EFFECT OF VARIOUS STRENGTH TRAINING MODALITIES ON SELECTED PERFORMANCE VARIABLES AMONG INDIAN FOOTBALL PLAYERS

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Abstract

This study was carried out with the aim of evaluating the impact of different modes of Strength training on selected performance variables in football players in the age range of 18 to 21 years. A total of eighty (n=80) male district level athletes were selected from Malappuram district of Kerala, India and were divided into four groups of twenty players (n=20) in each age group. The first group (Group I) served as control group and did not undergo any specific training regime. The other three groups were given training interventions for strength endurance (Group II), explosive strength (Group III), and maximum strength (Group IV) respectively. The training period was kept for 12 weeks, and a separate regime was formulated for each training intervention Programme with different intensities, repetitions and types of exercises. The study primarily examined the four performance parameters Passing, Dribbling, Tracking and Kicking. These variables were assessed using the appropriate tests and equipment. For statistical analysis, ANOVA was used to assess the significance among groups ($p<0.05$) and Fisher's post hoc test was used to assess the significance of the paired mean differences. The ANOVA demonstrated a significant improvement in all performance indicators over time, indicating that all three experimental groups progressed across the 12- week period. However, the groups did not differ from one another in overall performance, and the Time × Group interactions were not significant, confirming that the pattern of improvement was similar across all training conditions. The control group showed no significant difference in any of the performance variables. These findings support the integration of strength endurance, explosive strength and maximum strength training into football conditioning programs to optimize technical performance outcomes.

Keywords: Football Athletes, Strength Training Modalities, Performance Variables, Training Intervention, Resistance Training, Muscle Strength, Training Adaptation

1.INTRODUCTION

Football is a high-intensity intermittent sport that involves a amalgamation of technical skills, strategic intelligence, and certain physical fitness components. The player depends largely on muscular strength and power to perform repeated bouts of sprinting, jumping, tackling, kicking, and rapid directional changes throughout the match, making strength training an essential component of modern football conditioning programs. Studies have shown that even eight weeks' resistance training have positive influences on girth size of muscles (Schoenfeld, **2010;**. Tyagi et al, 2026).

Strength training improves force production, neuromuscular coordination, movement economy, and fatigue resistance thus, playing a crucial role in enhancing football performance. In elite players even slight improvements can significantly influence match outcomes. According to Reilly et al (2000) strength, power, and endurance significantly influenced technical efficiency and overall match performance. Different types of strength training (resistance, plyometric and contrast) have been shown to improve speed, agility, power, and strength. Likewise, Chen et al. (2024) performed a systematic review and meta-analysis of plyometric training and lower body explosive strength of adolescent soccer players. They found plyometric training significantly enhanced countermovement jump performance, with different effects at different stages of maturation. This further highlights the application of plyometric (resistance-type training) to increase explosive strength which is important for sprint performance and jumping in football.

Training for strength in football typically involves three key components: strength endurance, explosive strength and maximum strength (Bompa, 2009). All three play a unique role in performance. Strength endurance allows players to perform repeated muscular work during the course of the match, and is thus essential for maintaining high levels of technical execution and fatigue resistance. Power is the ability to produce a large force in a short period of time and is important for short-duration sprints, jumping, changing direction and kicking with force. Maximum strength is the greatest force that can be exerted by a muscle (or group of muscles) and provides the foundation for the development of power and speed.

Research supports the role of these strength qualities in football. For example, Wisløff et al. (2004) found a strong relationship between maximum lower-body strength and changes in sprint and jump performance in elite soccer players, highlighting the importance of resistance training in football training. Moreover, Bompa and Haff (2009) emphasized that training adaptations are specific according to the principle of specificity, where different strength training approaches will lead to different physiological and neuromuscular adaptations. As such, different approaches to strength can have varying effects on technical performance variables in football.

Key performance variables in football include dribbling, passing, trapping and kicking (Reilly et al, 2000; Lees, et al 2010; Ali 2011). These variables are primarily technical but their performance is dependent on a range of physical qualities such as strength, power, balance and coordination. For example, leg strength is important for forceful and precise kicking, while strength endurance is important for maintaining contact with the ball and passing ability in the second half of matches. These studies have found that explosive leg strength and power are highly correlated with performance of fundamental football skills including kicking velocity and ball control. For instance, researchers have identified that greater explosive leg strength helps increase ball speed during kicking, as well as being significantly associated with various technical actions on the field, showing that physical attributes like strength, balance and explosive power are necessary for performing technical football skills (Gadev and Peev, 2022 and Suresh, et al, 2023).

