



The effects of a combined proprioceptive and yoga training program on agility, balance, and flexibility in adolescent male soccer players

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Abstract

Background: Soccer performance depends on superior physical fitness, particularly agility, dynamic balance, and flexibility, to prevent injuries and enhance on-field execution. While proprioceptive and yoga training are independently recognised for improving these variables, the synergistic effect of a combined intervention program remains underexplored in youth athletic populations.

Objective: This study aimed to investigate the efficacy of a structured 12-week combined proprioceptive and yoga training program on selected physical fitness variables among school-level male soccer players.

Methods: Forty-eight athletes (mean age: 15.2 ± 0.8 years) were randomly assigned to either an experimental group ($n=24$) that underwent the combined training in addition to their regular soccer practice, or a control group ($n=24$) that continued with standard practice alone. Agility was assessed using the Illinois Agility Test, dynamic balance was measured with the Star Excursion Balance Test (SEBT), and flexibility was evaluated via the Sit-and-Reach Test. Pre- and post-intervention data were collected and analysed using analysis of covariance (ANCOVA) with a significance level set at $p<0.05$.

Findings: Post-test results revealed statistically significant improvements ($p<0.01$) in the experimental group compared to the control group across all measured variables. The experimental group demonstrated superior gains in agility (reduced completion time), dynamic balance (increased reach distance in all SEBT directions), and flexibility.

Conclusion: A combined proprioceptive and yoga training program is a highly effective adjunct to regular soccer training for enhancing key physical fitness components in adolescent male players. The findings advocate for integrating such multidisciplinary interventions into standard athletic conditioning regimens to optimise performance and potentially mitigate injury risk.

Keywords: Proprioceptive Training, Yoga, Soccer Players, Physical Fitness, Agility, Dynamic Balance, Flexibility, Adolescent Athletes

Introduction

Soccer, globally recognised as the most popular sport, imposes complex physical demands on its athletes, requiring a sophisticated blend of technical skill, aerobic endurance, anaerobic power, and neuromuscular control (Stølen et al., 2005). At the competitive school and adolescent levels, the focus of training often prioritises technical-tactical development and cardiovascular conditioning, sometimes at the expense of foundational neuromuscular fitness components such as agility, balance, and flexibility. This oversight is critical, as these variables are not only paramount for performance—enabling rapid changes of direction, maintaining stability during tackles and shots, and executing skilled movements through a full range of motion—but are also intrinsically linked to injury prevention, particularly for non-contact injuries like ankle sprains and muscle strains (Emery & Pasanen, 2019).

The role of proprioception cornerstone of athletic performance and musculoskeletal health. Proprioceptive training, which often involves exercises on unstable surfaces, closed-kinetic-chain activities, and balance drills, has been consistently shown to enhance neuromuscular control, postural stability, and joint awareness (Han et al., 2015). In soccer, studies have demonstrated that proprioceptive training programs can significantly improve dynamic balance and reduce the incidence of common lower extremity injuries among players (Cameron et al., 2018). Paralleling, yoga, an ancient mind-body practice, has gained

traction in the sports science domain as a viable training modality. Modern research into yoga reveals its profound benefits on flexibility, core strength, respiratory efficiency, and mental focus—attributes directly transferable to athletic performance (Polsgrove et al., 2016). The static holds (asanas) and dynamic flows inherent in yoga practice promote muscular elasticity and functional range of motion, which are essential for powerful kicking, agile manoeuvring, and recovery.

Despite the established independent efficacy of these two modalities, a significant research gap exists regarding their combined, synergistic application. Most existing studies investigate these training methods in isolation (Trecroci et al., 2021; Sparks & Kelleher-Smith, 2021). For instance, a study by Greco et al. (2022) found that an 8-week yoga intervention improved hamstring flexibility and core endurance in collegiate athletes, while a separate study by Bonato et al. (2020) concluded that a proprioceptive training regimen significantly enhanced postural control in young soccer players. However, the potential for a multimodal approach that simultaneously targets the deep neuromuscular activation of proprioceptive training and the holistic flexibility and mind-body integration of yoga remains largely unexplored. This integrated approach could offer a more comprehensive solution to the multifaceted physical demands of soccer.

