

Article

Rapid-Restart Protocol, Faster Players: A Practical Strategy to Maximize Playtime and Performance

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Featured Application

This study proposes a simple and low-cost match organization strategy based on a rapid-restart protocol (RRP) using spare balls (SB) to increase effective playing time (EPT) in male Tunisian youth soccer players. The approach could be implemented in official youth competitions and training matches to reduce stoppage time, enhance game continuity, and increase EPT during youth soccer matches. The protocol was associated with improvements in sprint and agility performance under the present experimental conditions. Its practical implementation may facilitate match organization while reducing unnecessary interruptions.

Abstract

Background: Effective playing time (EPT) is a crucial determinant of the physical, technical, and cognitive development of young soccer players. Reducing match interruptions may enhance game rhythm and support player progression. This study examined the effects of a rapid-restart protocol, based on the availability of spare balls (SB), on EPT, sprint performance, and agility in young Tunisian players. **Methods:** Sixty male youth players (aged 11–16) from a Tunisian first-division club were randomly assigned to an experimental group (EG, $n = 30$) or a control group (CG, $n = 30$) across three age categories (U12, U14, U16). The EG played 10 weekly matches using the rapid-restart protocol, while the CG competed under standard conditions. Sprint performance (5 m, 10 m, 20 m) and agility (Illinois Agility Test, IAT) were assessed at baseline (T0), mid-intervention (T1), and post-intervention (T2). EPT was determined through video analysis. **Results:** Compared with controls, the EG showed significant improvements in sprint (5 m and 20 m) and IAT performance across all age categories ($p < 0.01$). EPT increased, providing additional opportunities for ball-in-play exposure during matches. The protocol also reduced contact between ball retrievers and players, thereby improving safety and minimizing interruptions. **Conclusions:** The rapid-restart protocol (RRP) effectively increased EPT and was associated with improvements in



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sprint and agility performance. Whether these improvements were mediated by changes in match intensity or physiological load remains to be determined. Its simplicity, low cost, and safety benefits make it a practical strategy for coaches, organizers, and the Tunisian Football Federation. This approach may represent a practical organizational strategy for improving match continuity and EPT during youth soccer competitions.

Keywords: training innovation; youth soccer; effective playing time; match organization; sprint performance; agility; performance monitoring

1. Introduction

Football is a high-intensity intermittent sport [1,2] in which effective playing time (EPT), defined as the actual time during which the ball is in play [3], constitutes a crucial determinant of physical and technical–tactical performance [4]. Although a professional match lasts 90 min, EPT is generally much lower [2,4,5], averaging between 50 and 60 min depending on the level of competition [6,7]. In youth players, interruptions related to ball being out of play, fouls, or organizational delays occur even more frequent, further reducing actual engagement time [3,8]. This reduction limits opportunities for technical execution, tactical decision-making, and physiological stimulation, all of which are essential for long-term athlete development [4,8,9].

Recent studies have shown that these interruptions directly influence performance. A study conducted in the German Bundesliga reported that declines in running performance during matches were not solely related to fatigue but were also strongly associated with increased game stoppages [4]. Similarly, Stöckl et al. [5] demonstrated that periods when the ball is in or out of play significantly altered the observed physical intensity during competition, highlighting the importance of incorporating EPT in performance assessment [5]. Additional research has confirmed that stoppages, whether due to fouls, throw-ins, or other organizational delays, affect both the physical and tactical demands placed on players [10,11].

Accounting for EPT also changes the interpretation of performance. Altmann et al. [2] observed that physical indicators (distance covered, sprints, and high-intensity runs per minute) were significantly higher during effective playing phases compared with overall match averages [2]. Similarly, Tojo et al. [3] demonstrated that a game format with reduced interruptions led to significant changes in technical–tactical and physical parameters, highlighting the importance of considering EPT when evaluating performance.

Siegle and Lames [12,13] observed that the frequency and duration of stoppages significantly altered the rhythm and physiological load of players. Likewise, Lago-Peñas et al. [14] demonstrated that EPT affects the physical demands of elite soccer players. These findings support the relevance of a quick-restart protocol using spare balls (SB), as proposed in the present study [10,12–14]. The importance of EPT is further justified by its association with fundamental physical capacities. Match performance is strongly correlated with aerobic power and sprint capacity [2,15–17]. Reducing interruptions can therefore maximize opportunities to express and develop these qualities in a competitive setting, which is particularly crucial for young players [1,3,12,18–20].

Despite the growing international literature on EPT and game interruptions in football [1,7,12,17], few studies have examined this phenomenon in the African context. In Tunisia, a report by the National Technical Directorate indicated that EPT in local competitions ranges between 55 and 60 min, slightly higher than in the 1990s [21]. Nevertheless, organizational issues remain, notably delays during restarts. Structural factors may influence

youth football development, including training organization, competitive environment, and access to appropriate development programs [8]. In Senegal, initiatives such as the Diambars Institute illustrate the importance of structured programs to enhance young players' physical and technical capacities [17], although these efforts have predominantly focused on physical preparation rather than the management of game interruptions [15,16,19].

Although multi-ball systems are already used in some professional competitions to improve match continuity, their effects have primarily been considered from an organizational perspective. To our knowledge, no previous experimental study has investigated whether a standardized rapid-restart protocol (RRP) can modify EPT and influence physical performance indicators in youth soccer players.

In this context, increasing EPT may contribute to enhancing the physical and technical-tactical performance of young soccer players [2,11,13,14,20]. While studies in professional leagues and small-sided games support the benefits of strategies to improve game continuity [4,17], their application in youth competitions remains largely unexplored, and their impact on physical and technical performance is still poorly understood, particularly in North Africa. Therefore, the present study aimed to evaluate the effects of a rapid-restart protocol using SB on EPT and physical performance (sprint and agility) in young Tunisian players. We hypothesized that this protocol would significantly increase EPT and improve physical performance indicators compared with standard conditions.

2. Materials and Methods

2.1. Study Design

This study was conducted according to protocol Version 2.0, dated 15 September 2025. This longitudinal experimental study aimed to evaluate the effects of a rapid-restart protocol, consisting of placing SB on cones around the pitch, on EPT and the physical performance of young soccer players. A randomized pre-post design with an experimental group (EG) and a control group (CG) was used. Assessments were conducted three time points: baseline (T0), mid-intervention after five matches (T1), and post-intervention after ten matches (T2).

