement Jump (CMJ)

We used a portable bidirectional force platform (FDlite Forcedeck; VALD Performance, Sydney, Australia) to take these measurements. The players were told to stand up straight with their feet shoulder width apart, their knees straight, and their hands on their hips. After that, they were told to perform a quick squat with their knees bent at approximately 90° and then jump as high as they could without stopping. Each participant took two tests, and the best score was used for analysis (Balsalobre-Fernández et al., 2015; McMahon et al., 2018). The VALD ForceDecks software was used with its default configuration throughout all assessments. Before data collection, each participant completed one familiarization trial to ensure understanding of the testing procedure.

505 Change-of-Direction Test

Change-of-direction performance was evaluated using the 505 agility test conducted on a standard outdoor football field. Timing was measured using electronic photocell gates (SmartSpeed, Fusion Sport, Brisbane, Australia) positioned at hip height (approximately 1.0 m). Participants began from a standing start and accelerated over a 10-m distance before crossing the timing gate placed at the 15-m mark. After crossing the gate, participants continued for an additional 5 m, executed a 180° turn off the designated turning line, and sprinted back 5 m through the same gate. The time recorded corresponded to the 5-m sprint following the change of direction. Each participant performed two trials with a standardized 3-minute rest interval between attempts. The best time (s) was retained for statistical analysis. Recent research has demonstrated that the 505 change-of-direction (CoD) test exhibits moderate to excellent reliability across standard and modified protocols, supporting its use as a valid measure of change-of-direction speed in physically active populations (Živković et al., 2025).

Sprint Performance

Sprint performance over 30 meters was assessed using electronic timing gates (SmartSpeed, Fusion Sport, Brisbane, Australia). The timing gates were positioned at the start and finish lines at approximately hip height (1.0 m). Participants began from a standing start position 1 m behind the first timing gate to avoid premature triggering. On the tester's command, participants performed a maximal sprint over the full 30-m distance. Two trials were completed with a standardized 3-minute passive recovery period between attempts to minimize fatigue effects. Sprint time was recorded in seconds (s), and the fastest trial was retained for statistical analysis. Electronic timing systems are widely accepted as reliable and valid tools for assessing sprint performance in team-sport athletes (Haugen & Buchheit, 2016).

Data analysis

Statistical analyses were performed using SPSS (version 24, IBM Corp., Armonk, NY, USA). Data are presented as mean ± standard deviation (SD) and 95% confidence intervals (CI). The normality of data distribution was assessed using the Shapiro–Wilk test. The assumptions of homogeneity of variances and homogeneity of covariance matrices were evaluated using Levene's test and Box's M test, respectively, prior to conducting the mixed-design ANOVA. After confirming the suitability of the data for parametric analyses, parametric analyses were conducted.

A two-way mixed-design ANOVA was conducted to examine the interaction between group (research vs. control) and time (pretest vs. posttest). Main effects for group and time were also evaluated. Statistical significance was set at $p < 0.05$. When a significant main effect or interaction was detected, pairwise comparisons with Bonferroni adjustment were performed to control for multiple testing.

Effect sizes were calculated using partial eta squared (ηp^2) and interpreted as small (0.01), medium (0.06), and large (0.14) according to Cohen (1988). To provide a comprehensive interpretation of both statistical and practical significance, percentage changes, effect sizes, and confidence intervals were reported. A post-hoc sensitivity power analysis was performed using G*Power (version 3.1, Heinrich Heine University, Düsseldorf, Germany). A post-hoc sensitivity analysis was performed using G*Power (version 3.1, Heinrich Heine University, Düsseldorf, Germany). Based on a total sample of 24 participants (12 per group) and an alpha level of 0.05, the minimum detectable effect size for the interaction effect was $f = 0.52$ ($\eta p^2 \approx 0.21$), corresponding to a large effect size

