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Effects of Repeated Sprint Ability Versus Plyometric Jump Training on Aerobic Capacity, Vertical Jump, and Linear Sprint Performance among Soccer Players

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ABSTRACT

Soccer players require repeated sprinting, explosive muscular power, and adequate aerobic endurance due to the high-intensity demands of the sport. Although repeated sprint ability and plyometric jump training are commonly incorporated in conditioning regimens, little data exist comparing their effectiveness on aerobic capacity and vertical jump. **Objectives:** To compare the effects of repeated sprint ability and plyometric jump training on aerobic capacity, vertical jump, and linear sprint performance among soccer players. **Methods:** A quasi-experimental study was conducted on 32 amateur to semi-professional soccer players from Multan Sultan Football Club, Registered Multan, and BARKI Advanced Physiotherapy, Multan. Participants were recruited using convenient sampling and allocated to repeated sprint ability (Group A) or plyometric jump training (Group B), completing six weeks of training, assessed at baseline, the 3rd week, and the 6th week using the Cooper 12-minute run test, Standing Reach and Jump Test, and 40-Meter Sprint Test. Normality was confirmed via the Shapiro-Wilk test; repeated measures ANOVA was therefore applied, with $p \leq 0.050$ considered significant. **Results:** Thirty-two players completed training. Within-group analysis showed both groups had a statistically significant effect on VO2 max, vertical jump, and linear sprint performance ($p<0.050$ for all). Plyometric jump training significantly outperformed repeated sprint ability between groups for vertical jump ($F=381.648$, $p<0.050$) and linear sprint performance ($F=141.018$, $p<0.050$); both groups improved progressively in aerobic capacity with no superiority of one protocol over the other ($F=222.181$, $p<0.050$). **Conclusions:** Both plyometric jump training and repeated sprint ability produced positive effects on aerobic fitness, jump and sprint performance, with superior effects of plyometric jump training.

INTRODUCTION

Soccer, also known as association football, is a team sport with an estimated two hundred and seventy million players worldwide, which involves acyclic and unpredictable movement patterns combining several short explosive bouts of physical activity and repeated high-intensity actions [1]. This is the most popular sport played by eleven players of different levels of expertise on two sides of the rectangular field for ninety minutes, covering around eleven kilometers of distance with 3% to 5% of sprinting and running at high intensity, respectively [2]. The soccer players have to perform almost 1.35 seconds of high-intensity efforts every four to six seconds, including accelerations, decelerations, sudden directional changes, and vertical jumps, all of them interspersed with brief recovery intervals [3]. Aerobic capacity is a crucial aspect of soccer performance impacting players' ability to maintain high-intensity efforts throughout the game, with 90% of distance covered by low-intensity activities and the remainder comprised of high-intensity bouts of sprinting, leaping and changes in direction [4]. Linear sprint

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performance refers to straight-line maximal running acceleration and high-speed performance on short distances of 5-40 meters, necessitating rapid force production, intensive lower extremity strength, and effective stride mechanisms; evidence suggests that 95% of high-intensity activities among elite soccer players involve linear sprinting [5]. Vertical jump performance refers to an athlete's ability to produce explosive lower limb power to propel the body upwards and is considered reliable to indicate neuromuscular and short stretch cycle efficiency, directly associated with sprint speed, lower limb explosive power and change in direction ability [6]. Repeated sprint ability (RSA) is a type of training employed to enhance the ability of athletes to perform repeated bursts of short-duration high-intensity activity with short recovery intervals whilst maintaining maximal performance across repetitions [7]. RSA aims to improve fatigue resistance, enhance neuromuscular efficiency, boost anaerobic fitness, and accelerate phosphocreatine resynthesis, and typically includes 2 sessions per week of 20-40 meters per sprint, 6-15 maximal sprints with 100% maximal effort, and 10-30 seconds of rest intervals [8, 9]. Plyometric jump training (PJT) is an exercise regimen involving short stretch cycle movements incorporating activities like vertical jumping, single leg hopping, horizontal bounding and drop jumping, targeting neuromuscular adaptation and tendon loading to improve muscular power, speed metrics and reactive strength [10]. PJT employs the systemic use of jumping as a primary mode of training to improve physical fitness parameters [11], and the high-intensity efforts it mimics potentially raise transference effects between training [12], which might also exert a positive effect on aerobic capacity and linear sprint performance in addition to explosive power [13, 14].