2.2. Participants

A total of 60 male youth soccer players (aged 11–16 years) from a first-division Tunisian club voluntarily participated in this study. Players were divided into three competitive age categories (U12, U14, and U16). All participants were licensed players, reported to be in good health, and engaged in a regular training program (three sessions per week) during the study period. Written informed consent was obtained from all participants and their parents or legal guardians. Within each age category, participants were randomly assigned to either the experimental group (EG) or the control group (CG), resulting in six subgroups of 10 players each (EG: $n = 10$ per category; CG: $n = 10$ per category) and a total sample of 60 participants. The random allocation sequence was generated using a computer-based random number generator. The personnel who enrolled participants had no access to the sequence. Assignments were revealed only at the time of group allocation by opening sequentially numbered, opaque envelopes prepared by a researcher not involved in recruitment or assessment. The anthropometric characteristics of the participants are presented in Table 1.

Table 1. Mean values (Means $\pm$ SD) of age and anthropometric characteristics of control and experimental soccer players. Each age category included 20 players (10 EG and 10 CG; total N = 60).

Category	U12		U14		U16	
	CG	EG	CG	EG	CG	EG
Age (years)	10.90 $\pm$ 0.23	10.90 $\pm$ 0.23	13.70 $\pm$ 0.15	13.50 $\pm$ 0.16	15.50 $\pm$ 0.53	15.50 $\pm$ 0.53
BM (kg)	38.90 $\pm$ 0.70	37.90 $\pm$ 0.71	48.50 $\pm$ 0.50	45.80 $\pm$ 0.61	64.40 $\pm$ 2.06	59.90 $\pm$ 1.91
Height (cm)	144.60 $\pm$ 1.11	143.60 $\pm$ 1.11	160.10 $\pm$ 0.64	157.10 $\pm$ 0.74	176.40 $\pm$ 2.06	171.90 $\pm$ 1.91

BM: body mass; CG: Control Group; EG: Experimental Group; U12, U14, and U16: corresponding to under-12, under-14, and under-16 years, respectively.

2.2.1. Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee) of the Higher Institute of Sport and Physical Education of Ksar Said (protocol code CEUR17ISSEPKS 17-S2/2025, approved on 26 November 2025). Trial registration: The Pan African Clinical Trial Registry PACTR202511839785714 (26 November 2025).

2.2.2. Informed Consent Statement

Informed consent was obtained from all subjects involved in the study. Written informed consent has been obtained from the patient(s) to publish this paper.

2.3. Randomization Implementation

Participants were enrolled by the research team according to predefined eligibility criteria. To ensure balanced allocation across developmental stages, a stratified randomization procedure was applied according to age category (U12, U14, and U16). Within each age category, participants were randomly assigned in a 1:1 ratio to either the experimental group (EG) or the control group (CG) using a computer-generated random sequence.

The random allocation sequence was generated by an independent investigator who was not involved in participant recruitment, intervention delivery, or outcome assessment. Researchers responsible for participant enrollment had no access to the allocation sequence. Allocation concealment was maintained using sequentially numbered, opaque, sealed envelopes prepared by an independent researcher. The envelopes were opened only after completion of baseline assessments and participant enrollment.

2.4. Blinding (Masking)

Due to the nature of the intervention, complete blinding of participants and coaching staff was not possible. Furthermore, blinding of video assessors performing EPT analysis could not be fully guaranteed because the presence of SB in match recordings may reveal the intervention condition.

To minimize potential measurement bias, all video files were coded using anonymized identification numbers, and EPT assessment was performed according to a predefined standardized procedure. The assessors responsible for sprint and agility testing were blinded to group allocation, as these evaluations were conducted independently from match intervention procedures. Data analysts were also blinded during statistical analyses by using coded group identifiers.

2.5. Sample Size Determination

The required sample size was estimated a priori based on the primary outcome and informed by previous studies investigating sprint performance and agility in youth soccer players. Assuming a medium effect size (Cohen's $d = 0.6$), a two-sided significance level of 0.05, 80% statistical power, and a 1:1 allocation ratio between the experimental and

control groups, the minimum required total sample size was 54 participants. In line with International Council for Harmonisation (ICH) recommendations that the primary variable should be used to estimate sample size and that all assumptions should be prespecified in the protocol, this calculation was conducted before the start of the study. To account for potential dropouts, 60 participants were recruited and randomly assigned to the experimental group (EG, $n = 30$) and the control group (CG, $n = 30$) across three age categories (U12, U14, U16). All 60 randomized participants were included in the analyses. The sample size calculation was performed using G*Power software (version 3.1).

2.6. Strategies for Achieving Target Sample Size

Participants were recruited from a first-division Tunisian youth soccer club. Eligible players were identified based on age (11–16 years), health status, and regular participation in training sessions. Written informed consent was obtained from all players and their parents or legal guardians prior to enrollment. Recruitment was monitored weekly to ensure that the target sample size of 60 participants was reached across the three age categories (U12, U14, U16). Scheduling of training matches and assessments was coordinated to minimize dropouts and maximize participation compliance.

2.7. Experimental Group (EG)

The EG participated in matches implementing the RRP. This intervention involved placing five SB on cones along the touchlines and two additional balls behind the goal lines. Whenever the ball went out of play, the nearest available ball was used to immediately restart the match. The protocol aimed to minimize stoppages and maximize EPT, thereby increasing EPT and reducing unnecessary match interruptions (Figure 1).

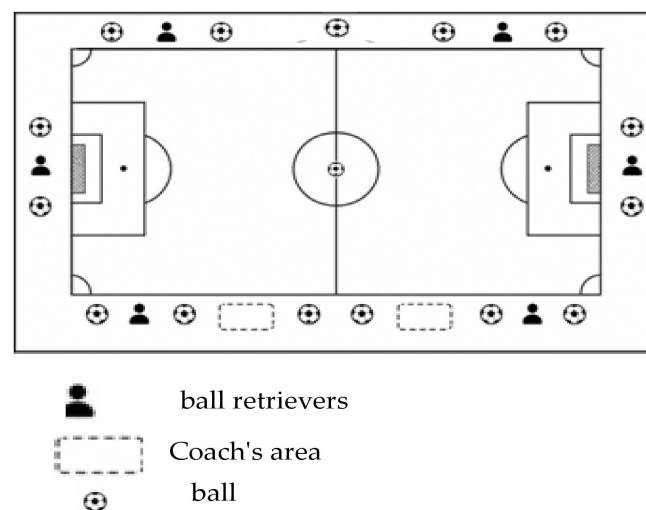


Figure 1. Illustration of the rapid-restart protocol with placement of spare balls along the touchlines and behind the goal lines.