Results

Table 2 presents a summary of the analysis results, including the main effects of time and group, as well as the time × group interaction. An examination of the data revealed statistically significant effects for flexibility, right hip flexion ROM, and left hip flexion ROM ($p < .05$ For flexibility, significant effects were observed for time ($F = 16.265$, $p = .001$, $\eta^2 = .425$, large effect size), the time × group interaction ($F = 13.814$, $p = .001$, $\eta^2 = .386$, large effect size), and group ($F = 25.439$, $p < .001$, $\eta^2 = .536$, large effect size). For right hip flexion ROM, significant effects were found for time ($F = 14.326$, $p = .001$, $\eta^2 = .394$, large effect size) and the time × group interaction ($F = 4.728$, $p = .041$, $\eta^2 = .177$, large effect size), whereas the group effect was not statistically significant ($p = .112$). Similarly, left hip flexion ROM showed significant effects of time ($F = 10.894$, $p = .003$, $\eta^2 = .331$, large effect size), the time × group interaction ($F = 7.602$, $p = .011$, $\eta^2 = .257$, large effect size), and group ($F = 13.884$, $p = .001$, $\eta^2 = .387$, large effect size). Bonferroni-adjusted pairwise comparisons indicated that flexibility significantly increased in the research group ($p < .001$), whereas no significant change was observed in the control group ($p = .646$). Likewise, significant improvements in right hip flexion ROM ($p < .001$), left hip flexion ROM ($p = .001$), and sprint performance ($p = .004$) were detected only in the research group. No significant pre–post differences were observed in the control group for right hip ROM ($p = .444$), left hip ROM ($p = .916$), or sprint performance ($p = .825$). In addition, countermovement jump performance significantly increased in the research group ($p = .008$), while the control group demonstrated a significant pre–post decrease ($p = .010$).

Note: η^2 = partial eta squared. Effect size interpretation: small = .01, medium = .06, and large = .14 (Cohen, 1988). $p < .05$, $p < .01$.

Table 2. ANOVA Results for Time, Group, and Time × Group Interaction in Football Players

Variables	Time Effect			Time × Group Effect			Group Effect		
	F	p	η^2	F	p	η^2	F	p	η^2
Flexibility (cm)	16.265	.001**	.425	13.814	.001**	.386	25.439	<.001**	.536
Right range of motion(0)	14.326	.001**	.394	4.728	.041*	.177	2.745	.112	.111
Left range of motion (0)	10.894	.003**	.331	7.602	.011*	.257	13.884	.001**	.387
Countermovement Jump (cm)	0.471	.500	.021	9.533	.005**	.302	2.057	.166	.085
Sprint (s)	3.216	.087	.128	4.328	.049*	.164	1.911	.181	.080
Agility (s)	1.361	.256	.058	0.937	.344	.041	0.062	.805	.003

As shown in Table 3, the research group demonstrated clear improvements in flexibility, hip flexion ROM, and CMJ performance, with percentage increases ranging from 3.7% to 6.5% and corresponding medium effect sizes. Sprint performance increased slightly (+1.5%), whereas agility showed a small reduction (−1.6%); however, this change did not reach statistical significance and was not considered meaningful.

In the control group, only small and statistically nonsignificant changes were observed in flexibility (+0.04%), right hip flexion ROM (+1.0%), left hip flexion ROM (+0.7%), sprint performance (+0.2%), and agility (≈0%). A 3.0% decrease in CMJ performance was observed, but this change was not statistically significant. These results indicate that the joint distraction exercise program improved flexibility, hip flexion ROM, and CMJ performance, particularly in the study group. Note. The values are presented as the means ± SDs and 95% confidence intervals. According to Cohen (1988), partial η^2 values were interpreted as small (.01), medium (.06), or large (.14).

Table 3. Pre- and Posttest Means, Percentage Changes, and Effect Sizes of the Research and Control Groups.