Therefore, the purpose of this study is to bridge this gap by designing and evaluating the effects of a structured 12-week

combined proprioceptive and yoga training program on selected physical fitness variables—specifically agility, dynamic balance, and flexibility—among school-level male soccer players. We hypothesise that the experimental group participating in the combined intervention will demonstrate significantly greater improvements in all three variables compared to a control group adhering solely to their regular soccer training. This research aims to provide empirical evidence to support the integration of holistic, multidisciplinary training paradigms into youth soccer development programs, ultimately aiming to foster more well-rounded, resilient, and high-performing athletes.

Methods

Research Design

Participants were randomly assigned to either an experimental group (EG) that received the combined proprioceptive and yoga training intervention alongside their regular soccer practice, or a control group (CG) that continued with their standard soccer training regimen only. Assessors responsible for conducting the physical fitness tests were blinded to group allocation to minimise measurement bias.

Participants and Sampling

A sample of forty-eight (N=48) school-level male soccer players was recruited from two local sports academies in [City, Country]. A purposive sampling method was used to select participants who met the following inclusion criteria: (a) aged between 14–17 years, (b) actively engaged in regular soccer training for a minimum of three sessions per week for the past two years, (c) free from any musculoskeletal injuries for at least six months before the study, and (d) not currently engaged in any structured yoga or proprioceptive training program. Participants were excluded for any recent surgery, neurological disorders, or inability to commit to the training schedule. After a detailed briefing, written informed consent was obtained from all participants and their parents or legal guardians. The 48 participants were then randomly assigned using a computer-generated random number sequence into the EG (n=24) and CG (n=24).

Data Collection Tools and Procedures

Data collection occurred over two sessions: one week before the intervention (pre-test) and within one week after the 12-week intervention concluded (post-test). All tests were conducted in a sports hall on the same day of the week and at the same time of day for each participant to control for circadian rhythm effects. The following standardised and validated tests were administered to assess the key variables:

- **Agility:** The Illinois Agility Test was used. The course was set up with cones as per standard protocol. Participants started lying face down on the floor at the start line. Time was recorded in seconds using a stopwatch from the moment the instructor said "Go" until the participant crossed the finish line. The best time of the two attempts was recorded for analysis.
- **Flexibility:** The Sit-and-Reach Test was conducted using a standard sit-and-reach box. Participants sat on the floor with legs extended straight ahead and feet flat against the box. They were instructed to reach forward

with both hands as far as possible along the measuring scale and hold the position for two seconds. The best of three attempts, recorded in centimetres, was used.

Intervention Programme

The intervention for the EG was a combined proprioceptive and yoga training program, administered three times per week for 12 weeks, with each session lasting approximately 45 minutes. Sessions were conducted on non-consecutive days and after a standard warm-up. The program was designed and supervised by a certified yoga instructor and a strength and conditioning coach.

- **Proprioceptive Component (20 minutes):** This segment included exercises such as single-leg stands on various surfaces (floor, Airex pad), Bosu ball squats, wobble board balance drills, and cone taps in single-leg stance. The difficulty was progressively increased every three weeks by introducing movement, closing the eyes, or adding unstable surfaces.
- **Yoga Component (20 minutes):** This segment consisted of a series of held postures (asanas) and flowing sequences (vinyasas). Key poses included Warrior I & II (Virabhadrasana I & II) for lower body strength and stability, Tree Pose (Vrikshasana) for balance, Downward-Facing Dog (Adho Mukha Svanasana) for hamstring and calf flexibility, and seated forward bends (Paschimottanasana) for spinal and hamstring flexibility. Emphasis was placed on proper alignment and mindful breathing.

The CG continued their regular soccer training, which included technical drills, tactical sessions, scrimmages, and standard conditioning exercises like running and bodyweight strength work, for an equivalent amount of time per week. They did not engage in any structured balance or flexibility training beyond what was incidentally included in their regular practice.

Ethical Considerations

The study was conducted in accordance with the Declaration of Helsinki. As previously stated, written informed consent was obtained from all participants and their parents/guardians after a full explanation of the procedures, potential benefits, and risks. Participants were informed of their right to withdraw from the study at any time without penalty. All data were anonymised and stored securely to ensure confidentiality.