2.8. Match Ball Allocation

A total of 16 balls were available during the matches, including one official match ball and 15 SB positioned around the pitch according to the predefined rapid-restart protocol.

2.9. Spare Ball Placement Protocol

The 15 SB were positioned on cones according to a predefined distribution (Figure 2). Two balls were placed behind each goal line (four balls in total), six were positioned along the touchline adjacent to the Technical Area, and five were arranged along the opposite touchline. The cones were evenly spaced near the pitch boundaries, while maintaining a

sufficient safety margin for players, assistant referees, and substitutes. No additional SB were permitted beyond those specified in the predefined rapid-restart protocol.



Figure 2. Ball Positioning.

2.10. Restarting Play

When the ball went out of play, players were required either to retrieve the original match ball themselves in order to resume play or to collect the nearest replacement ball from a cone to restart the game.

2.11. Intervention and Comparator

The EG participated in matches using the rapid-restart protocol, delivered by the team's coaches and assisted by trained ball retrievers along the sidelines. SB were immediately available to minimize interruptions, and all 30 participants adhered fully to the protocol. Intervention fidelity was systematically monitored throughout the 10-week intervention period using video recordings and a standardized verification checklist developed by the research team. Each experimental match was reviewed to verify adherence to the rapid-restart protocol, including the correct positioning of spare balls and their availability throughout play, and adherence to the predefined restart procedures. All planned experimental matches were completed, and no protocol deviations or interruptions related to implementation failure were recorded. The CG played matches under standard conditions, representing usual practice in youth soccer. Using this comparator allows the effects of the RRP on EPT, sprint performance, and agility to be assessed relative to standard conditions.

2.12. Intervention Duration

The intervention lasted for 10 weeks, during which each subgroup played 10 training matches (one per week). Match scheduling was balanced to ensure comparability in terms of opponents, playing conditions, and competitive context.

2.13. Assessment of Harms

Potential harms related to the RRP were defined as any injuries or adverse events occurring during matches, including collisions between players or with SB, falls, or musculoskeletal injuries. All adverse events were systematically recorded by the research team and supervising coaches using an injury log maintained for each match. No serious adverse events were reported during the intervention period.

2.14. Ancillary and Post-Trial Care

All participants were covered by the club's medical team. During the study period, participants received appropriate medical care, including physiotherapy and follow-up treatment, whenever injuries or adverse events related to trial participation occurred. No financial compensation was offered, as all interventions involved standard sports practice with minimal risk, but participants were fully informed of this arrangement during the consent process.

2.15. Measured Variables

2.15.1. Effective Playing Time (EPT) Measurement

EPT was defined as the total duration during which the ball was actively in play during a match. All matches were recorded using a high-definition digital video camera positioned at the halfway line on an elevated platform, providing a complete view of the playing field. Videos were recorded at 50 frames·s⁻¹ and analyzed frame-by-frame using VLC Media Player (Video LAN, Paris, France). EPT was quantified by excluding all stoppages in play, including the ball leaving the field of play, fouls, injuries, substitutions, referee interruptions, and goals, according to the IFAB Laws of the Game. Two observers experienced in soccer performance analysis independently reviewed the match recordings following a standardized coding protocol. To determine measurement reliability, a randomly selected sample of matches was reanalyzed by the same observer after a two-week interval to assess intra-rater reliability, while the same matches were independently analyzed by a second observer to assess inter-rater reliability.

2.15.2. Physical Performance

Physical performance was assessed at T0, T1, and T2 using two standardized and validated field tests widely applied in team sports. The primary outcomes of the present study were sprint performance (5 m, 10 m, and 20 m) and agility, assessed using standardized field tests. No measures of internal or external match load, including total running distance, high-speed running distance, accelerations, decelerations, heart-rate responses, or rating of perceived exertion (RPE), were collected during the intervention, as the primary objective was to evaluate the effects of the RRP on EPT and standardized physical performance outcomes.

2.15.3. Linear Sprint (5 m, 10 m, and 20 m)

Linear sprint performance was assessed over 5 m, 10 m, and 20 m distances to evaluate both acceleration and maximal sprint speed. Performances were recorded using electronic timing gates (Brower Timing Systems, Salt Lake City, UT, USA) positioned at hip height (approximately 1 m). Players started from a standing two-point position behind the starting line and were instructed to run at maximal speed through the final gate. Each player performed two trials separated by approximately three minutes of rest, and the best time was retained for analysis. This protocol has been shown to be reliable, demonstrating high intraclass correlation coefficients (ICC) for both acceleration and sprint speed assessments [1].

2.15.4. Agility Measurement

Agility was measured using the IAT, which combines linear sprints and multiple changes in direction around cones. The protocol involved an initial 9.2 m sprint, a return run, a slalom through four cones, followed by two additional 9.2 m sprints. Times were recorded using an electronic timing system (Brower Timing) positioned at hip height. Each player performed two trials separated by a period of rest, and the best time was

retained for analysis. The IAT is widely used in sports science and has demonstrated high test–retest reliability ($ICC = 0.96$) as well as strong criterion-related validity compared with other change-of-direction tests [2]. All assessments were conducted under consistent environmental conditions and were preceded by a standardized warm-up.

2.16. Study Protocol

Participants and their parents were not involved in the design or conduct of the study, and the protocol was implemented solely by the research team, the trial was completed as planned after 10 weeks, according to the prespecified protocol. No early stopping occurred. Figure 3 illustrates the experimental protocol conducted with 60 young players divided into three categories (U12, U14, and U16). Participants were allocated into two groups, one following the RRP and the other playing standard matches, with assessments performed at three time points (T0, T1, and T2). The evaluations included EPT, the Illinois Agility Test, and sprint tests over 5, 10, and 20 m (Figure 3).