Strength training is a critical component of modern football training, and many studies have shown that strength training has a positive effect on various aspects of football performance including sprinting, jumping, kicking speed, passing and agility. While it is widely recognized, few studies have directly compared the influence of different types of strength training on various performance factors in football players. A better understanding of the effects of different training approaches on physical and technical aspects of football performance needs to be clarified to guide training programming.

Practically, resistance training prescriptions for elite football players should include a balanced combination of strength endurance (SE), explosive strength (ES) and maximum strength (MS). Such training should be tailored to the football season and individual position and performance requirements. Given these considerations, the aim of the current study was to determine the impact of various strength training approaches on a number of performance variables in elite football players, and to provide a basis for the development of scientifically based football conditioning programs.

2.METHODOLOGY

To interpret the purpose of this study, eighty (n=80) district level male football players in the age range of 18 to 21 years were selected from the Malappuram district of Kerala state in India. The research design of the study was random group design The selected subjects were randomly divided into four groups with twenty (n=20) players in each group- namely, Group – I was kept as the control group, Group – II was for Strength Endurance training, Group – III for Explosive Strength training and Group – IV as the Maximum Strength training Group.

2.1 Selection Of Variables

The Four Football performance variables that were selected included Dribbling which was tested using Ronaldo speed test; Trapping examined using McDonald Soccer Skill Test; Passing measured using McDonald Soccer Skill Test and Kicking tested using Johnson Soccer Skill Test. Standard measuring procedures were followed as given by Kansal (2012). A pretest was conducted on four groups in the selected Performance Variables before the actual training Programme started. The training period spanned for twelve weeks – four days a week on alternately scheduled. Weight training (station training) was provided to groups II, III, and IV whereas the control group (Group I) received no training. Before the commencement of the training program, the investigator explained the objective of the training program to the subjects and their contribution entailed to be in the investigation. The subjects were motivated to attend the practice sessions regularly. All the subjects were encouraged to perform to the best of their potential during the training sessions and the testing periods.

2.2 Training Programme

The weight training regimen was designed for four days per week (Monday, Wednesday, Friday, and Sunday) in the evenings from 4.30 p.m. to 6:00 p.m. Weight training schedules included 10 Minutes Warm-up and 10 Minutes Cool Down.

- **Group I**

The control group did not undergo any form of special training. But they were performing their regular training routine.

- **Group II- Strength Endurance Training Group**

The Strength Endurance Training Group's initial intensity was determined at 20% of 1 Rep Max. The intensity of the exercise was set at 10 to 12 repetitions of three sets, with 60 seconds of rest time between each recurrence. In the first and second weeks, the initial intensity of load was fixed based on the principle of progression of load. A five percent of load was increased every two weeks up to twelve weeks. The training program was followed by flat barbell bench press, bent-over barbell rows, seated dumbbell presses, dips, pull-ups or pull-downs, lying dumbbell triceps extensions, incline dumbbell curls, barbell back squats, leg-press, seated leg extensions, dumbbell or barbell walking lunges, calf press on the leg press, decline crunches, overhead press, incline dumbbell bench press, one-arm cable rows, cable lateral raises, face pulls, dumbbell shrugs seated overhead triceps extensions, machine preacher curls, barbell deadlift, barbell hip thrusts, Romanian dumbbell dead lifts, lying leg curls, seated calf raises, leg raises on a Roman chair.

- **Group III- Explosive Strength Training Group**

The Explosive Strength Training Group's initial intensity was fixed at 75 % of 1 Rep Max. The intensity of exercise was fixed as 5 to 7 repetitions of 3 sets and 60 seconds of recovery time between each repetition. During the inaugural and second weeks, the starting intensity of the load was determined using the load progression concept. The load was raised by five percentage points every two weeks for a total of twelve weeks. The training program was followed by similar exercises as mentioned above.

- **Group IV- Maximum Strength Training Group**

The Maximum Strength Training Group's baseline intensity was set at 100% of 1 Rep Max. The exercise's intensity was set at 1 to 2 repetitions of 3 sets, with a 60-second rest period between each. The preliminary degree of load was set throughout the first and second weeks using the progressive load approach. The load was raised by five percentage points every two weeks for a total of twelve weeks. The training program was followed by similar set of exercises as followed by other two groups.

3.STATISTICAL ANALYSIS

Descriptive statistics were implemented for the statistical evaluation of the subject data. Analysis of Variance (ANOVA) was employed to determine whether there was a significant difference among groups. A level of confidence of 0.05 was set to test for significance, which was deemed appropriate. Fisher LSD post hoc test was used to determine the significance of the paired mean differences between the groups if significant differences had been identified.

