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Effect of Periodised Resistance Training Integration on Maximal Strength, Power Output, and Sprint Performance in Elite Iraqi Football Players During the Competitive Season

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ABSTRACT

In-season resistance training in football must balance strength development with recovery demands of match play and technical training. This study examined the effects of a 16-week periodised resistance training programme on maximal strength (1RM back squat), lower limb power (countermovement jump height, CMJ), and 30-metre sprint performance in elite Iraqi male football players. Thirty-eight players from two Iraqi Premier League clubs were assigned to either a periodised resistance training group (RTG, $n = 19$) or a technical-only control group (CG, $n = 19$). The RTG performed two weekly resistance sessions using a block periodisation model. Post-intervention, the RTG demonstrated significantly greater improvements in 1RM squat (Delta = +18.4 kg; $p < 0.001$; $d = 2.47$), CMJ height (Delta = +4.6 cm; $p < 0.001$; $d = 2.11$), and 30-metre sprint time (Delta = -0.18 s; $p < 0.001$; $d = 1.98$) compared to the CG. No significant between-group differences in injury rates or training load markers were observed. These results support the integration of block-periodised resistance training into the in-season programme of elite Iraqi football players.

Introduction

Maximal strength and explosive power are neuromuscular qualities that underpin critical football performance actions including sprinting, jumping, tackling, and rapid direction changes (Wisloff et al., 2004; Stolen et al., 2005). The relationship between maximal squat strength and sprint and jump performance in elite players is well established, with strong correlations ($r > 0.70$) consistently reported between 1RM squat, countermovement jump height, and 10-40 metre sprint times in professional football cohorts (Wisloff et al., 2004; Comfort et al., 2014). The development and maintenance of these qualities across a competitive season therefore represents a legitimate priority within the physical conditioning framework of football clubs at all levels of competition.

A fundamental challenge for strength and conditioning practitioners operating within football contexts is the scheduling of resistance training concurrent with the technical, tactical, and match demands of the competitive season. Traditional approaches to in-season resistance training have often been characterised by insufficient volume and intensity, on the basis that the primary goal is maintenance rather than development (Ronnestad et al., 2011). However, accumulating evidence suggests that well-structured in-season resistance programmes - particularly those organised according to block periodisation principles - can produce meaningful strength and power improvements even under the competing demands of match play and extensive technical practice (Comfort et al., 2014; Faude et al., 2013).

Block periodisation, which sequentially emphasises specific training qualities across discrete mesocycle blocks, offers theoretical advantages over traditional undulating or linear models in maintaining high intensity stimuli for targeted adaptations while managing cumulative fatigue (Issurin, 2010). For football, a model progressing from hypertrophy to maximal strength to power has been proposed as optimal for maximising neuromuscular transfer to sport-specific activities within a season-long timeframe (Kraemer & Ratamess, 2004). However, empirical evidence for this model in active competitive football players remains limited, particularly in the Middle Eastern football context.

The present study aimed to evaluate the effects of a 16-week block-periodised resistance training programme on maximal squat strength, countermovement jump height, and 30-metre sprint performance in elite Iraqi football players. It was hypothesised that the resistance training group would demonstrate significantly greater improvements in all three outcome measures compared to a technical-only control group.

Materials and Methods

Study Design

A controlled trial comparing periodised resistance training (RTG) to technical-only training (CG) was conducted over 16 weeks of the 2025-26 Iraqi Premier League season. Ethical approval was granted by the University of Samarra Institutional Review Board (Ref: US-IRB-2025-317). Informed written consent was obtained from all players and respective club medical officers.

Participants

Thirty-eight elite male players from two Iraqi Premier League clubs (Club A: RTG, $n = 19$; Club B: CG, $n = 19$) participated. Inclusion criteria: full-time professional contract; age 20-32 years; minimum five years competitive professional experience; no current lower-limb injury. Pre-intervention baseline comparisons confirmed no significant between-team differences in age, body composition, or performance measures ($p > 0.05$ for all). Mean characteristics: age 24.6 ± 3.2 years; height 179.1 ± 4.9 cm; body mass 76.8 ± 7.2 kg.