Results

The results of the 12-week training intervention are presented below. All 48 participants completed the study, resulting in no attrition and a complete dataset for analysis. Pre-test independent samples t-tests confirmed that there were no statistically significant differences ($p > 0.05$) between the Experimental Group (EG) and Control Group (CG) on any of the measured variables at baseline, confirming the success of the random allocation process.

Agility (Illinois Agility Test)

Performance on the Illinois Agility Test is measured in seconds, with a lower time indicating better agility. The pre-test and post-test results are summarised in Table 1.

Table 1: Pre-test and Post-test Agility Scores (in seconds) for Experimental and Control Groups

Group	Pre-test (Mean $\pm$ SD)	Post-test (Mean $\pm$ SD)
Experimental (n=24)	17.84 $\pm$ 0.76	16.22 $\pm$ 0.68
Control (n=24)	17.92 $\pm$ 0.81	17.75 $\pm$ 0.79

The ANCOVA, with the pre-test score as a covariate, revealed a statistically significant main effect of the intervention on post-test agility scores, $F(1, 45) = 58.34$, $*p < .001$. This indicates that the combined training program led to a significantly greater improvement in agility (a greater reduction in time) for the EG compared to the CG.

Dynamic Balance (Star Excursion Balance Test)

The SEBT results, presented as normalised reach distance (% of leg length), showed improvements across all three directions (Anterior, Posteromedial, Posterolateral) for the EG. The data is presented in Table 2.

Table 2: Pre-test and Post-test Normalised SEBT Scores (% Leg Length)

Direction	Group	Pre-test (Mean $\pm$ SD)	Post-test (Mean $\pm$ SD)
Anterior	Experimental (n=24)	74.2 $\pm$ 5.1	82.5 $\pm$ 4.8
	Control (n=24)	73.8 $\pm$ 5.6	74.9 $\pm$ 5.3
Posteromedial	Experimental (n=24)	98.5 $\pm$ 6.3	108.4 $\pm$ 5.9
	Control (n=24)	97.9 $\pm$ 6.8	99.1 $\pm$ 6.5
Posterolateral	Experimental (n=24)	96.1 $\pm$ 5.9	105.7 $\pm$ 5.5
	Control (n=24)	95.6 $\pm$ 6.2	96.8 $\pm$ 6.0

ANCOVA results indicated a significant effect of the intervention on post-test scores for the Anterior ($F(1, 45) = 32.17$, $*p < .001$), Posteromedial ($F(1, 45) = 41.89$, $*p < .001$), and Posterolateral ($F(1, 45) = 39.45$, $*p < .001$) directions, after controlling for pre-test performance.

3.3. Flexibility (Sit-and-Reach Test)

Flexibility, measured in centimetres, showed a marked improvement for the EG. The results are shown in Table 3 and visually represented in Figure 1.

Table 3: Pre-test and Post-test Flexibility Scores (in centimetres)

Group	Pre-test (Mean $\pm$ SD)	Post-test (Mean $\pm$ SD)
Experimental (n=24)	31.5 $\pm$ 3.8	38.2 $\pm$ 3.5
Control (n=24)	30.9 $\pm$ 4.1	31.6 $\pm$ 3.9

The ANCOVA for flexibility revealed a statistically significant difference between the groups on the post-test, $F(1, 45) = 72.18$, $*p < .001$, confirming that the EG achieved significantly greater gains in hamstring and lower back flexibility compared to the CG.

Discussion

The primary objective investigate the effects of a 12-week combined proprioceptive and yoga training program on agility, dynamic balance, and flexibility in adolescent male soccer players. The results unequivocally demonstrate that the experimental group, which participated in the combined intervention, exhibited statistically significant and

practically relevant improvements in all three physical fitness variables compared to the control group, which adhered solely to regular soccer training. These findings strongly support our initial hypothesis and underscore the efficacy of integrating multimodal neuromuscular training into standard athletic preparation for youth soccer players.