4.RESULTS

Table 1: Descriptive Statistics For Dribbling Ability, Trapping Ability, Passing Ability And Kicking Ability Scores Of The Control Group And Experimental Groups

Group	Sample Size (n)	Pre-Test Mean (SD)	Post-Test Mean (SD)
DRIBBLING ABILITY			
Group I-Control	20	27.75 (2.36)	27.78 (2.45)
Group II-Strength Endurance	20	27.15 (2.35)	28.08 (2.46)
Group III-Explosive Strength	20	27.57 (2.29)	28.12 (2.45)
Group IV-Maximum Strength	20	27.65 (2.28)	28.33 (2.21)
TRAPPING ABILITY			
Group I-Control	20	19.95 (4.17)	20.10 (4.10)
Group II-Strength Endurance	20	19.40 (3.23)	20.10 (3.14)
Group III-Explosive Strength	20	19.40 (3.23)	20.25 (3.24)
Group IV-Maximum Strength	20	19.85 (3.99)	20.50 (4.01)
PASSING ABILITY			
Group I-Control	20	19.25 (3.09)	19.26 (2.78)
Group II-Strength Endurance	20	20.25 (2.36)	21.40 (2.33)

Group III-Explosive Strength	20	20.25 (2.36)	21.30 (2.70)
Group IV-Maximum Strength	20	19.20 (3.09)	20.10 (3.14)
KICKING ABILITY			
Group I-Control	20	32.45 (4.98)	32.80 (5.05)
Group II-Strength Endurance	20	33.50 (5.27)	34.45 (5.43)
Group III-Explosive Strength	20	33.55 (4.94)	34.45 (4.84)
Group IV-Maximum Strength	20	32.45 (4.98)	33.25 (4.63)

A total of 80 district level football players were analyzed (n = 20 per group). Descriptive statistics for pre-test and post-test scores across all performance variables are presented in Table 1.

- **Dribbling Ability**

Baseline dribbling scores were comparable across groups (means ranging from 27.15 to 27.75. Following the 12-week intervention, the control group demonstrated minimal change (27.75 ± 2.36 to 27.78 ± 2.45), whereas all experimental groups exhibited modest increases: strength endurance (27.15 ± 2.35 to 28.08 ± 2.46), explosive strength (27.57 ± 2.29 to 28.12 ± 2.45), and maximum strength (27.65 ± 2.28 to 28.33 ± 2.21).

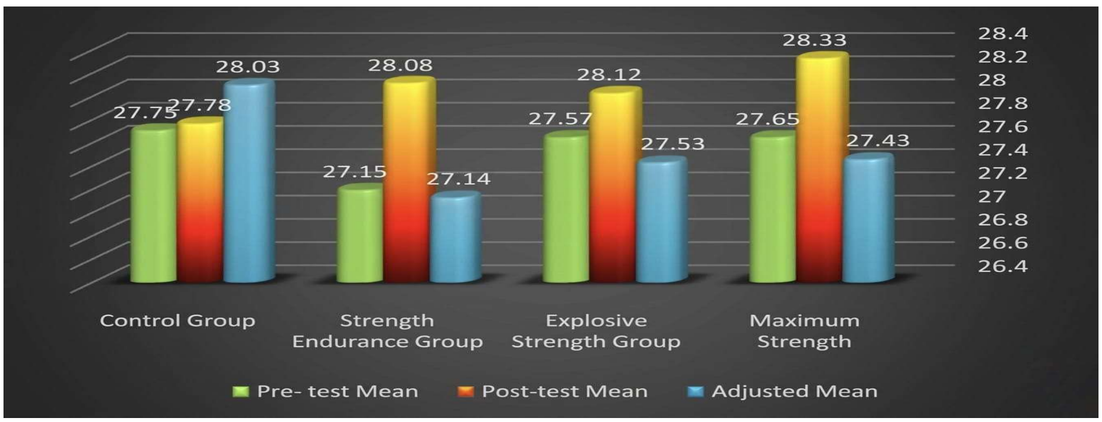


Figure 1: Pre-Test and Post-Test Mean Scores of Dribbling Ability across All Experimental Groups and Control Group

Two-way repeated measures ANOVA revealed a significant main effect of time, $F(1,76) = 50.00$, $p < .001$, indicating overall improvement from pre-test to post-test (table 2). A significant main effect of group was also observed, $F(3,76) = 6.08$, $p < .001$. However, the Time × Group interaction was not significant ($p > .05$), indicating that the magnitude of improvement did not differ between groups. As is clear from table 3, Post-hoc LSD comparisons showed no statistically significant pair-wise differences between any groups (all $p > .05$). All 95% confidence intervals included zero, confirming the absence of between-group differences at post-test.