While substantial evidence exists advocating the effectiveness of PJT and RSA individually, there is still a lack of clear evidence on which training type best improves key performance indicators among semi-professional to elite players. This deficiency of comparative analysis compelled an investigation of whether RSA or PJT offers superior effects on these crucial components of performance among soccer players, eventually guiding training protocols matching the physical demands of an advanced level of expertise. Hence, this study aimed to compare the effects of repeated sprint ability and plyometric jump training on aerobic capacity, vertical jump, and linear sprint performance among soccer players, offering practical and soccer-specific evidence to promote better decision-making among athletic coaches, sports therapists, and scientists.

METHODS

A quasi-experimental study design was employed. Study settings were Multan Sultan Football Club, Registered Multan, and BARKI Advanced Physiotherapy, Multan. The study was conducted from July 2024 to March 2025, following approval of the research proposal by the Research and Ethics Committee, Riphah College of Rehabilitation and Allied Health Sciences, Riphah International University, Lahore (Ref. No. REC/RCR & AHS/24/0449, dated 30 July 2024). Sample size was calculated using the Epi Tools software for comparing two means. The calculation was based on mean Repeated Sprint Ability (RSA) values of 7.9 in Group A and 8.3 in Group B, as reported by Negra *et al.* [8], yielding an effect size (Cohen's d) of 0.61. With 80% power and a 95% confidence level, the required sample size was 16 participants per group. After adding a 10% attrition rate, the sample size was 18 in each group, totaling 36 participants. A non-probability convenience sampling technique was employed. Inclusion criteria were both genders, 18-28 years of age, active soccer players of all positions (semi-pro level) with at least ≥4 years of systematic soccer training and competitive experience, continuous soccer training for the previous 3 months with minimum of 3 training sessions per week and regular participation in matches, and no systematic plyometric jump training or repeated sprint ability training during the previous 5 months. Exclusion criteria were active musculoskeletal injuries within the last six months, chronic health conditions, recent surgical procedures, inability to follow the intervention protocol, regular use of performance-enhancing drugs, participation in another federated sport, failure to sign informed consent, or inadequate training experience. Non-Randomization allocation was performed to divide the participants into two groups: Group A (Repeated Sprint Ability) served as one experimental/comparator arm, and Group B (Plyometric Jump Training) as the control; the study compared these two active interventions head-to-head and did not include a separate non-intervention control group, which is acknowledged among the study's limitations. The Cooper 12-minute run test was used to assess aerobic fitness and VO2 max. The Standing Reach and Jump Test, a feasible manual method (chalk and wall), was used to evaluate vertical jump [15, 16]. The 40-Meter Sprint Test, the gold standard for measuring linear sprint performance in soccer players, was used for linear sprint performance [17]. Recruitment was conducted through collaboration with local soccer clubs and teams. Participants were interviewed in person during screening to confirm eligibility. Subjects were non randomly allocated to the two groups using the lottery method, with allocation concealment maintained through sealed opaque envelopes. The study was single-blinded; the assessor was

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blinded to basic demographic and clinical characteristics of the study population as well as to different treatment groups and intervention protocols [18]. Neither group received conventional physiotherapy or any additional training alongside their assigned intervention protocol throughout the six-week study period. Group A performed repetitive sprint training, with the number of sprints ranging from 6 sprints per set in the first week up to 10 sprints per set in the 6th week, with two to three sets per training session, conducted over a 20 m section with passive rest of 25 seconds between repetitions and 2 minutes between sets [14]. Group B performed unilateral and bilateral plyometric jumps in vertical and horizontal directions, ranging from 1 to 3 sets per session with 120 jumps in a single practice up to a maximum of 180 jumps per session (550 jumps per week), with 30 seconds to 1-minute rest between sets and 2 minutes between types of jumps [14].

Data were analyzed using SPSS version 26.0. The Shapiro-Wilk test confirmed normality of baseline data (p>0.050 for all variables). To compare outcome variables across the three follow-up points (baseline, 3rd week, 6th week), a repeated-measures analysis of covariance (ANCOVA) was applied, with age, sex, playing experience, and baseline fitness levels included as covariates. Mauchly's test of sphericity was examined; where sphericity was violated, the Greenhouse-Geisser correction was applied. Effect sizes are reported as partial eta squared (η^2). Per-protocol analysis was performed on completers only (n=32); no intention-to-treat analysis was conducted. The p-value ≤0.050 was considered statistically significant.

RESULTS

The total sample size enrolled was 36; Group A had 18 participants, of whom 2 dropped out (n=16), and Group B had 18 participants, of which 2 dropped out (n=16). Dropouts occurred due to personal reasons unrelated to the intervention; all 32 completers were included in the per-protocol analysis. Males comprised 56.3% of the total sample. Professional and semi-professional players formed the majority of the sample (each 34.4%), while elite players comprised 31.3%, demonstrating a balanced representation of expertise levels. An independent samples t-test confirmed no significant baseline differences between groups for VO2 max (t (30) = -0.176, p=0.862), vertical jump (t (30) = 0.236, p=0.815), or linear sprint performance (t (30) = 0.258, p=0.798). Baseline characteristics between groups were clinically comparable (Table 1).