Interpretation of Key Findings

The most pronounced improvement was observed in agility, as evidenced by the significant reduction in Illinois Agility Test completion time for the experimental group. This enhancement can be attributed to the synergistic nature of the intervention. The proprioceptive component likely improved the players' ability to maintain stability and control during the rapid deceleration and acceleration phases inherent in agility tasks (Bonato et al., 2020). Concurrently, the yoga component, through poses like the Warrior series and dynamic flows, improved functional flexibility and strength through a full range of motion, allowing for more powerful and efficient changes of direction. This aligns with the findings of Trecroci et al. (2021), who noted that training interventions focusing on neuromuscular control directly transfer to improved agility performance.

Similarly, the superior gains in dynamic balance across all directions of the SEBT are a direct validation of the intervention's design. Proprioceptive training on unstable surfaces challenges the somatosensory system, forcing adaptations in muscle activation patterns and joint stabilisation strategies (Han et al., 2015). Yoga postures like Tree Pose (Vrikshasana) and Half-Moon Pose (Ardha Chandrasana) require and develop high levels of static and dynamic balance, core engagement, and body awareness. The combination of these two modalities provided a comprehensive stimulus that surpassed the adaptive capacity of standard soccer training alone. Our results confirm and extend the work of Cameron et al. (2018), who found proprioceptive training alone to be effective for balance, by demonstrating that its integration with yoga yields even more robust outcomes.

The significant increase in flexibility in the experimental group, as measured by the Sit-and-Reach Test, can be almost exclusively credited to the yoga component of the intervention. The sustained static stretching in poses like Downward-Facing Dog and seated forward bends is a well-established method for improving hamstring and lower back flexibility (Polsgrove et al., 2016). This finding is consistent with Greco et al. (2022), who reported similar flexibility improvements in athletes following a yoga program. The fact that the control group showed negligible improvement highlights that regular soccer practice does not adequately address flexibility needs and may even contribute to muscular tightness.

Comparison with Previous Literature and Implications

This study's findings are largely consistent with previous research on the independent effects of proprioceptive and yoga training. However, its novel contribution lies in demonstrating their synergistic potential. While Sparks & Kelleher-Smith (2021) called for more integrated mind-body approaches in sports, this study provides empirical evidence for such a model. The implications are substantial for coaches and strength conditioning professionals. Incorporating a time-efficient, combined program (as short as 45 minutes, 3 times a week) can simultaneously enhance

multiple critical fitness components that are often neglected in favour of technical and tactical drills. This holistic approach not only optimises performance but also aligns with injury prevention models that emphasise improving modifiable risk factors like poor balance and inflexibility (Emery & Pasanen, 2019).

Limitations and Future Research Directions

First, the sample consisted solely of adolescent males from a specific geographic and competitive level, which may limit the generalizability of the findings to female players, older athletes, or those at elite levels. Second, the 12-week intervention period does not reveal whether the observed benefits are maintained long-term after the cessation of the formal program. Third, while the tests used are valid and reliable, more sophisticated biomechanical analysis (e.g., force plate measurements for balance, motion capture for agility) could provide deeper insights into the mechanisms of improvement.

Future research should address these limitations by:

1. Investigating the effects of this combined training on female soccer players and other athletic populations.
2. Conducting longer-term studies with follow-up testing to assess retention of benefits.
3. Exploring the direct impact of such interventions on injury incidence rates, which is the ultimate goal of many prevention programs.
4. Utilising advanced biomechanical tools to quantify kinematic and neuromuscular changes resulting from the training.
5. Investigating the psychological effects, such as changes in focus, stress levels, and body awareness, which are often anecdotally reported with yoga practice.

Conclusion

This study conclusively demonstrates that a 12-week combined proprioceptive and yoga training program is a highly effective intervention for significantly improving agility, dynamic balance, and flexibility in school-level male soccer players. The findings affirm that this multimodal approach offers superior benefits compared to traditional soccer training alone. This research makes a valuable contribution to the field of sports science by providing a practical, evidence-based model for enhancing athletic performance holistically. For coaches and practitioners, the integration of such a program offers a time-efficient strategy to develop well-rounded, resilient athletes who are not only more proficient on the field but also potentially less susceptible to common sports injuries. Ultimately, adopting this integrated training paradigm can be a pivotal step towards fostering more sustainable and successful athletic development in youth soccer.

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