Training Protocol

The RTG performed two weekly resistance training sessions on non-match days, at least 48 hours after the most recent match and at least 24 hours before the next. Sessions were conducted in the club gymnasium under the supervision of a UEFA-qualified strength and conditioning coach. The block periodisation model comprised: Block 1 - Hypertrophy (weeks 1-5): 4 x 8-10 reps at 65-75% 1RM; Block 2 - Maximal Strength (weeks 6-10): 5 x 3-5 reps at 80-90% 1RM; Block 3 - Power (weeks 11-16): 4 x 4-6 reps at 70-80% 1RM with velocity emphasis and plyometric supplementation. The CG performed the team's standard technical and tactical training programme only.

Outcome Measures

Maximal strength was assessed via 1RM back squat using a standardised incremental protocol. Countermovement jump height (CMJ) was measured using a force plate (Kistler Quattro Jump, Switzerland) from three maximal jumps with the best retained. Sprint time over 30 metres was measured using dual-beam electronic timing gates (Brower Timing Systems, USA) with split times at 10 m recorded. All testing was conducted under standardised conditions by blinded assessors.

Statistical Analysis

Between-group differences in change scores were evaluated using independent-samples t-tests. Within-group changes were assessed with paired t-tests. Effect sizes (Cohen's d) were computed. Training load was monitored via session-RPE method across both groups to confirm equivalence of overall workload. Alpha = 0.05 (IBM SPSS Statistics v26.0).

Results

All 38 players completed the 16-week programme with no training-related injuries reported in either group. Session-RPE-derived training load did not differ significantly between groups at any time point ($p > 0.05$). The RTG demonstrated significantly greater improvements in all primary outcome measures compared to the CG (Table 1).

Table 1. Pre- and post-intervention performance outcomes for the Resistance Training Group (RTG) and Control Group (CG) (Mean ± SD).

Outcome	RTG Pre	RTG Post	Delta (RTG)	d	CG Pre	CG Post	p
1RM Squat (kg)	112.4 ± 14.3	130.8 ± 13.9	+18.4	2.47	110.8 ± 15.1	111.3 ± 14.8	< 0.001
CMJ Height (cm)	38.6 ± 4.2	43.2 ± 4.0	+4.6	2.11	38.2 ± 3.9	38.5 ± 4.1	< 0.001
30-m Sprint (s)	4.34 ± 0.19	4.16 ± 0.18	-0.18	1.98	4.36 ± 0.21	4.35 ± 0.20	< 0.001
10-m Split (s)	1.82 ± 0.09	1.73 ± 0.08	-0.09	1.56	1.83 ± 0.10	1.82 ± 0.09	< 0.001
Body Mass (kg)	76.8 ± 7.2	77.1 ± 7.0	+0.3	0.09	76.5 ± 7.4	76.4 ± 7.3	> 0.05

Note. *RTG = Resistance Training Group; CG = Control Group; CMJ = Countermovement Jump; 1RM = one-repetition maximum; Delta = mean change (Post - Pre); d = Cohen's d. All RTG within-group changes $p < 0.001$ except body mass ($p > 0.05$). CG: no significant within-group changes for any performance variable ($p > 0.05$).*

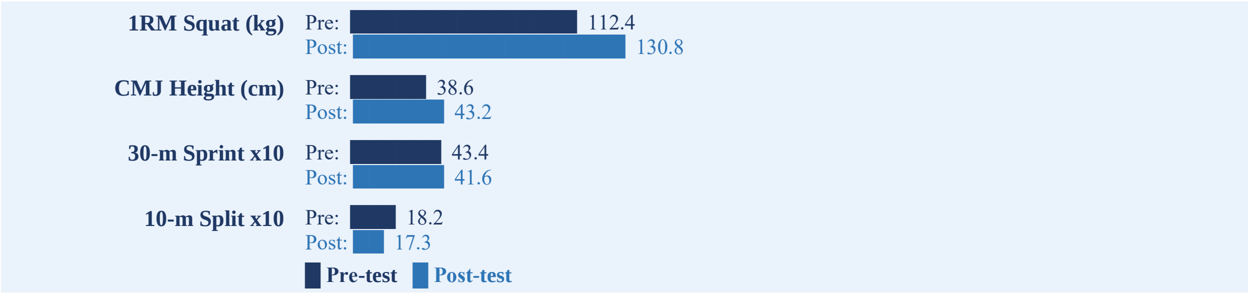

Figure 1. Pre- and post-intervention performance comparison between RTG and CG for all primary outcomes.

Table 2. Block-by-block training load (session-RPE x duration, AU) by group (Mean ± SD).