Table 1: Baseline Demographic and Clinical Characteristics of Participants (n=32)

Variables	n (%) / Mean ± SD
Age (years)	22.06 ± 2.85
Height (feet)	5.48 ± 0.33
Weight (kg)	73.34 ± 3.19
BMI (kg/m^2)	22.95 ± 0.19
Male	18 (56.3%)
Female	14 (43.8%)
Elite	10 (31.3%)
Professional	11 (34.4%)
Semi-Professional	11 (34.4%)

The Shapiro-Wilk test confirmed that all baseline variables (VO2 Max, Vertical Jump, and Linear Sprint Performance) were normally distributed in both groups (p>0.050 for all; e.g., VO2 Max PJT p=0.463, Vertical Jump RSA p=0.348), confirming suitability for parametric repeated-measures ANOVA. The study presents the within-group analysis showing descriptive statistics and repeated-measures ANOVA time effects for all three outcome variables. Both groups demonstrated a statistically significant linear progressive improvement in VO2 max, vertical jump, and linear sprint performance across all three time points. The PJT group consistently showed larger gains from baseline to the 6th week compared to the RSA group across all outcomes. For example, the mean improvement in vertical jump from baseline to week 6 was 7.70 cm for the PJT group compared to 2.57 cm for the RSA group. The full post hoc results, including mean differences and 95% confidence intervals (Table 2).

Table 2: Within-Group Analysis - Descriptive Statistics and Time Effect (Repeated-Measures ANOVA)

Outcome Variables	Group	Baseline Mean ± SD	3rd Week Mean + SD	6th Week Mean + SD	F	p-value	Partial η^2
Aerobic Capacity (Vo2 Max, ml/kg/min)	PJT	47.894 ± 0.9497	49.238 ± 0.9373	50.950 ± 0.9771	3933.497	<0.001	0.998
	RSA	47.456 ± 0.9980	48.500 ± 1.0100	49.438 ± 1.0794	2307.978	<0.001	0.997
Vertical Jump (cm)	PJT	42.181 ± 1.6786	44.800 ± 1.6777	49.881 ± 1.7433	1217.937	<0.001	0.994
	RSA	42.125 ± 1.7380	43.394 ± 1.7249	44.694 ± 1.7563	2515.213	<0.001	0.997
Linear Sprint Performance (seconds)	PJT	3.2975 ± 0.0963	3.2031 ± 0.1010	3.0837 ± 0.0867	620.823	<0.001	0.989
	RSA	3.3325 ± 0.0863	3.2888 ± 0.0855	3.2269 ± 0.0878	573.981	<0.001	0.988

PJT = Plyometric Jump Training; RSA = Repeated Sprint Ability; F = F-statistic for time effect; η^2 = Partial Eta Squared. Lower sprint times indicate better performance. The p-value ≤0.050 is considered statistically significant

The results present the between-group analysis across all three time points. A significant time × group interaction was observed for vertical jump (F=381.648, p<0.001, η^2=0.963) and linear sprint performance (F=141.018, p<0.001, η^2=0.907),

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demonstrating the superiority of PJT over RSA for these outcomes. Post-hoc pairwise comparisons with Bonferroni correction were conducted for all significant interactions, revealing significant improvements between all-time points (baseline vs. 3rd week, 3rd vs. 6th week, and baseline vs. 6th week) for both groups across all outcomes. The full post hoc results, including mean differences and 95% confidence intervals (Table 3).

Table 3: Between-Group Analysis - Time × Group Interaction (Repeated-Measures ANOVA)

Outcome Variables	Time Point	PJT Mean ± SD	RSA Mean ± SD	Time × Group F	p-value	Partial η^2
Aerobic Capacity (VO2 Max, ml/kg/min)	Baseline	47.894 ± 0.9497	47.456 ± 0.9980	222.181	<0.001	0.939
	3rd Week	49.238 ± 0.9373	48.500 ± 1.0100			
	6th Week	50.950 ± 0.9771	49.438 ± 1.0794			
Vertical Jump (cm)	Baseline	42.181 ± 1.6786	42.125 ± 1.7380	381.648	<0.001	0.963
	3rd Week	44.800 ± 1.6777	43.394 ± 1.7249			
	6th Week	49.881 ± 1.7433	44.694 ± 1.7563			
Linear Sprint Performance (seconds)	Baseline	3.2975 ± 0.0963	3.3325 ± 0.0863	141.018	<0.001	0.907
	3rd Week	3.2031 ± 0.1010	3.2888 ± 0.0855			
	6th Week	3.0837 ± 0.0867	3.2269 ± 0.0878			

