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Effectiveness of Lower Extremity Power Training Exercises on Lower Extremity Power for Risk Factors in Hamstring Injury Among Recreational Football Players After 4 Weeks: An Experimental Study

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ABSTRACT

Hamstring strain injury (HSI) is the most commonly reported injury in professional football (25.4%) and amateur football (13%). This experimental study aimed to determine the effectiveness of a 4-week lower extremity power training programme on lower extremity power as a risk-factor mitigation strategy for hamstring injury among recreational football players, assessed via the vertical jump test. Sixty male recreational football players aged 18–25 years were recruited by convenient sampling in Pune, India. Participants completed a structured plyometric and strength protocol (2 sessions/week, 40–50 minutes) over 4 weeks. Pre- and post-intervention vertical jump heights were recorded. Mean vertical jump height improved significantly from 260.27 cm to 265.27 cm ($p = 0.00001$), with standard deviation reducing from 13.60 to 13.20, indicating improved performance and greater consistency. Lower extremity power training exercises significantly improved lower extremity power, thereby addressing key risk factors for hamstring injury in recreational football players.

Keywords: *Hamstring strain injury, lower extremity power, recreational football, plyometric training, vertical jump test, injury prevention*

INTRODUCTION

Football (also called 'soccer') is the most popular sport in the world, played in over 200 countries by nearly 400 million people. While its physical and psychosocial health benefits are well established, recreational football is also associated with significant musculoskeletal injury risk. The incidence of football injuries among recreational players is estimated at up to 10 per 1,000 football hours, predominantly in the lower limbs and during competition.[1]

Hamstring strain injury (HSI) is the most commonly reported injury in professional football (25.4% of all injuries) and in amateur football (13% of all injuries). Previous studies report that 4–6 hamstring injuries per season result in several weeks of match absence. In soccer, the risk of hamstring injury is 2.5 times greater than quadriceps injury. [2,3] Hamstring injuries typically occur during the late swing and early stance phases of sprinting, when the hamstrings contract forcefully while reaching maximum length.[4]

High-speed running elicits greater peak hamstring force and negative muscle-tendon work compared with slower-speed running. Maximal running speed represents a more appropriate stimulus for hamstring activation than isolated eccentric strengthening, capturing elastic energy transfer, reflexes, hip-knee kinematics, and intra/inter-muscular coordination. [2,5]

The key risk factors for HSI include lack of regular high-speed football training, lack of regular exposure to strength training (eccentric, isometric, and concentric), and insufficient warm-up.[6] Recreational players are particularly vulnerable due to low daily activity levels and absence of structured training sessions.[7]

Need of Study

Recreational sports are undertaken for physical fitness and compensation of physical inactivity, combined with sporting enjoyment. Recreational football training incorporates high-speed runs, sprints, turns, jumps, and tackles, providing high musculoskeletal loading. Research confirms that training plan errors and insufficient warm-up are significant risk factors for HSI.[8]

Recreational football has been shown to enhance fat oxidation, produce marked muscle hypertrophy, elevate bone mass, and improve musculoskeletal, metabolic, and cardiovascular adaptations relevant to health, thereby reducing lifestyle disorder risk.[7] Despite these benefits, recreational players remain understudied compared to professional athletes, necessitating targeted injury-prevention research in this population.

Aim

To determine the effectiveness of lower extremity power training exercises on lower extremity power for risk factors in hamstring injury among recreational football players after 4 weeks.

Objective

To determine the effectiveness of lower extremity power training exercises on lower extremity power for risk factors in hamstring injury among recreational football players after 4 weeks using the vertical jump test.

Hypothesis

Null Hypothesis (H_0): There will be no effectiveness of lower extremity power training exercises on lower extremity power for risk factors in hamstring injury among recreational football players after 4 weeks.

Alternate Hypothesis (H_1): There will be effectiveness of lower extremity power training exercises on lower extremity power for risk factors in hamstring injury among recreational football players after 4 weeks.