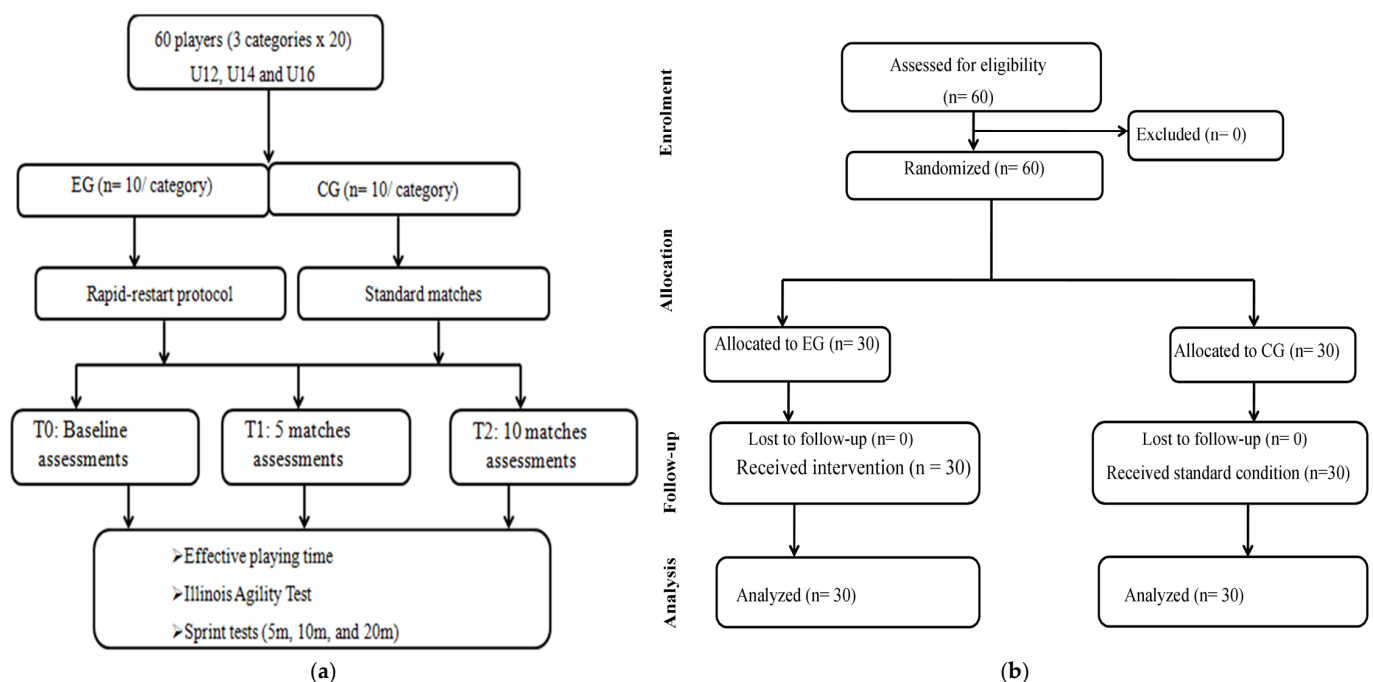


Figure 3. (a) Schematic representation of the experimental design. (b) CONSORT flow diagram of participant recruitment, allocation, follow-up, and analysis.

2.17. Experimental Flow

A CONSORT flow diagram has been added to illustrate the progress of participants through the trial, including screening, exclusion, randomization, allocation, follow-up, and analysis (Figure 4).

2.18. Statistical Analysis

All analyses were conducted using IBM SPSS Statistics version 26.0 (Armonk, NY, USA). Data are presented as mean $\pm$ Standard Error of the Mean ($M \pm SEM$). Prior to analysis, assumptions were checked for normality (Shapiro–Wilk test), homogeneity of variances (Levene’s test), and sphericity (Mauchly’s test) where applicable. To examine the main effects of time, group, and the Group $\times$ Time interaction, a Group (2: experimental vs. control) $\times$ Time (3: T0, T1, T2) mixed-design repeated-measures ANOVA was performed. When significant effects were found, Bonferroni-adjusted post hoc comparisons were performed. Test reliability was evaluated using intraclass correlation coefficients (ICC).

Effect sizes for ANOVA were reported using partial eta squared (η^2), with statistical significance set at $p < 0.05$. Between-group effect sizes were also calculated using Cohen's d , defined as the difference between two group means divided by the pooled standard deviation. Cohen's d effect sizes were calculated using the pooled standard deviation the gain scores from the experimental and control groups. Specifically, Cohen's d was computed according to the conventional formula:

$$\text{Cohen's } d = \frac{\text{MeanGainEG} - \text{MeanGainCG}}{SD_{\text{pooled of gain}}}$$

where SD_{pooled} of gain represents the pooled standard deviation of the gain scores of the experimental and control groups.

