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Sprint kinematics of amateur soccer players post half-time of simulated soccer match

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ABSTRACT

The aim of this study was to investigate the impact of half-time simulated soccer matches on the sprint kinematics of amateur soccer players. This study was a pilot experimental study with a pre-test/post-test design. Eighteen amateur-level soccer players (age: 22.88±4.19 years) attending a preparatory camp for the senior national championship were recruited for the study. Baseline assessments of sprint kinematics using a 30 m linear sprint test were conducted before the simulated soccer match. The F-V profiling of the participants was the dependent variable. Post-assessments were conducted immediately after the simulation protocol. Although there were no statistically significant changes (p = 0.12 to 0.65) observed from pre- to post-test, trivial to small effect sizes were found, with percent changes ranging from 0% to 3.7%. The results showed that half-time simulation had a negative effect (i.e., trivial to small) on sprint kinematics in amateur-level soccer players. The findings of this study suggest that half-time simulated soccer matches negatively affect sprint kinematics in amateur-level soccer players.

KEYWORDS

Sprint Kinematics; Amateur Soccer Players; Half-Time Simulation; Linear Sprint Test

1. INTRODUCTION

Soccer is a game of actions, with sprinting being one of the most frequently performed by players (Faude et al., 2012). High-intensity actions, like sprints, are required approximately every 70 seconds during soccer matches, and therefore play a vital role in decisive situations (e.g., straight sprints are the most common action performed by the goal-scorer prior to scoring) (Faude et al., 2012; Stølen et al., 2005). Sustaining sprinting ability throughout a soccer match is crucial for maximizing performance.

Sprinting ability of a player is highly dependent on mechanical power, which results from lower limb muscle and tendon actions. Additionally force and velocity are considered to be the determinants of mechanical power output (Cronin & Hansen, 2005). Recent development suggests possibility of determining an individual's sprint force-velocity-power (F-v-P) profile by utilizing simple calculations (i.e., calculations derived from the inverse linear force-velocity and parabolic power-velocity relationship) (Samozino et al., 2016). F-v-P outputs such as theoretical maximum horizontal force (HZT-F0), velocity (HZT-V0), power output (HZT-Pmax), the ratio of force (FC), and decline in the ratio of force production (DRF) can be computed and may provide an insightful detail of the player's sprinting capabilities.

Sprint performance in players has been shown to decrease both temporarily and at the end of a friendly soccer match (Krustrup et al., 2006). This decline in sprint performance may be attributed to mechanisms such as muscle lactate accumulation and glycogen depletion, which cause fatigue during exercise (Sahlin, 1992). Low glycogen levels in individual muscle fibers may also contribute to decreased sprint performance (Krustrup et al., 2006). Although studies (Huthöfer et al., 2020; Nagahara et al., 2016) have been conducted to understand the effects of soccer match-play on professional players' performance (e.g., sprint kinematics), there is a lack of literature concerning amateur soccer players. Therefore, this pilot study aims to identify the effects of a simulated half-time soccer match on the sprint kinematics of amateur-level soccer players. We also hypothesize that there will be changes in sprint kinematics after half-time match play.

2. METHODS

2.1. Study Design and Participants

This study was a pilot experimental study with a pre-test/post-test design. A total of 18 players initially agreed to participate in the study and were involved in the familiarization session. The participants were attending a preparatory camp for the senior national championship. Thereafter, eighteen participants (age: 22.88 ± 4.19 years; height: 1.73 ± 0.03 m; body mass: 69.93 ± 3.26 kg; Yo-Yo IR Level 1: 16.74 ± 0.87) were included in the study (10 players dropped out) (Table 1). Only field players (i.e., excluding goalkeepers) were included in the study. All players were informed about the experimental procedures and possible risks associated with the study. Informed consent forms were signed by the participants. The study was approved by the institutional review board of the university and conducted in line with the Declaration of Helsinki.

Table 1. Participants' characteristics

Variable	Mean±SD
Age (years)	22.88±4.19
Height (meters)	1.73±0.03
Body mass (kg)	62.93±3.26
Yo-Yo IR L1	16.74±0.87

2.2. Procedure

A familiarization session (i.e., SAFT 90 protocol, 30 m linear sprints) was conducted one week prior to the data collection. The experiment was conducted at 1500 hours (i.e., 3 PM) during pre-competition period. The participants had no intense training session 24 hours prior to the day of assessment. Participants were also asked to refrain from heavy meal 3 hours prior to the assessment. The surface used for the test was a standard artificial soccer turf. Body mass of the participants were recorded prior to the test. A schematic representation of the study is shown in Figure 1.