Group	Variable	Pretest (Mean ± SD)	95% CI	Posttest (Mean ± SD)	95% CI	Change (%)	Effect Size
Research Group	Flexibility (cm)	31.13 ± 4.52	27.88 - 34.37	33.17 ± 4.73	29.96 -36.37	+6.5%	Medium
	Right range of motion (^{0})	75.57 ± 5.72	71.30 –79.83	78.34 ± 5.99	74.54 - 82.14	+3.7%	Medium
	Left range of motion (^{0})	69.06 ± 6.72	65.41 –72.70	73.52 ± 7.53	69.36 – 77.68	+6.4%	Medium
	Countermovement Jump (cm)	35.43 ± 6.90	31.91 –38.95	37.00 ± 7.20	33.03 – 40.97	+4.4%	Medium
	Sprint (s)	4.76 ± 0.14	4.64 – 4.88	4.69 ± 0.16	4.57 – 4.82	−1.5%	Small
	Agility (s)	2.43 ± 0.11	2.34 – 2.51	2.39 ± 0.13	2.30 – 2.48	−1.6%	None
Control Group	Flexibility	21.08 ± 6.20	17.84 –24.33	21.17 ± 5.92	17.96 – 24.37	+0.4%	None
	Right range of motion (^{0})	72.08 ± 8.28	67.82 –76.35	72.83 ± 6.68	69.04 – 76.63	+1.0%	None
	Left range of motion (^{0})	61.53 ± 5.39	57.89 –65.18	61.93 ± 6.31	57.77 – 66.09	+0.7%	Small
	Countermovement Jump (cm)	33.09 ± 4.64	29.57 –36.61	32.09 ± 6.01	28.12 – 36.06	−3.0%	None
	Sprint (s)	4.61 ± 0.24	4.50 – 4.73	4.62 ± 0.24	4.50 – 4.74	+0.2%	None
	Agility (s)	2.42 ± 0.15	2.34 – 2.50	2.42 ± 0.16	2.33 – 2.51	~0%	None

Discussion

The objective of this study was to examine the impact of joint distraction exercises on specific motor parameters in male soccer players. The findings indicate that the incorporation of joint distraction exercises into the warm-up routine led to significant improvements in flexibility and hip flexion range of motion (ROM). In addition, a significant time × group interaction with a large effect size was observed for countermovement jump (CMJ) performance, indicating a favorable change in the joint-distraction group compared with the control group. A significant time × group interaction was also found for sprint performance, with post-hoc comparisons showing a significant reduction in sprint time in the joint-distraction group but not in the control group. However, no significant effect was observed for agility performance.

The utilization of joint distraction exercises in clinical settings is predominantly aimed at alleviating pain (Puentedura & O'Grady, 2015). The impact of these exercise techniques on athletic performance is a nascent area of research. In the domain of sports medicine, elastic bands are utilized to induce joint distraction, a procedure that can be readily executed in a variety of settings. When elastic bands are utilized for joint distraction, a constant tensile resistance is generated, thereby increasing synovial fluid circulation within the joint and supporting the nutrition of the fibrocartilage within the joint (Guillot et al., 2019).

A review of studies by Taş et al. (2024) indicated that the incorporation of joint distraction exercises into warm-up routines resulted in significant improvements in flexibility and range of motion among female volleyball players. Guillot et al. (2019) reported that rugby players who performed joint distraction exercises using foam rollers and elastic bands demonstrated both short- and long-term improvements in flexibility. In a long-term investigation, Teichmann et al. (2021) demonstrated that improvements in hip flexibility were associated with the correction of muscular imbalances and a reduced risk of injury in athletes. In accordance with the extant literature, the increases in flexibility and ROM observed in the present study are consistent with previous research. The collective analysis of this body of evidence suggests that joint distraction exercises may contribute to injury prevention in football players by enhancing joint range of motion and flexibility. This assertion is further substantiated by Knapp (2016) who reported that the integration of self-myofascial release with elastic-band-based joint distraction exercises led to augmented range of motion, diminished muscular imbalances, and enhanced athletic performance in female athletes. However, a number of studies have indicated that while mobilization exercises utilizing elastic bands may yield substantial short-term benefits, their impact on the enhancement of performance parameters over an extended timeframe is reportedly limited (Konrad & Tilp, 2014). This finding underscores the necessity for additional long-term research to be conducted in this area.