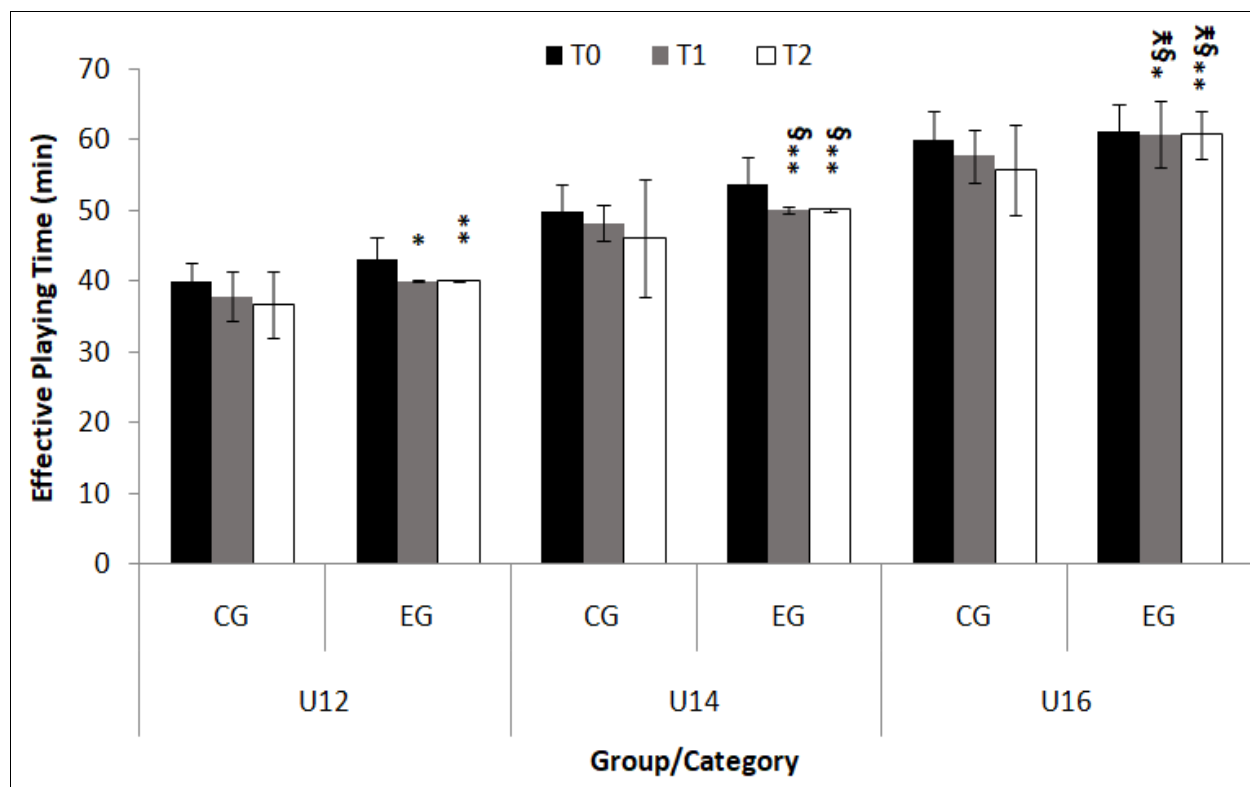


Figure 4. Mean of effective playing time (EPT) values (Means $\pm$ SEM) in control (CG) and experimental (EG) soccer players. Each age category included 20 players (10 EG and 10 CG). * significantly different ($p < 0.05$; ** $p < 0.01$) compared to CG; § significantly different ($p < 0.001$) compared to U12; ¥ significantly different ($p < 0.001$) compared to U14.

Effect sizes were interpreted according to Cohen's conventional thresholds: trivial (<0.20), small (0.20 – 0.49), medium (0.50 – 0.79), and large (≥ 0.80). The percentage of EPT gained was calculated for each age category by dividing the effective time gained (i.e., the difference between intervention and control conditions) by the official total match duration for that category. Specifically, total match durations were set at 60 min (U12), 80 min (U14), and 90 min (U16). The resulting values were expressed as percentages to allow comparison across age categories. The absolute reliability was determined through the standard error of measurement (SEM), which was expressed as a coefficient of variation (CV). A value of $SEM \leq 5\%$ was considered indicative of good absolute reliability. The SEM was obtained by dividing the standard deviation of the score differences by $\sqrt{2}$. Ninety-five percent confidence intervals (95% CI) were computed for all mean CV values.

Data will be entered into a secure database and coded with participant IDs. Double data entry and range checks will be performed to ensure accuracy. All data will be stored on password-protected computers, and procedures for data management are documented and available upon request. A Data Monitoring Committee (DMC) is not deemed necessary for this study due to its short duration, minimal risk to participants, and the non-invasive nature of the interventions.

All collected data were coded using participant identification numbers and checked for completeness and accuracy before statistical analysis. Data management procedures were conducted by the research team according to standard practices for experimental studies.

Additional Analyses

Subgroup analyses were performed for each age category (U12, U14, U16) to examine whether the RRP had differential effects on EPT, sprint performance, and agility. Sensitivity analyses were conducted to assess the impact of missing data on the study outcomes, confirming that the main findings were robust and not influenced by the exclusion of participants with incomplete data.

3. Results

The inter-rater reliability for playing time was excellent (ICC = 0.913, 95% CI: 0.866–0.945). SEM and CV values further supported good absolute reliability for EPT. Restart time gain increased across age categories, with SEM values ranging from 0.20 to 0.45 and 95% CIs indicating consistent improvement after 5 and 10 matches.

3.1. Time Points (T0, T1, T2), in the EG Compared to the CG

The results clearly indicate significant improvements in sprint and agility performance across time points (T0, T1, T2), particularly in the EG compared to the CG (Table 2).

Table 2. Sprint performance Mean (95% CI) of U12, U14 and U16 players across time points in experimental (EG) and control groups (CG). Each age category included 20 players (10 EG and 10 CG; total N = 60).

	Time (s)	5 m Sprint (s)	10 m Sprint (s)	20 m Sprint (s)	IAT (s)
U12 EG	T0	0.822 (0.815–0.829)	3.052 (3.045–3.059)	5.052 (5.045–5.059)	17.976 (17.898–18.054)
	T1	0.803 (0.794–0.812) **	3.026 (3.012–3.040) **	5.014 (5.007–5.021) **	17.764 (17.709–17.819) **
	T2	0.784 (0.776–0.792) **\$\$	3.001 (2.988–3.014) **\$	4.991 (4.977–5.005) **\$	17.567 (17.491–17.643) **\$\$
CG	T0	0.829 (0.822–0.836)	3.058 (3.051–3.065)	5.059 (5.052–5.066)	18.075 (17.997–18.153)
	T1	0.835 (0.826–0.846)	3.053 (3.039–3.067)	5.061 (5.054–5.068)	18.090 (18.035–18.145)
	T2	0.836 (0.828–0.844)	3.07 (3.056–3.078)	5.063 (5.049–5.077)	18.081 (18.005–18.157)
U14 EG	T0	0.831 (0.824–0.838)	3.028 (3.013–3.043)	5.011 (5.003–5.019)	18.048 (17.997–18.099)
	T1	0.833 (0.826–0.840)	3.010 (2.992–3.028)	4.970 (4.962–4.978) **	18.051 (17.979–18.123)
	T2	0.833 (0.826–0.840)	2.934 (2.794–3.074)	4.928 (4.918–4.938) **\$\$	18.026 (17.954–18.09)
CG	T0	0.804 (0.797–0.811)	3.011 (2.996–3.026)	5.063 (5.055–5.071)	17.838 (17.787–17.889)
	T1	0.779 (0.772–0.786)	2.981 (2.963–2.999)	5.062 (5.054–5.070)	17.584 (17.512–17.656) **
	T2	0.755 (0.748–0.762) **\$\$	2.942 (2.802–3.082)	5.061 (5.051–5.071)	17.328 (17.256–17.400) **\$\$
U16 EG	T0	0.792 (0.779–0.805)	2.961 (2.936–2.986)	4.961 (4.956–4.966)	17.562 (17.481–17.643)
	T1	0.769 (0.753–0.785) **	2.923 (2.841–3.005) **	4.910 (4.904–4.916) **	17.236 (17.171–17.301) **
	T2	0.745 (0.734–0.756) **\$\$	2.881 (2.856–2.906) **\$\$	4.860 (4.856–4.866) **\$	16.986 (16.909–17.063) **\$\$
CG	T0	0.826 (0.813–0.839)	3.024 (2.999–3.049)	5.025 (5.020–5.030)	17.936 (17.855–18.017)
	T1	0.827 (0.811–0.843)	3.047 (2.965–3.129)	5.027 (5.021–5.033)	17.992 (17.927–18.057)
	T2	0.820 (0.809–0.831)	3.017 (2.992–3.042)	5.025 (5.019–5.031)	17.968 (17.891–18.045)

** significantly different ($p < 0.01$) compared to T0; \$ significantly different ($p < 0.05$; \$\$ $p < 0.01$) compared to T1; CG: Control Group; EG: Experimental Group; IAT: Illinois Agility Test; Baseline/Pre-test; T1: Mid-intervention; T2: Post-intervention; U12, U14, and U16: corresponding to under-12, under-14, and under-16 years, respectively.