Table 2: Two-Way Repeated Measures ANOVA of Dribbling Ability Performance among Training Groups

	df1	**df2**	**F**	***P***
Time	1	76	50.00*	<0.001
Group	3	76	6.08*	<0.001
Time*Group	3	76		Not significant

***Significant (p< 0.05)**

Table 3: Post Hoc Comparison for Dribbling Ability Variable

Groups Compared	Mean Difference	Sig. (*p*)	95% CI for Difference
Strength Endurance-Control	0.15	.844	[-1.32 ,1.61]
Explosive Strength-Control	0.08	.911	[-1.39,1.55]
Maximum Strength - Control	0.23	.757	[– 1.24, 1.70]
Strength Endurance -Explosive Strength	0.23	.758	[– 1.24, 1.70]
Strength Endurance-Maximum Strength	0.37	.614	[– 1.10, 1.84]
Explosive Strength-Maximum Strength	0.15	.844	[– 1.32, 1.62]

***Significant (p< 0.05)**

- **Trapping Ability**

Table 1 show Pre-test trapping scores were similar across groups (means ranging from 19.40 to 19.95). Post-test scores showed slight increases in all groups, including the control (19.95 ± 4.17 to 20.10 ± 4.10), strength endurance (19.40 ± 3.23 to 20.10 ± 3.14), explosive strength (19.40 ± 3.23 to 20.25 ± 3.24), and maximum strength (19.85 ± 3.99 to 20.50 ± 4.01).

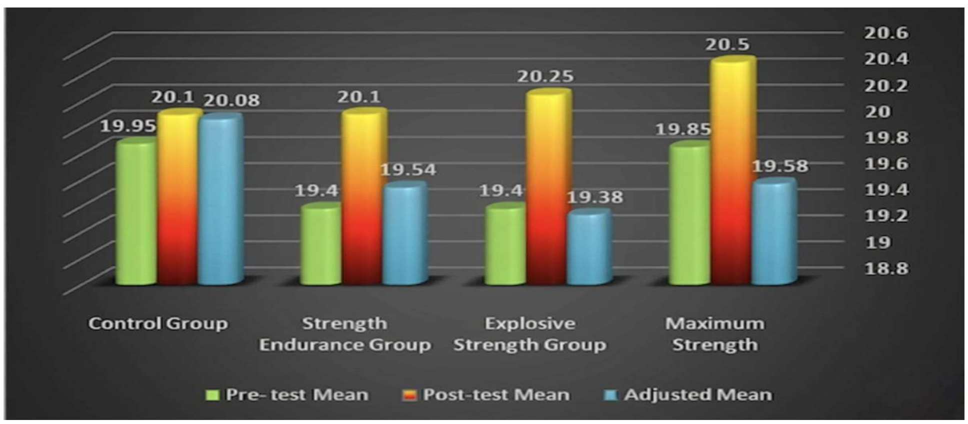


Figure 2: Pre-Test and Post-Test Mean Scores of Trapping Ability Across Experimental Groups and the Control Group

Repeated measures ANOVA demonstrated a significant main effect of time, F(1,76) = 81.18, p < .001. No significant main effect of group was found, F(3,76) = 1.49, p = .983, and the Time × Group interaction was not significant (p > .05) (table 4). LSD post-hoc analysis revealed no significant pairwise comparisons between groups (all p > .05). Confidence intervals for all mean differences crossed zero (table 5).

Table 4: Two-Way Repeated Measures ANOVA on Trapping Ability Performance among Training Groups

	df1	df2	F	*P*
Time	1	76	81.18*	<0.001*
Group	3	76	1.490	.983
Time*Group	3	76		Not significant

Table 4 shows a significant effect of time on trapping ability performance [(F = 81.18, p < 0.001)], while the group effect [(F = 1.490, p = .983)] and time × group interaction were not significant.