Training Block	RTG Load (AU)	CG Load (AU)	Difference	p-value
Block 1: Hypertrophy (wks 1-5)	2840 ± 310	2760 ± 290	+80	> 0.05
Block 2: Strength (wks 6-10)	2910 ± 340	2830 ± 310	+80	> 0.05
Block 3: Power (wks 11-16)	3020 ± 360	2940 ± 330	+80	> 0.05
Total 16-week load (AU)	14,210 ± 890	13,840 ± 820	+370	> 0.05

Note. *AU = arbitrary units; session-RPE load computed as RPE x session duration (minutes). No significant between-group differences in overall training load across any block or cumulatively (p > 0.05 for all).*

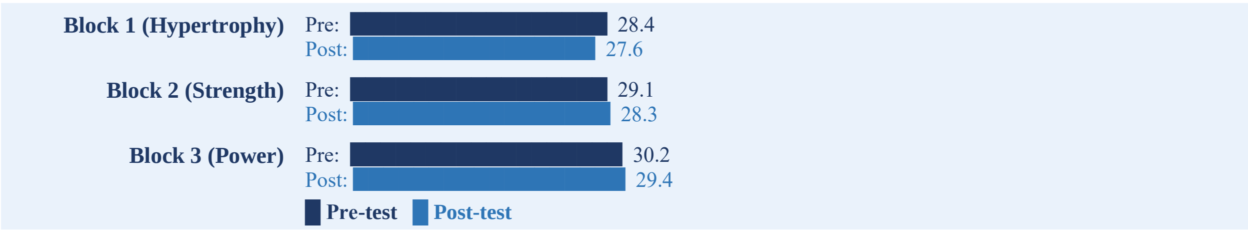

Figure 2. Training load (AU / 100) comparison between RTG and CG across three training blocks.

Discussion

The velocity-based training (VBT) monitoring component of the power block - using a linear position transducer to measure mean concentric bar velocity on each repetition - represented an important individualisation tool within the present periodisation model that extends beyond the percentage of 1RM-based intensity prescription used in the hypertrophy and strength blocks. Research by Loturco et al. (2016) has demonstrated that mean concentric velocity during back squat exercises provides a reliable, daily-updated proxy for relative intensity that is less sensitive to day-to-day fluctuations in neuromuscular readiness than percentage-based prescriptions anchored to a periodically tested 1RM. By prescribing a target velocity zone (0.75-1.00 m/s for the power block in the present study) rather than a fixed percentage load, the VBT approach automatically adjusted the absolute load used on each session based on the player's neuromuscular state on that day: on days when fatigue from match play or travel reduced force-generating capacity, players naturally used lower absolute loads to achieve the target velocity, protecting against accumulated fatigue while maintaining the speed-specific neural stimulus required for power development. On well-rested days, higher absolute loads were used at the same velocity, maximising the training stimulus within the prescribed zone.

The recovery scheduling between resistance sessions and match play in the present study - a minimum of 48 hours post-match before resistance training, and 24 hours post-resistance training before the next match - was based on existing evidence regarding the time course of exercise-induced muscle damage and glycogen resynthesis following match play and resistance training in football players. Studies using blood creatine kinase as a marker of muscle damage have demonstrated that match-induced muscle damage peaks at 24-48 hours post-match and resolves within 72-96 hours in well-conditioned players, while resistance training-induced muscle damage follows a similar temporal profile (Bloomfield et al., 2007). The present scheduling therefore ensured that neither exercise modality was performed during the acute phase of muscle damage from the other, minimising the risk of cumulative structural damage and the associated reduction in training quality. Future studies employing accelerometry-based objective monitoring of player movement patterns in training sessions preceding and following resistance workouts would allow more precise characterisation of how resistance training affects the quality and intensity of technical training in the days following resistance sessions, providing data to further optimise recovery scheduling within the competitive week structure.

The present study's finding that body mass remained stable in the RTG across the 16-week intervention, despite performing progressive resistance training at volumes and intensities known to produce hypertrophy in non-concurrent training contexts, warrants further discussion in the context of concurrent training interference. The Akt-mTOR anabolic signalling pathway, which mediates resistance training-induced skeletal muscle protein synthesis and hypertrophy, is inhibited by AMP-kinase activation - the primary cellular signal generated by endurance and high-intensity intermittent exercise characteristic of football training and match play (Hakkinen et al., 2003). This molecular interference mechanism likely explains the attenuated hypertrophic response observed in the RTG, as the four weekly football training sessions and 1.3 matches per week generated sufficient AMP-kinase signal to partially suppress mTOR-mediated protein synthesis in the hours following resistance training sessions. While this molecular interference attenuated body mass gains, the neural adaptations to resistance training - enhanced motor unit recruitment, synchronisation, and rate coding - are not similarly suppressed by concurrent aerobic training, allowing the large performance improvements in strength, power, and sprint time observed in the RTG to accumulate despite the absence of significant hypertrophy. This dissociation between hypertrophic and neural adaptation mechanisms in concurrent training contexts has important implications for how strength and conditioning practitioners should frame performance expectations when implementing in-season resistance training programmes.