REVIEW OF LITERATURE

Ribeiro-Alvares et al. investigated the effects of a 4-week Nordic Hamstring Exercise (NHE) programme in twenty physically active young adults. The training group demonstrated significantly higher percent changes than controls for hamstring isometric peak torque (+9%), eccentric peak torque (+13%), eccentric work (+18%), and functional H: Q torque ratio (+13%), concluding that short-term NHE counteracts multiple HSI risk factors.[9]

Mendiguchia et al. examined a neuromuscular training programme combining eccentric hamstring strength, plyometrics, and sprint exercises in footballers. The experimental group showed moderate-to-large increases in concentric (ES = 0.70–0.74) and eccentric (ES = 0.66–0.87) hamstring strength with maintained sprinting performance, suggesting positive injury-prevention outcomes.[10]

Sancese and Taylor compared in-season sprint versus Nordic hamstring training. Sprint training improved rate of torque development (+29.4%) while strength training improved eccentric peak torque (+24.5%), demonstrating that both programmes reduce HSI risk through distinct mechanisms.[2]

Rudisill et al. conducted a systematic review and meta-analysis of randomised controlled trials on hamstring injury prevention. Eccentric strengthening was found to reduce injury incidence and improve hamstring strength, fascicle length, H:Q ratio, and limb asymmetry; plyometric training also increased concentric hamstring strength.[11]

Bisciotti et al. reviewed hamstring injury prevention in soccer and classified risk factors into primary, recurrent, and bivalent categories, concluding that effective prevention protocols must address anatomical, biomechanical, and physiological principles specific to each hamstring muscle.[8]

Hamilton et al. examined hamstring anatomy and injury mechanisms, noting that injury most commonly occurs at the muscle-tendon junction due to biarticular crossing and eccentric contraction during the gait cycle, with increasing emphasis on optimised rehabilitation protocols for elite athletes.[12]

MATERIALS AND METHODS

Study Design and Setting

An experimental study design was employed. The study was conducted over 6 months in Pune, Maharashtra, India, following ethical clearance from the Institutional Ethics Committee of P.E.S. Modern College of Physiotherapy.

Participants

A total of 60 male recreational football players aged 18–25 years were recruited using convenient sampling. Inclusion criteria required players to engage in football at least once or twice per week, and to present with identified risk factors: lack of regular high-speed football training and/or lack of regular strength training exposure. Exclusion criteria were recent lower extremity injury, fracture, or surgery within 6 months; diagnosed lower extremity or spinal deformities; auditory or visual deficits; involvement in professional physical training; diagnosed neurological, musculoskeletal, or cardiorespiratory pathology; and participation in daily physical fitness regimes.

Materials

Measuring tape, chalk, pen, paper, stopwatch, data collection sheet, and medicine ball.

Outcome Measure

The Vertical Jump Test was used to assess lower limb explosive power pre- and post-intervention. Participants stood facing a wall, marked their standing reach height, and then performed three maximal vertical jumps with 30-second rest intervals between trials. The highest jump height, calculated as the difference between standing reach height and maximum jump reach, was recorded for analysis.[13]

Procedure

Following ethical clearance and written informed consent, eligible participants were assessed at baseline using the vertical jump test. The 4-week intervention programme (2 sessions/week, 40–50 minutes) was then administered. Post-intervention vertical jump height was assessed at week 4.

Warm-Up and Cool-Down Protocol

Each session began with lower extremity stretching (15–20 minutes), skipping (2 laps), and side shuffles (2 laps). Cool-down comprised a 2-minute walk and 5-minute stretching. A 30-second rest was provided after each jump exercise.

Intervention Protocol

Phase 1 (Weeks 1–2): Technique Phase – exercises emphasised correct posture (spine erect, shoulders back) and body alignment (chest over knees) throughout each jump.

Table 1. Phase 1 Exercise Protocol

Exercise	Week 1	Week 2
Tuck Jumps	20 sec	25 sec
Spot Marching	20 sec	25 sec
Squat Jumps	15 sec	20 sec
Box Jumps (24")	5 reps	10 reps
Heel Flicks	20 sec	25 sec

Phase 2 (Weeks 3–4): Fundamental Phase – concentrated on proper jumping technique to build a base of strength and power.