Table 5: Post-Hoc Comparison LSD Test for Trapping Ability

Groups Compared	Mean Difference	Sig. (*p*)	95% CI for Difference
Strength Endurance- Control	0.28	.813	[-2.58, 2.03]

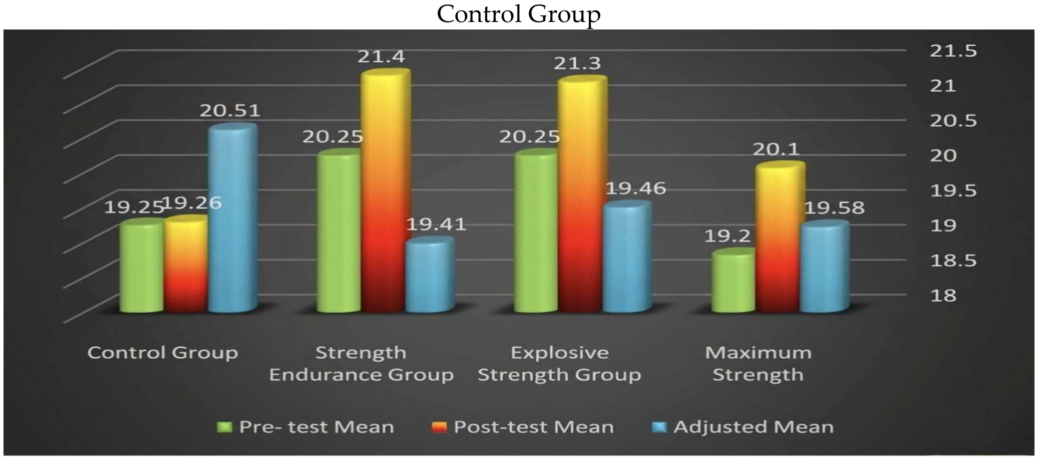
Explosive Strength–Control	0.20	.863	[-2.50, 2.10]
Maximum Strength-Control	0.15	.897	[-2.15, 2.45]
Strength Endurance-Explosive Strength	0.08	.948	[-2.38, 2.23]
Strength Endurance-Maximum Strength	0.43	.714	[-2.73, 1.88]
Explosive Strength-Maximum Strength	0.35	.763	[-2.65, 1.95]

***Significant (p<0.05)**

- **Passing Ability**

Baseline passing scores ranged from 19.25 to 20.25 across groups (table 1). Post-intervention improvements were observed in the strength endurance group (20.25 ± 2.36 to 21.40 ± 2.33) and explosive strength group (20.25 ± 2.36 to 21.30 ± 2.70), while the maximum strength group showed a smaller increase (19.20 ± 3.09 to 20.10 ± 3.14). The control group remained almost unchanged (19.25 ± 3.09 to 19.26 ± 2.78).

Figure 3: Pre-Test and Post-Test Mean Scores of Passing Ability across Experimental Groups and Control Group



As depicted in table 6, a significant main effect of time was identified, F(1,76) = 48.41, p < .01. The main effect of group was not significant, F(3,76) = 1.821, p = .151. No significant Time × Group interaction was detected (p > .05). Post-hoc comparisons did not reveal statistically significant differences between any groups (all p > .05; table 7). Although the strength endurance and explosive strength groups demonstrated numerically greater improvements relative to control, these differences did not reach statistical significance.

Table 6: Two-Way Repeated Measures ANOVA On Passing Ability Performance Among Training Groups

	df_1	df_2	F	*P*
Time	1	76	48.41*	<0.01*
Group	3	76	1.821	.151

***Significant (p< 0.05)**

Table 7: Post Hoc Comparison LSD Test for Passing Ability Variable

Groups Compared	Mean Difference	Sig. (*p*)	95% CI for Difference
Strength Endurance– Control	1.63	.061	[0.08,3.33]

Explosive Strength-Control	1.58	.069	[0.13,3.28]
Maximum Strength – Control	0.45	.600	[-1.25,2.15]
Strength Endurance-Explosive Strength	0.05	.953	[-1.65, 1.75]
Strength Endurance-Maximum Strength	1.18	.173	[-0.53, 2.88]
Explosive Strength-Maximum Strength	1.13	.192	[-0.58, 2.83]

***Significant (p<.0.05)**

- **Kicking Ability**

According to table 1, Pre-test kicking scores ranged from 32.45 to 33.55. Post-test values increased in all experimental groups: strength endurance (33.50 ± 5.27 to 34.45 ± 5.43), explosive strength (33.55 ± 4.94 to 34.45 ± 4.84), and maximum strength (32.45 ± 4.98 to 33.25 ± 4.63). The control group exhibited a minimal increase (32.45 ± 4.98 to 32.80 ± 5.05).