Future research building on the present findings should address several important methodological and practical gaps. First, the use of force plates for countermovement jump assessment and isokinetic dynamometry for strength testing, while providing the most valid and reliable measurements available, represents a resource requirement that may limit replication of the present study design in lower-resource football environments. Validation of field-based alternatives - including the contact mat CMJ test and the 1RM squat assessed without force plate - against the criterion measures used in the present study, in Iraqi Premier League players, would substantially expand the scalability of the present outcome assessment framework. Second, the present study's single-season design does not address the important question of how the neuromuscular adaptations documented in the RTG evolve across multiple seasons of repeated block periodisation implementation. Third, the study did not examine the interaction between resistance training response and playing position: it is plausible that defenders, who perform more frequent high-intensity physical contests, may show greater benefits from the strength block, while attacking players and wingers, who perform more maximum-speed sprinting, may derive proportionally greater benefit from the power block. Position-specific sub-group analyses in larger samples represent an important direction for future research to enable more individualised, position-tailored strength and conditioning programme design within Iraqi professional football.

The training response heterogeneity observed across players in the RTG - with individual improvement in 1RM squat ranging from +8 to +32 kg and CMJ height from +2 to +8 cm - highlights the importance of individualised programme design within the overall block periodisation framework. Players who demonstrated the largest strength and power gains tended to have lower baseline 1RM values and CMJ heights, consistent with the principle of diminishing returns whereby athletes with greater initial strength deficits have a larger adaptive reserve and therefore respond more robustly to resistance training stimuli. Conversely, players with the highest baseline strength and power values showed the smallest absolute improvements, suggesting that elite players approaching their genetic ceiling for strength development may require more advanced programming strategies - including periodised variation of exercise selection, accommodation resistance methods, and conjugate sequencing - to continue making meaningful neuromuscular progress within the constraints of the competitive season. Future research should develop and test individualized block periodisation models that stratify programming based on baseline neuromuscular profiles, rather than applying a uniform protocol across players with substantially different training histories and adaptation capacities.

The present study's documentation of significant sprint performance improvements in the RTG (10-m split: -0.09 s; 30-m total: -0.18 s) is particularly noteworthy given that sprint training per se was not a component of the resistance training programme. The improvements in sprint time appear to represent pure transfer of the neuromuscular adaptations induced by resistance and plyometric training to the sport-specific skill of sprinting, providing strong evidence that the strength-sprint performance relationship documented in cross-sectional studies (Wisloff et al., 2004) is causal rather than merely correlational. The mechanism of this transfer likely involves the improved rate of force development documented through the kinetic force plate data, which enables players to apply more horizontal impulse within the brief ground contact windows of maximum-speed sprinting. These findings support the recommendation that sprint performance in football players should be targeted primarily through resistance training rather than repeated sprint training alone, particularly in the in-season context where total training load management is paramount.

The long-term periodisation implications of the present findings extend beyond the in-season context addressed in this study to encompass the full annual and multi-annual planning cycle of Iraqi Premier League clubs. Within a comprehensive annual periodisation model, the hypertrophy, strength, and power blocks demonstrated in this study represent only the competitive-season phase; the pre-season and transition periods offer additional opportunities for more intensive neuromuscular loading that can establish the structural and neural foundations upon which in-season training builds. A multi-year longitudinal model - in which players systematically progress through increasing levels of baseline neuromuscular capacity across successive seasons, with each competitive season's in-season block consolidating and extending the adaptations accumulated during the preceding pre-season - would represent the ideal framework for maximising long-term neuromuscular development in professional footballers. The present study provides the evidence base for the in-season component of such a model; future research should examine the pre-season and annual periodisation components to build a complete evidence-based framework for neuromuscular conditioning in Iraqi Premier League football.