Table 2. Phase 2 Exercise Protocol

Exercise	Week 3	Week 4
Scissor Jumps	30 sec	40 sec
Nordic Hamstring Curls	8×3 sets	12×3 sets
Sumo Squat	8×3 sets	12×3 sets
Fwd Jump Bwd Lunge	30 sec	40 sec
Curtsy Lunge	30 sec	40 sec

STATISTICAL METHODS

Pre- and post-intervention vertical jump heights were compared using a paired t-test. Descriptive statistics (mean, variance, standard deviation) were calculated for both pre- and post-intervention values. A p-value of less than 0.05 was considered statistically significant.

RESULT

Sixty recreational football players completed the 4-week intervention. Table 3 shows the distribution of participants by years of football experience.

Table 3. Distribution by Years of Playing Football

Years Playing	No. of Players
0 – 5 years	21
6 – 10 years	29
11 – 15 years	10
Total	60

Pre- and post-intervention vertical jump test values are presented in Table 4. The mean vertical jump height increased from 260.27 cm to 265.27 cm, an improvement of 5 cm (p = 0.00001).

Table 4. Pre- and Post-Intervention Descriptive Statistics

Parameter	Pre-Intervention	Post-Intervention	Mean Difference
Mean (cm)	260.27	265.27	5 cm
Variance	185.05	174.13	-
Standard Deviation	13.60	13.20	-
p-value	0.00001	0.00001	-

The variance of jump heights decreased from 185.05 to 174.13, and the standard deviation from 13.60 to 13.20 post-intervention. These findings demonstrate both significant improvement in mean explosive power and reduced variability in performance, indicating more consistent outcomes among participants.

DISCUSSION

The observed increase in mean vertical jump height from 260.27 cm to 265.27 cm (p = 0.00001) confirms that the 4-week lower extremity power training programme produced measurable gains in explosive power in recreational football players. The highly significant p-value underscores the clinical and statistical relevance of these findings.

The improvement in muscle performance is attributable to enhanced motor unit recruitment patterns and increased muscle fibre cross-sectional area. Increased inhibition of antagonist muscles, improved co-contraction of synergistic muscles, and greater activation of synergistic muscles collectively contribute to enhanced muscle performance.[14]

Fibre hypertrophy in both type I and type II fibres likely contributed to increased jump height and peak and average power output.[15] The utilisation of stored elastic energy and the stretch reflex further enable greater work in the concentric phase, improving sport performance outcomes.[15]

Previous studies confirm that short-interval plyometric training improves lower-extremity strength, power, and stretch-shortening cycle (SSC) function through increased neural drive to agonist muscles, improved intermuscular coordination, changes in mechanical characteristics of the muscle-tendon complex, changes in muscle size and architecture, and alterations in single-fibre mechanics.[16]

The eccentric component is critical in stimulating muscle growth and performance adaptations inherent to SSC movements.[16,17] In the context of injury prevention, improved strength and jump performance reduce susceptibility to muscle strains, including HSI prevalent in football players.[18]

The risk factors directly targeted by this intervention – lack of regular high-speed training and insufficient strength training exposure – are addressed through the jumping and multidirectional movement exercises employed. The findings align with broad-spectrum benefits of recreational football on health-related physical fitness, including improvements in blood pressure, resting heart rate, fat mass, LDL cholesterol, and counter-movement jump performance.[19,20]

CONCLUSION

The effect of lower extremity power training exercises is statistically significant (p = 0.00001) in improving lower extremity power, thereby addressing risk factors for hamstring injury among recreational football players. The significant improvement in vertical jump test performance (260.27 cm to 265.27 cm) supports the integration of this structured 4-week plyometric and strength protocol into injury prevention programmes for recreational football populations.

Limitations

This study was limited to a recreational population and findings may not generalise to elite athletes. Confounding factors such as nutrition and pre-existing injury history were not controlled. Only one outcome measure (vertical jump test) was used; performance in other domains was not evaluated.

Future Scope

Future research should include a larger and more diverse sample size and investigate the long-term maintenance of physical gains. Outcome measures should be expanded beyond the vertical jump test to include sprint speed, balance, and functional movement screening. Comparative interventional studies examining recreational football against other exercise modalities may clarify its unique benefits and optimise injury prevention strategies.

Declaration by Authors

Ethical Approval: Approved

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