3.2. Sprint Performance Across Distances (5 m, 10 m, 20 m)

3.2.1. 5 m Sprint

Significant main effects of Time and Group, as well as a significant Group $\times$ Time interaction, were observed in all age categories (all $p < 0.001$). For the U12 category, the corresponding statistics were $F(2, 36) = 23.15$, $\eta^2 = 0.563$ for Time, $F(1, 18) = 38.23$, $\eta^2 = 0.680$ for Group, and $F(2, 36) = 48.46$, $\eta^2 = 0.729$ for the Group $\times$ Time interaction. Similar patterns were observed in the U14 and U16 categories (Supplementary Table S1).

3.2.2. 10 m Sprint

For U12 players, significant effects of Time ($F(2, 36) = 12.105$, $p < 0.001$, $\eta^2 = 0.402$), Group ($F(1, 18) = 144.80$, $p < 0.001$, $\eta^2 = 0.889$), and Group $\times$ Time interaction ($F(2, 36) = 23.657$, $p < 0.001$, $\eta^2 = 0.568$) were observed, indicating a greater improvement in the experimental group (EG). In contrast, U14 players showed no significant Time, Group, or Group $\times$ Time interaction effects ($p > 0.05$). For U16 players, only the Group effect was significant ($F(1, 18) = 15.834$, $p = 0.001$, $\eta^2 = 0.468$), whereas Time and Group $\times$ Time interaction effects were not significant ($p > 0.05$).

3.2.3. 20 m Sprint

Significant effects of Time, Group, and Group $\times$ Time interaction were observed across all age categories. In U12, significant effects were found for Time ($F(2, 36) = 54.591$, $p < 0.001$, $\eta^2 = 0.752$), Group ($F(1, 18) = 47.915$, $p < 0.001$, $\eta^2 = 0.727$), and the Group $\times$ Time interaction ($F(2, 36) = 70.620$, $p < 0.001$, $\eta^2 = 0.797$). Similar significant effects were observed in U14 and U16, with particularly large effect sizes for Time and Group $\times$ Time interaction (U14: $\eta^2 = 0.968$ and 0.965 ; U16: $\eta^2 = 0.988$ and 0.988 , respectively). These findings indicate differential changes in 20 m sprint performance between groups across the intervention period.

3.3. Illinois Agility Test (IAT) Performance

Significant effects of Time, Group, and Group $\times$ Time interaction were observed in all age categories. In U12, significant effects were found for Time ($F(2, 36) = 35.923$, $p < 0.001$, $\eta^2 = 0.666$), Group ($F(1, 18) = 65.353$, $p < 0.001$, $\eta^2 = 0.784$), and the interaction ($F(2, 36) = 38.200$, $p < 0.001$, $\eta^2 = 0.680$). Similar significant effects were observed in U14 and U16, with larger effect sizes for the interaction (U14: $\eta^2 = 0.938$; U16: $\eta^2 = 0.956$). These results suggest that IAT performance changes differed between groups across the testing period (Table 3).

Overall, sprint and agility performances showed significant improvements over time, with group-related differences observed across several age categories. The effects were more consistent for the 5 m and 20 m sprints and the IAT, whereas 10 m sprint performance showed less consistent changes, particularly in U14 and U16 players.

Table 3 presents the mean values and 95% confidence intervals for sprint and agility outcomes across the three age categories. These confidence intervals provide a more precise estimate of the observed means and improve the interpretation of group and time effects.

Overall, the experimental and control groups showed different patterns of change across the intervention period. This presentation allows a clearer comparison of performance changes over time and between groups.

Table 4 presents the restart time gain across categories following the implementation of the rapid-restart protocol. The EG demonstrated a progressive reduction in restart times over the 10-match intervention period, with improvements ranging from medium to large effect sizes.

Table 3. Repeated-measures ANOVA results for sprint and agility tests in U12, U14 and U16 Soccer Players. Each age category included 20 players (10 EG and 10 CG).

Measure	Effect	U12			U14			U16		
		F with df	p Value	ηp^2	F	p Value	ηp^2	F	p Value	ηp^2
5 m Sprint	Time	F(2, 36) = 23.15	<0.001	0.71	119.30	<0.001	0.87	F(2, 36) = 21.51	<0.001	0.74
	Group	F(1, 18) = 38.22	<0.001	0.68	144.28	<0.001	0.89	F(1, 18) = 52.90	<0.001	0.75
	Time $\times$ Group	F(2, 36) = 48.46	<0.001	0.84	140.61	<0.001	0.89	F(2, 36) = 12.87	<0.001	0.60
10 m Sprint	Time	F(2, 36) = 12.10	<0.001	0.67	2.64	0.085	0.13	F(2, 36) = 3.06	0.059	0.14
	Group	F(1, 18) = 30.57	<0.001	0.63	0.126	0.727	0.00	F(1, 18) = 15.83	<0.001	0.47
	Time $\times$ Group	F(2, 36) = 23.66	<0.001	0.80	0.134	0.875	0.00	F(2, 36) = 2.17	0.129	0.11
20 m Sprint	Time	F(2, 36) = 54.59	<0.001	0.81	541.90	<0.001	0.97	F(2, 36) = 1530.60	<0.001	0.99
	Group	F(1, 18) = 47.91	<0.001	0.73	277.00	<0.001	0.94	F(1, 18) = 970.67	<0.001	0.98
	Time $\times$ Group	F(2, 36) = 70.62	<0.001	0.85	492.10	<0.001	0.97	F(2, 36) = 1531.40	<0.001	0.99
IAT	Time	F(2, 36) = 35.92	<0.001	0.71	321.69	<0.001	0.95	F(2, 36) = 308.46	<0.001	0.94
	Group	F(1, 18) = 65.35	<0.001	0.78	116.22	<0.001	0.87	F(1, 18) = 210.66	<0.001	0.92
	Time $\times$ Group	F(2, 36) = 46.44	<0.001	0.72	270.65	<0.001	0.94	F(2, 36) = 393.76	<0.001	0.96

F: F-statistic; IAT: Illinois Agility Test; ηp^2 : partial eta squared; p value: probability value; U12, U14, and U16: corresponding to under-12, under-14, and under-16 years, respectively.