PJT = Plyometric Jump Training; RSA = Repeated Sprint Ability; F = F-statistic for Time × Group interaction; η^2 = Partial Eta Squared. Lower sprint times indicate better performance. The p-value ≤0.050 is considered statistically significant

DISCUSSION

This quasi-experimental study investigated the comparative effects of repeated sprint ability and plyometric jump training on aerobic capacity, vertical jump, and linear sprint performance among young semi-professional to elite soccer players. The findings revealed that both interventions yielded promising results over six weeks across key performance metrics, but plyometric jump training outperformed repeated sprint ability, especially in vertical jump and linear sprint performance. The statistical analysis reported strong within-group effects among both groups, but between-group analysis demonstrated the superiority of plyometric jump training over repeated sprint ability. Notably, the within-group effect sizes were extremely large (partial η^2 >0.97 for all variables), which should be interpreted with caution given the small sample size (n=16 per group); such magnitudes may partly reflect the sensitivity of repeated-measures designs to within-person variance rather than solely the treatment effect, and require verification in larger randomized trials. A study conducted by Hasan reported significant improvement in explosive lower limb muscle strength and power, ultimately enhancing vertical jump and sprint performance, with sprint timing improved by 20.14% and single-leg hop distance by 7.78%, supporting the theoretical mechanism of neuromuscular adaptation in response to short stretch cycles observed in plyometric jump training [19]. The current study's findings strongly resonate with the notion that plyometric-induced explosive power promotes acceleration and vertical jump performance in comparison to other strength training regimes. The current study's findings were also endorsed by Ferley *et al.* whose trial investigating combined plyometric, sprint training and conventional strength training protocols revealed significant improvement in power, strength, speed and ability of change in direction among young soccer players, reinforcing the notion that plyometric jump training, whether employed independently or combined, outperforms other strength training protocols for crucial performance metrics among young soccer players [20]. On the other hand, Aloui et al. reported that two different frequencies of repeated sprint ability training demonstrated equal progress among U-15 soccer players in 20-m sprint performance but failed to improve vertical jump and other sprint metrics, indicating the limited ability of repeated sprint training to ignite neuromuscular adaptation; this contradiction underscores that repeated sprint ability emphasizes metabolic conditioning more than plyometric physiological adaptation [10]. A randomized controlled trial conducted by Niering *et al.* observed combined effects of plyometric jump training and repeated sprint ability on performance metrics among soccer players; although overall functional capacity was enhanced, jump performance metrics did not improve to the same magnitude as in plyometric-dominant modalities, further supporting the exclusivity of plyometric jump training's jump performance benefits observed in the current study [21].

This study is limited by its targeting of a smaller pool of soccer players from limited study settings, a short training duration and frequency, non-monitoring of athletes' diet and recovery regimens, and inability to employ advanced-level outcome measures. Additional statistical limitations include: absence of formal baseline group comparison between groups, which precludes confirmation of pre-intervention equivalence; no post-hoc pairwise comparisons were performed across time points, limiting

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interpretation of which specific intervals drove the significant time effects; restricting the precision of effect estimates; confounding variables including sex, age, playing experience and baseline fitness levels were not controlled in the analysis; and the very large within-group effect sizes (partial η^2 >0.97) require cautious interpretation given the small sample. Future research is recommended to conduct large-scale randomized studies including athletes from diverse backgrounds and competitive levels, perform post hoc pairwise comparisons and report mean differences with confidence intervals, analyze differences in training responses between male and female soccer players, investigate the effectiveness of plyometric jump training and repeated sprint ability during different phases of the competitive season, and investigate which intervention prevents and reduces the risk of sports injury.

CONCLUSIONS

This study demonstrated that both plyometric jump training (PJT) and repeated sprint ability (RSA) improved aerobic capacity (VO2 max), vertical jump, and linear sprint performance among soccer players; however, plyometric jump training resulted in more pronounced gains across all outcome measures. This implies that plyometric jump training might offer a more effective and holistic approach to improving athletes' physical performance when time and resources are limited. This study also suggests that plyometric jump training should be specifically prioritized when the goal is to improve acceleration and power, whereas repeated sprint ability should be considered to develop repeated sprint endurance and aerobic resilience.

Authors' Contribution

Conceptualization: ZM, SS, MNT, MSK
Methodology: ZM, SS, MNT, MSK
Formal analysis: ZM, SS, AK, AJ
Writing and Drafting: ZM, SS, AK, AA, MSK, AJ
Review and Editing: ZM, SS, MNT, AK, AA, MSK, AJ

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

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