In their study on soccer players, Holland et al. (2015) reported that ankle mobilization techniques resulted in improved dorsiflexion range of motion. The improvements in hip ROM obtained in our study are similar to those reported in previous studies, suggesting that joint distraction may be an effective method for increasing ROM in athletes. Concurrently, Hudson et al. (2017), reported that the concurrent administration of neuromuscular stabilization exercises in conjunction with the Mulligan concept led to a reduction in functional movement limitations and an enhancement in shoulder mobility among soccer players. Guillot et al. (2019) reported increases in flexibility and ROM following 5–7 weeks of joint distraction exercises in rugby players. These findings suggest that more pronounced effects may be observed with longer intervention periods. Furthermore, Afonso et al. (2021) have indicated that mobilization exercises do not uniformly result in increases in ROM, suggesting that their effects may be contingent on individual characteristics. It has been established that increases in ROM have a positive effect on strength parameters (Pinto et al., 2012; Taş et al., 2024). Çağlın et al. (2023) reported that joint distraction exercises performed with elastic bands increased maximal strength in the lower extremities of male bodybuilders. The subsequent enhancement in CMJ performance is believed to be a consequence of the augmented ROM. In a similar vein, Pinto et al. (2012) and Schoenfeld and Grgic (2018) reported that increased range of motion (ROM) positively contributed to lower extremity strength development. Additionally, Driller and Overmayer (2017) and other researchers (Panoutsakopoulos et al., 2022; Yun et al., 2016; Roso-Moliner et al., 2023) reported a positive relationship between ankle dorsiflexion ROM and jump performance. Roso-Moliner et al. (2023) posited that restricted range of motion (ROM) is a variable that impedes jump performance. Upon evaluation of the studies, it is evident that enhancements in CMJ performance are predominantly associated with augmented flexibility and ROM. However, a number of meta-analyses have reported that improvements in range of motion (ROM) do not necessarily translate into substantial strength and countermovement jump (CMJ) performance. These benefits may be constrained, particularly in professional athletes (Behm et al.,2016). This observation may provide a rationale for the findings reported in our study.