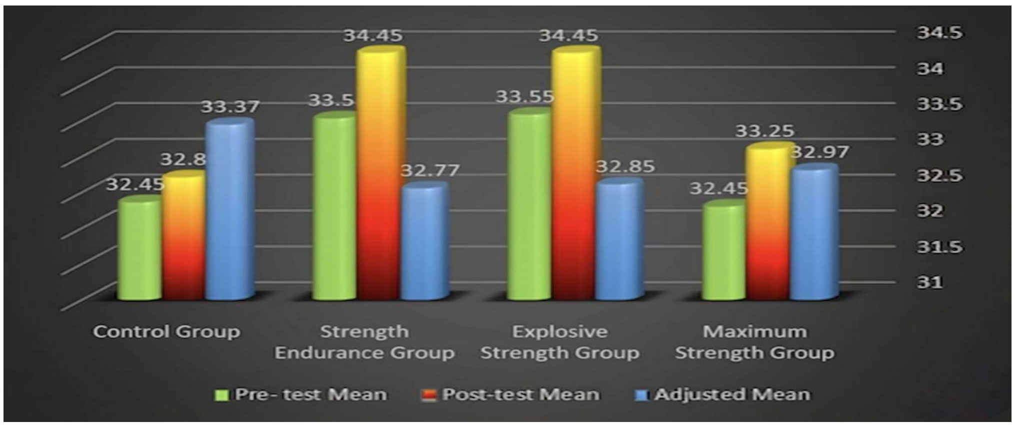


Figure 4: Pre-Test and Post Test Mean Scores of Kicking Ability Across Experimental Groups and Control Group

Table 8: Two-Way Repeated Measures ANOVA On Kicking Ability Performance Among Training Groups

Source	df_1	df_2	F	*P*
Time	1	76	93.70*	<0.01*
Group	3	76	0.422	0.738
Time*Group	3	76	-	Not significant

The analysis of Table 4 showed a significant main effect of time, [F (1, 76) = 81.18, p < .001], indicating that trapping ability changed significantly over time. However, the main effect of group was not significant, [F (3, 76) = 1.49, p = .983], suggesting no significant differences among the training groups. The time × group interaction was also not significant, indicating that the pattern of change over time was similar across all groups.

Table 9: Post Hoc Comparison LSD Test for Kicking Ability Variable

Group Compared	Mean Difference	Sig.(p)	95% CI for Difference
Strength Endurance-Control	1.35	.397	[1.80– 4.50]
Explosive Strength– Control	1.38	.388	[1.78– 4.53]
Maximum Strength–Control	0.23	.887	[2.93– 3.38]
Strength Endurance-Explosive Strength	0.03	.987	[3.18– 3.13]
Strength Endurance-Maximum Strength	1.13	.480	[2.03– 4.28]
Explosive Strength-Maximum Strength	1.15	.470	[2.00– 4.30]

***Significant (p< 0.05)**

Repeated measures ANOVA indicated a significant main effect of time, F (1,76) = 93.70, p < .001 (table 8). The main effect of group was not significant, F (3,76) = 0.422, p = .738. The Time × Group interaction was also non-significant ($p > .05$). As depicted in table 9, LSD post-hoc comparisons confirmed the absence of statistically significant differences between groups.

Across all four performance variables, a consistent pattern emerged where significant improvements over time were observed in dribbling, trapping, passing, and kicking and no significant Time × Group interactions were detected. Post-hoc comparisons revealed no statistically significant differences between strength endurance, explosive strength, maximum strength, and control groups. These findings indicate that while performance improved over the 12-week period, the magnitude of change did not differ significantly among training modalities. The descriptive statistics displayed that the control group remained virtually unchanged in dribbling performance over the 12-week period with scores shifting only from 27.75 to 27.78 while all other three groups showed improvements in dribbling ability after 12-week training programmed.

5. DISCUSSION

The present investigation evaluated the comparative effectiveness of three distinct strength-training modalities mstrength endurance, explosive strength, and maximum strength—on football-specific technical performance variables in district level Indian players. All experimental groups showed statistically significant change during the 12-week interval of period of intervention, though there was no superiority of one modality over the other. The lack of large effects of interaction can imply that the effects of performance improvement were generalized and not modality specific.

The enhancement in dribbling, trapping, passing, and kicking as sources of improvement were noted in all training conditions, which means that organized strength training is a positive contributor to overall performance capability. Nonetheless, the extent of change was small and was similar across groups. This trend would indicate that the muscle-strengthening training can possibly ameliorate the physical bases of technical practice including lower-proportionate stability, power transmission, and neuromuscular coordination without necessarily guiding significant improvement on skills accuracy.