Table 4. Restart time gains across age categories. Each age category, included 20 players (10 EG and 10 CG). Data are presented as mean $\pm$ SD, gain percentage; standard error of measurement (SEM), 95% confidence interval (CI), and Cohen's d, and magnitude.

	Restart Time Gain over 5 Matches						Restart Time Gain over 10 Matches				
	Means $\pm$ SD	Gain (%)	SEM	95% CI	Cohen's d	Magnitude	Means $\pm$ SD	SEM	95% CI	Cohen's d	Magnitude
U12 (n = 20)	2.5 $\pm$ 0.98	4.17	0.22	2.07–2.93	0.43	Small–Medium	3.40 $\pm$ 1.44	0.32	2.77–4.03	0.12	Trivial
U14 (n = 20)	2.1 $\pm$ 0.89	2.62	0.20	1.68–2.52	−0.74	Medium–large	3.59 $\pm$ 1.61	0.36	2.8–4.30	0.88	Large
U16 (n = 20)	3.68 $\pm$ 2.02	4.09	0.45	2.80–4.56	−1.01	Large	4.94 $\pm$ 2.03	0.45	4.06–5.82	0.65	Medium–large

SD: standard deviation; U12, U14, and U16: corresponding to under-12, under-14, and under-16 years, respectively.

In particular, the U16 players exhibited the greatest benefit, achieving a significant reduction in restart time compared to both their baseline values and the CG. U14 players also showed meaningful improvements, though to a slightly lesser extent, while U12 players displayed smaller but still consistent gains.

These results highlight the capacity of the RRP to accelerate ball recovery and resumption of play, thereby contributing directly to the observed increase in EPT.

3.4. Effective Playing Time: EPT

Figure 4 illustrates the differences in EPT between the EG and the CG across the three age categories (U12, U14, U16). Overall, the EG consistently demonstrated higher EPT

values compared to the CG at post-intervention, confirming the positive impact of the rapid-restart protocol. Notably, the greatest relative improvement was observed in the U16 category, where EPT increased by approximately 4%, while U14 and U12 players showed more moderate gains of about 2.6% and 1.8%, respectively.

4. Discussion

The primary objective of this study was to evaluate the effects of a rapid-restart protocol, based on the availability of SB, on EPT and physical performance in young Tunisian soccer players. Our findings confirm our hypothesis, showing that this protocol significantly increased EPT and was associated with notable improvements in sprinting (5 m and 20 m) and agility (IAT), whereas gains in the 10 m sprint were less consistent across age groups. However, the present study was not designed to investigate the physiological or biomechanical mechanisms responsible for these changes. Accordingly, any discussion regarding potential alterations in match intensity, locomotor demands, neuromuscular loading, or cognitive engagement should be considered as plausible explanations rather than direct evidence derived from the present dataset.

These results highlight the positive influence of the RRP on EPT across all age categories. Consistently higher EPT values were observed in the EG compared to the CG, indicating that the intervention increased EPT and reduced game interruptions. Notably, the greatest relative improvement occurred in the U16 category, with an increase of approximately 4%, while U14 and U12 players exhibited more modest gains of 2.6% and 1.8%, respectively. These findings indicate that the effectiveness of the protocol may be influenced by age, with older players possibly benefiting more from the increased match continuity observed during the intervention. These age-dependent differences may reflect maturational and cognitive factors, as older players typically possess superior decision-making skills, spatial awareness, and ability to maintain focus under dynamic conditions, which could allow them to capitalize more effectively on reduced interruptions. Furthermore, the enhanced EPT observed in older players may have practical implications for game performance, as uninterrupted playing time may increase opportunities for tactical execution, physical engagement, and skill expression.

Although very large effect sizes were observed for some variables, these findings should be interpreted cautiously, particularly given the relatively small sample size. The practical significance of these results requires confirmation in larger independent cohorts.

Although the RRP increased EPT by only approximately 2–4% per match, its potential influence should not be interpreted solely in terms of additional playing minutes. Rather than increasing the overall duration of exercise, the intervention primarily modified the temporal structure of match play by reducing interruptions and prolonging uninterrupted playing sequences. Such changes may increase the density of high-intensity actions, including repeated accelerations, decelerations, directional changes, and decision-making demands, while reducing passive recovery opportunities. Therefore, the observed improvements may be partially related to alterations in the quality and continuity of match exposure accumulated throughout the intervention. Nevertheless, this interpretation remains hypothetical because internal training load (e.g., heart rate, GPS-derived running demands, or perceived exertion during matches) was not measured in the present study. Importantly, our findings should be interpreted with caution. The intervention was not designed as a replacement for structured physical training but rather as an organizational modification intended to optimize match continuity. Because both groups completed identical weekly training programs, the present study cannot establish a direct physiological mechanism explaining the observed performance changes. Future studies incorporating GPS tracking, heart-rate monitoring, accelerometry, and external load analyses are required to deter-

mine whether increased match continuity effectively translates into a greater cumulative training stimulus.

The observed increase in EPT in our study aligns with previous research in professional leagues, which highlighted the impact of game interruptions on physical demands and tactical engagement [2,3,5,12,13]. In particular, our findings are consistent with those of Altmann et al. [2] and Tojo et al. [3], who reported that reduced interruptions were associated with greater running intensity and technical actions per minute. Importantly, our data extend these observations to the youth context, particularly in North Africa, where research on this topic remains scarce.

However, previous findings regarding the relationship between EPT, match continuity, and physical performance are not entirely consistent. Some studies have suggested that increased ball-in-play periods may amplify physical demands, whereas others have reported that match intensity depends on multiple contextual factors, including competitive level, tactical behavior, playing position, and methodological approaches used to quantify physical demands. These differences highlight that the influence of increased EPT is complex and may not necessarily translate directly into improved physical performance without considering the broader training and developmental context [19,22–24].

In addition to the observed improvements in sprint and agility performance, our findings showed that the RRP was associated with shorter ball-restart times and a faster resumption of play.