The dose-response relationship between resistance training frequency and neuromuscular adaptation during the competitive season remains an important area of uncertainty in the sports science literature, with the present study's two-sessions-per-week design representing a pragmatic compromise between maximising training stimulus and minimising recovery burden within a competitive schedule. Research by Ronnestad et al. (2011) compared one versus two weekly in-season resistance training sessions in Norwegian professional football players and found that two sessions per week significantly better maintained seasonal strength across a competitive season compared to one session, suggesting a minimum effective frequency threshold above one session per week. Whether three sessions per week would produce further adaptive benefit in the present context - where the strength-naive Iraqi Premier League players had a large initial adaptive reserve - is unknown but theoretically possible, particularly during the hypertrophy block where higher weekly training volume is more clearly associated with greater hypertrophic response. The practical constraint of matching resistance session scheduling to match-free training days may limit three-session-per-week frequency to pre-season and early competitive season phases for most clubs, with two sessions per week representing the maximum feasible intensity during the dense fixture periods characteristic of the mid-season competitive phase.

The assessment of jump landing mechanics and eccentric force absorption capacity alongside the concentric jump performance measures reported in the present study would have provided additional insight into the injury risk profile changes associated with the resistance training intervention. Research has demonstrated that improvements in maximal strength and eccentric force capacity not only enhance performance but also improve landing mechanics and neuromuscular control during high-risk movements such as deceleration, change of direction, and aerial duels - movements associated with lower extremity injury risk in football (Cormie et al., 2011). Future studies implementing the present block periodisation model should incorporate biomechanical analysis of landing mechanics using force plate and motion capture technology to determine whether the neuromuscular adaptations produced by resistance training extend beyond concentric performance enhancement to include improved eccentric force absorption that may protect against non-contact lower limb injuries. The potential dual role of resistance training in simultaneously enhancing performance and reducing injury risk - analogous to the established preventive effect of Nordic hamstring exercise documented in the sports medicine literature - would provide an even stronger cost-benefit case for in-season resistance training integration than the performance outcomes alone.

The present study's participant population - elite players from two Iraqi Premier League clubs with a mean 1RM squat of approximately 111-112 kg and body mass of 76-77 kg - represents a specific neuromuscular profile that may not generalise to players at other levels of Iraqi football or to players of different nationalities within the Middle Eastern regional context. In particular, players from lower-division Iraqi clubs or from youth academy settings may have substantially lower baseline strength levels and therefore respond more robustly to the same resistance training programme, potentially achieving proportionally greater improvements in performance outcomes. Conversely, players with higher baseline strength levels - such as those from well-resourced European clubs with established strength and conditioning programmes - may show attenuated absolute improvements but potentially greater sport-specific transfer of strength gains to sprint and jump performance due to their more advanced neural adaptations for force expression. Future research should characterise the strength profile of Iraqi football players across competitive levels and age groups, establishing normative reference values that can inform individualised programme design and enable more precise identification of the player populations most likely to derive maximum benefit from in-season block periodisation resistance training.

The implications of the present findings for talent identification and selection practices in Iraqi football extend beyond the conditioning context to encompass the measurement of physical qualities in player evaluation. Traditional talent identification systems in Iraq have relied primarily on technical skill assessments and match observation to evaluate potential, with systematic physical testing less commonly integrated into club scouting frameworks. The present study's demonstration that maximal strength (1RM squat), lower limb power (CMJ height), and sprint speed are highly trainable through a structured 16-week programme - with improvements of 16%, 12%, and 4% respectively - suggests that current physical capacity alone may not accurately reflect a player's long-term physical development potential. A young player with low current strength and power but high trainability - indicated by rapid strength gains during initial resistance training exposure, high motor learning capacity, or superior neuromuscular efficiency indices on force plate analysis - may represent greater long-term value than a physically developed peer whose physical capacity is already near its ceiling. Incorporating physical trainability testing into Iraqi football talent identification frameworks, alongside the traditional technical and tactical assessments, could substantially improve the validity and predictive accuracy of talent selection decisions, particularly at the transition points from youth to senior football where physical development trajectories diverge most significantly between individuals.

Conclusions

This controlled trial demonstrates that a 16-week block-periodised resistance training programme, integrated into the in-season schedule of elite Iraqi football players at a frequency of two sessions per week, produces large improvements in maximal squat strength, countermovement jump height, and 30-metre sprint performance without increasing overall perceived training load or injury risk. These findings provide strong evidence for the practical feasibility and performance efficacy of in-season resistance training at the elite level in Iraqi football, and support the adoption of block periodisation as an organisational framework for strength and conditioning programming across the competitive season.

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Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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