Rapid coordination, balance control, and perceptual-motor integration all play important roles in dribbling performance, for example. Though a higher force-generating capacity has the potential to enhance the acceleration and directional changes (Wisløff et al., 2004), the technical efficiency during ball manipulation mostly is still controlled by the motor learning process and rehearsal (Reilly et al., 2000). This consistent improvement of modalities means that the better neuromuscular performance whether focus on strength or not may have indirectly contributed to dribbling expertise. Nevertheless, the lack of differential effects means that the increase of raw strength qualities is not enough to influence the complex coordination-based skills significantly.

The same trend was observed in the performance in traps. Reception of a ball involves anticipation and proprioception, as well as foot coordination instead of a top level of force output. Despite a marginally higher numerical improvement in the experimental groups as compared to the control group, post hoc comparisons did not show significant between groups differences. The results support the idea that technical skills with high perceptual-cognitive demand might be more strongly responsive to sport-specific training compared with the isolated development of strength (Little and Williams, 2005).

Passing performance were similar. Strength modality was not a significant factor although over time, there was measurable improvement. Passing accuracy is multidimensional, and it entails biomechanical stability, visual scan, tactical awareness, and decision making efficiency (Williams and Ford, 2008). Although lower-body strength is a factor in postural control and efficiency of kinetic chains during ball contact (Rampinini et al., 2007), the physical improvements do not seem to be enough to result in statistically significant superior effects on precision-based tasks. The data thus indicate that strength training offers background support as opposed to playing a major role of determining passing accuracy.

Kicking skill revealed the greatest improvement with time, which conforms to body of literature associating lower-limb force against the speed of the ball (Cometti et al., 2001). But again, there was no difference in modalities. Since rates of force development are affected by both explosive and maximal strength, it is possible to believe that all of the three programs have adequately contraindicated neuromuscular changes in promotion of better kicking mechanics. This may be due to a lack of differentiation suggesting that over a 12 week duration and similar training volumes, different emphasis on strengths leads to comparable functional outcomes.

To some extent, these findings agree with the principle of training specificity (Behm and Sale, 1993) but they also show its contextual constraints. But despite the specificity of neuromuscular adaptations to the demands imposed, it is likely that the modality-specific effects are moderating the effect of the simultaneous football practice. Every participant has maintained standard trainings in terms of, technical and tactical training; this could have masked the slight differences that can be ascribed to strength orientation alone. In turn, adaptations seemingly represent a product of interaction between overall zed physical enhancement and continuing sport-related exposure.

Moreover, lack of group divergence indicates that early-to-intermediate neuromuscular benefits could result in extensive transferable neuromuscular benefits across several football tasks. Further modality differentiation can take a considerable period of time after a certain minimum level of strength acquisition has been reached, necessitating increased intensity gradients or more stringent training variable isolation.

In practical terms, the findings show that coaches can choose between strength endurance, explosive or maximal strength protocols without anticipating significant differences in the short-term outcomes in terms of the technical performance indicators. Program design must focus on instead more balanced integration of strength qualities to the larger competitive calendar. Considering the multidimensional aspect of the football performance, resistance training has to be considered as the supplement factor that develops physical preparedness with technical performance being maintained through anthropomorphic exercises.

There are a number of reasons that could be attributed to the absence of between-group differentiation. The 12 weeks period used was enough time needed to measure strength adaptation, but possibly not enough time to demonstrate clear differentiation between modalities. Also, similar amounts of total training in both groups and sustained football training would have neutralized different neuromuscular patterns. The medium sample size (n = 20/group) also impairs statistical sensitivity to identify a weak effect.

The future research needs to consider longer intervention periods, higher contrast loading parameters as well as possible interactions between strength, modality and positional role. Including the methods of biomechanical and electromyography measurements could also help to elucidate the processes that occur during the transfer of skills.

In the current study, therefore, structured strength training considerably improved football-specific performance variables over time although modern modality was not found to be more effective than the rest of the interventions during the 12 weeks treatment period. These results indicate that changes in technical performance probably occur as mediated by general neuromuscular efficacy in collaboration with constant drilling of the skill and not the direction of the strength training. An efficient football conditioning program should thus be able to incorporate a combination of various strength attributes but a sense of endowing sport specific skills should be emphasized as well.

6. CONCLUSION

The findings indicate that consistent strength training has a positive but moderate and non-specific effect on modalities of the football technical performance variables. In the case of football players, combination of strength training and specific technical exercises can present stronger effect on the variables based on skills.