Taş et al. (2024) reported that joint distraction exercises applied to the lower extremities during warm-up improved both vertical and horizontal jump performance. Concurrently, research has demonstrated that dynamic stretching techniques enhance flexibility and contribute to improvements in sprint and CMJ performance (Opplert & Babault, 2018). Melocchi et al. (2020) reported that dynamic stretching improved CMJ scores and joint range of motion in female gymnasts. The findings of this study lend support to the existing body of literature that demonstrates a positive correlation between flexibility and increased range of motion (ROM) on one hand, and CMJ performance on the other. However, contradictory findings have been reported in the literature. Specifically, some studies have indicated that dynamic stretching and mobilization techniques do not always lead to significant improvements in sprint or CMJ performance (Kay & Blazevich, 2012). These disparities are hypothesized to be attributable to the duration and intensity of the exercises and the intrinsic dynamics of the sports branches. The findings of our research indicated that joint distraction exercises exerted no significant influence on parameters associated with sprinting or agility. McMillian et al. (2006) reported that dynamic warm-up programs improved strength and agility, whereas static stretching did not have these effects. A systematic review by Silva et al. (2018) also concluded that dynamic warm-up strategies improved sprint, agility, and countermovement jump (CMJ) performance in team sports, whereas static stretching had limited effects. Fletcher and Jones (2004) reported that dynamic stretching reduced sprint times, whereas static and passive protocols negatively affected sprint performance. Collectively, these findings suggest that a single session of joint distraction may not be sufficient to improve sprint performance. A number of researchers have underscored the potential limitations of warm-up programs in affecting skills that necessitate coordination, such as sprinting and agility (Samson et al., 2012). Elastic bands have been demonstrated to offer distinct advantages over free bands in terms of enhancing muscle strength, power, and speed (Wallace et al.,2006). This superiority can be attributed to the variable resistance created by elastic bands. Moreover, resistance exercises performed through a wide range of motion have been documented to augment muscular hypertrophy and strength (Hadamus et al., 2022; Hopkins, 2000). In a study involving 17 male bodybuilders, joint distraction exercise performed during warm-up significantly increased the maximal strength of squat movements (Çağlın et al., 2023). Research focusing on the combined use of proprioceptive neuromuscular facilitation (PNF) techniques and elastic bands has described improvements in strength and balance outcomes (Choi, 2019). In older adults, 12-week exercise protocols involving elastic bands have been associated with gains in range of motion and muscle strength, along with favorable changes in quality of life (Park et a.l 2015; Lee et al., 2022). A comparison of elastic-band-based exercises and free-weight training has been demonstrated to indicate that the former may result in more limited long-term strength adaptations (Anderson et al., 2008). In this particular context, elastic band exercises seem to function more effectively as a supportive training component than as a primary method for strength development.

From a practical perspective, the findings suggest that incorporating joint-distraction exercises into the warm-up may be a useful strategy for acutely improving flexibility, hip flexion range of motion, countermovement jump performance, and sprint performance in healthy male football players. Coaches and strength and conditioning professionals may consider including these exercises as part of pre-exercise warm-up routines when the objective is to optimize acute neuromuscular performance.

Conclusions

The findings of the present study indicate that joint distraction exercises improve flexibility and range of motion in soccer players, which may be associated with improvements in CMJ performance. The results of the present study are largely consistent with those of previous studies in the literature, which have demonstrated that increasing ROM contributes positively to other performance parameters. A secondary finding of our study was that no significant effect was identified on sprint or agility parameters. In light of the inconsistent findings reported in the extant literature, the efficacy of interventions such as the present approach appears to be influenced by multiple factors, including individual characteristics, intervention duration, and athlete background. Consequently, subsequent studies should take these factors into consideration and encompass long-term applications in conjunction with acute applications.

Limitations

The present study has several important strengths. First, its randomized and single-blind controlled design enhances internal validity by limiting potential allocation and assessment bias. Second, the use of standardized, reliable, and field-based performance assessments allows direct comparison with existing football and sports performance literature. Third, the intervention protocol was deliberately designed to be time-efficient, low-cost, and easily applicable within real-world warm-up routines, thereby increasing the ecological validity and practical relevance of the findings for coaches and practitioners. Fourth, all testing procedures were conducted under standardized environmental conditions, with controlled warm-up duration and rest intervals, minimizing potential confounding effects related to fatigue or circadian variation. Importantly, the study provides novel insight into the acute effects of joint distraction exercises when implemented specifically during the warm-up phase, addressing a gap in the literature where most previous studies have focused on rehabilitation or longer-term interventions. Together, these strengths support the methodological rigor of the study and the practical applicability of its findings in football-specific contexts. Despite these strengths, the findings of the present study should be interpreted in light of the following limitations. The number of athletes included in the present study was relatively small, and the exclusive inclusion of male football players limits the generalizability of the findings to other populations. Furthermore, due to the acute design of the study, conclusions regarding potential long-term adaptations cannot be drawn. Although a randomized test order was implemented to reduce fatigue and measurement error, administering the full test battery on the same day may have contributed to residual fatigue effects. Performance outcomes were derived from the best value obtained across two trials for each test, which, while commonly applied in performance research, may have introduced some variability in the measurements.

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