The RRP resulted in reduced restart times across age categories; however, the magnitude of standardized effects varied according to age and intervention duration. While U14 and U16 players maintained moderate-to-large effects after ten matches, the U12 category demonstrated a smaller standardized effect at the end of the intervention. This finding should be interpreted cautiously, as effect size estimates are particularly sensitive to variability in small samples. Younger players may exhibit greater fluctuations in attentional control, decision-making, and consistency of behavioral execution during competitive situations. Additionally, because the intervention targeted match organization rather than physiological adaptation, a progressive accumulation of effects was not necessarily expected. The initial improvements observed after five matches may reflect rapid familiarization with the protocol, followed by stabilization once the rapid-restart procedure became integrated into match routines.

As shown in Table 4, the experimental group demonstrated reductions in restart times across the intervention period, although the magnitude of the standardized effects varied between age categories. The largest and most consistent effects were observed in U14 and U16 players, whereas the U12 category showed a smaller effect at the end of the intervention. These findings suggest that the effectiveness of the protocol may be influenced by developmental characteristics and behavioral variability among younger players. Notably, U16 players benefited the most, achieving a substantial reduction in restart time compared with both their baseline values and the control group. U14 players also displayed meaningful improvements, whereas U12 players showed smaller yet consistent gains. These findings confirm that the protocol effectively reduced restart delays and increased EPT. Previous studies have suggested that improved match continuity may be associated with higher physical demands during play [2,10,12,14,25]. However, because no internal or external-load variables were collected in the present study, it cannot be determined whether the increased EPT translated into greater match intensity or physiological loading.

Regarding physical performance, the observed improvements in sprint and agility are consistent with a beneficial effect of greater engagement time on fundamental physical capacities. In line with Linke et al. [1] and Lago-Peñas et al. [14], our results indicate that longer periods of ball-in-play may provide greater exposure to physical actions requiring

sprinting and changes in direction [26]. Notably, the U14 and U16 categories exhibited the greatest improvements, may be related to maturational differences and greater responsiveness to repeated match exposure [8,19,27].

Interestingly, performance in the 10 m sprint showed less consistent improvements, particularly in older categories. One possible explanation is that very short accelerations are already highly solicited during match play regardless of EPT [28], whereas longer sprints and agility actions appear more sensitive to accumulated engagement time [29]. This observation highlights the importance of tailoring interventions to specific performance qualities [30].

From a practical perspective, our results highlight the potential of an RRP in youth competitions to improve match continuity and may contribute to favorable training and developmental conditions when implemented alongside conventional coaching practices. Unlike complex regulatory changes, this intervention is simple [14,31,32], low-cost [3,10], and easily implementable in competitive contexts [6,14,28,33]. For coaches and technical staff, the rapid provision of SB can be considered a pragmatic strategy to facilitate match organization and may provide additional opportunities for technical and physical involvement during match play [7,10,12,13,18].

An additional point deserves consideration regarding the magnitude of the observed intervention effects. Some repeated-measures ANOVA analyses yielded exceptionally large partial eta squared values accompanied by very high F statistics. Although these estimates are fully consistent with the original dataset and statistical analyses, they should be interpreted with caution. Effect size estimates obtained from repeated-measures designs are influenced by the residual variance within the sample and may be amplified in relatively small and homogeneous groups. Consequently, the magnitude of these effects should be interpreted within the specific context of the present study and should not be assumed to represent effects of similar magnitude in other youth soccer populations.

4.1. Study Limitation

Despite these promising findings, some limitations must be acknowledged. First, the external validity of the findings is limited by the recruitment of 60 male youth players aged 11–16 years from a single Tunisian first-division club. Therefore, the results may not be directly generalizable to female players, older or professional athletes, other age groups, or players competing in different national, organizational, and competitive contexts. Replication in larger, multicenter samples involving more diverse populations and competitive environments is warranted. Second, the analysis focused exclusively on physical performance outcomes, and no physiological or external-load variables, such as GPS-derived running demands, heart rate, accelerometry, or rating of perceived exertion, were collected. Consequently, the mechanisms underlying the observed performance changes remain speculative, and the technical–tactical, perceptual–cognitive, and psychological effects of increased EPT remain unknown.

Third, given the age range of the participants, individual differences in biological maturation, training exposure, coaching effects, and learning effects associated with repeated testing may have contributed to the observed performance changes, despite randomization within age categories [34–36]. Accordingly, the improvements observed in the experimental group should not be attributed exclusively to increased EPT.

Finally, the 10-week intervention period does not permit conclusions regarding long-term player development, sustained training adaptations, or potential risks associated with prolonged exposure, including accumulated fatigue, overuse, or injury. Future studies should therefore combine longer follow-up periods with biological maturation assessment and systematic monitoring of internal and external training load.

4.2. Practical Implications

The findings of this study have relevant practical implications for coaches, competition organizers, and the Tunisian Football Federation, including its Technical Directorate. The implementation of a RRP increases EPT in youth matches, thereby offering greater opportunities to engage in physical, technical, and cognitive activities during match play. In addition, the protocol promotes a faster game rhythm, which may contribute to improved motor development and overall performance quality. Importantly, this intervention is simple, cost-effective, and easily applicable in competitive settings, without requiring complex rule changes or additional equipment.

Moreover, by reducing contact between ball retrievers and players, it may enhance on-field safety and limit interruptions related to ball recovery. Overall, the RRP represents a practical strategy to support player development and safety during official matches. Because the present intervention was designed as an organizational match-management strategy rather than a physical training intervention, these findings should not be interpreted as evidence of long-term athletic development or chronic training adaptations.

5. Conclusions

This study suggests that implementing an RRP increases EPT and is associated with improvements in sprint and agility performance in young soccer players, rather than directly causing these adaptations. However, these performance improvements should not be attributed solely to the additional playing time provided by the intervention. The protocol primarily modifies match organization by reducing interruptions and increasing game continuity, which may provide greater exposure to high-intensity actions and decision-making situations. Nevertheless, the physiological mechanisms underlying these adaptations remain unclear and require confirmation through future studies incorporating objective measures of internal and external match load, such as heart-rate monitoring, GPS tracking, and accelerometry.

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Abbreviations

The following abbreviations are used in this manuscript:

EPT	Effective Playing Time
EG	Experimental Group
CG	Control Group
U12	Under 12
U14	Under 14
U16	Under 16
T0	Baseline/Pre-test
T1	Mid-intervention
T2	Post-intervention
IAT	Illinois Agility Test
SB	Spare Balls

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