REFERENCES

1. Ali, A. (2011). Measuring soccer skill performance: A review. *Scandinavian Journal of Medicine & Science in Sports, 21*(2), 170–183. https://doi.org/10.1111/j.1600-0838.2010.01256.x.

2. Arnason, A., Sigurdsson, S. B., Gudmundsson, A., Holme, I., & Bahr, R. (2004). Physical fitness, injuries, and team performance in soccer. *Medicine & Science in Sports & Exercise, 36*(2), 278–285.

3. Behm, D. G., & Sale, D. G. (1993). Intended rather than actual movement velocity determines velocity-specific training response. *Journal of Applied Physiology, 74*(1), 359–368.

4. Bompa, T. O., & Haff, G. G. (2009). *Periodization: Theory and methodology of training* (5th ed.). Human Kinetics.

5. Chen, L., Yan, R., Xie, L., Zhang, Z., Zhang, W., & Wang, H. (2024). Maturation-specific enhancements in lower extremity explosive strength following plyometric training in adolescent soccer players: A systematic review and meta-analysis. *Heliyon, 10*(12), e33063.

6. Cometti, G., Maffiuletti, N. A., Pousson, M., Chatard, J. C., & Maffulli, N. (2001). Isokinetic strength and anaerobic power of elite, subelite and amateur French soccer players. *International Journal of Sports Medicine, 22*(1), 45–51.

7. Gadev, M., & Peev, P. (2022). Correlation of the ball speed and relative strength potential and explosive power of the lower limbs of in-step kick of elite football players. *Trakia Journal of Sciences, 3*, 221–226.

8. Hoff, J., & Helgerud, J. (2004). Endurance and strength training for soccer players. *Sports Medicine, 34*(3), 165–180.

9. Lees, A., Asai, T., Andersen, T. B., Nunome, H., & Sterzing, T. (2010). The biomechanics of kicking in soccer: A review. *Journal of Sports Sciences, 28*(8), 805–817.

10. Little, T., & Williams, A. M. (2005). Specificity of acceleration, maximum speed, and agility in professional soccer players. *Journal of Strength and Conditioning Research, 19*(1), 76–78.

11. Lockie, R. G., Murphy, A. J., & Spinks, C. D. (2012). Effects of resisted sprint training on acceleration performance and sprint mechanics in soccer players. *Journal of Strength and Conditioning Research, 26*(8), 2080–2086.

12. McGuigan, M. R., Newton, M., & Winchester, J. B. (2006). Effects of combined strength and sprint training on maximal sprint performance. *Journal of Strength and Conditioning Research, 20*(2), 404–408.

13. Ramirez-Campillo, R., et al. (2014). Effects of plyometric training on performance in youth soccer players. *Journal of Strength and Conditioning Research, 28*(1), 300–308.

14. Reilly, T., Bangsbo, J., & Franks, A. (2000). Anthropometric and physiological predispositions for elite soccer. *Journal of Sports Sciences, 18*(9), 669–683.

15. Rønnestad, B. R., et al. (2011). The effects of combining heavy strength training with high-intensity interval training in well-trained female soccer players. *Journal of Strength and Conditioning Research, 25*(10), 2739–2745.

16. Schoenfeld, B. J. (2010). The mechanisms of muscle hypertrophy and their application to resistance training. *Journal of Strength and Conditioning Research, 24*(10), 2857–2872. https://doi.org/10.1519/JSC.0b013e3181e840f3

17. Suresh, C., Rajan, A. K., & Muniraju, M. G. (2023). Role of resistance and SAQ training in improving lower limb strength and ball control in collegiate football players. *Journal for ReAttach Therapy and Developmental Diversities, 6*(10s(2)), 2306–2309.

18. Tyagi, S., Vanaik, A. K., Wasuja, M., Sharma, A., Rexwal, P., Yadav, D., Bindu, M., & Abraham, G. (2026). Resistance training as a stimulus for skeletal muscle hypertrophy in novice urban university students—An experimental investigation. *International Journal of Advances in Signal and Image Sciences, 12*(2s), 548–558.

19. Williams, A. M., & Ford, P. R. (2008). Expertise and expert performance in sport. *International Review of Sport and Exercise Psychology, 1*(1), 4–18.

20. Wisløff, U., Castagna, C., Helgerud, J., Jones, R., & Hoff, J. (2004). Strong correlation of maximal squat strength with sprint performance and vertical jump height in elite soccer players. *British Journal of Sports Medicine, 38*(3), 285–288.