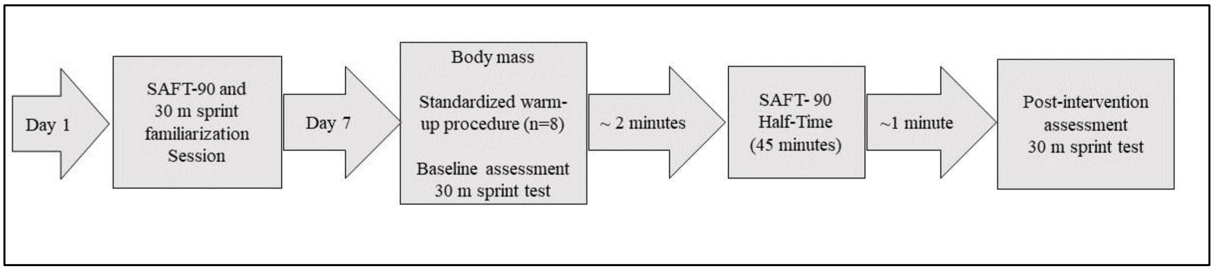

Figure 1. Schematic of the study design

2.2.1. SAFT 90 protocol

The experiment involved a pre- and post- assessment of F-V-P profiling through 30 m sprint. A standardized 15 minutes soccer-specific dynamic warm up was performed before the baseline assessment. After completing the baseline assessment, the participants performed SAFT90 protocol (Barrett et al., 2011) for 45 min. The SAFT90 protocol is a soccer match simulation which was developed using Prozone® match-analysis data from English Championship matches. The protocol is a pre-programmed shuttle running simulation that focuses on an agility course and has intermittent training requirements specified by an audio file (Barrett et al., 2011). Participants alternated between standing (0 km/h), walking (5.5 km/h), jogging (10.7 km/h), striding (15 km/h), and sprinting around a 20 m agility course with maximal effort (Figure 2). Over the course of 90 minutes, the players cross 11.1 km, with 18.5 percent of the distance (2.04 km) being covered at high speed (15 km/h), with 1269 speed changes (every 4.3 seconds), 888 direction changes (180 degrees), and 444 cutting moves (1332 directional changes) (Marshall et al., 2014).

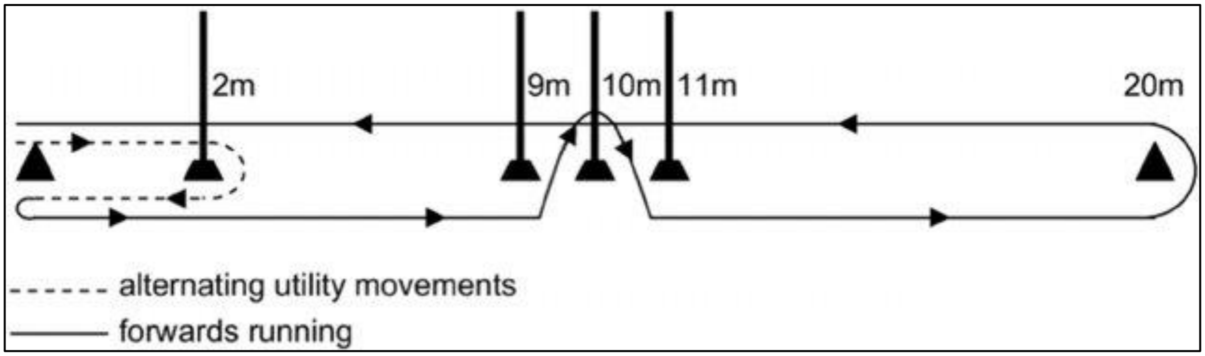

Figure 2. Schematic representation of the soccer simulation protocol (SAFT 90)

During the 45-minute simulated soccer match, a 15-minute movement pattern was created and repeated three times. The participant's movement intensity and activity were maintained utilising verbal signals from an audio file in mp3 format while completing the SAFT protocol. This allowed for consistency in exercise intensity. After the completion of 45 minutes of SAFT90, the participants performed post-test assessment.

2.2.2. Sprint F-V profiling

The sprint F-V profiling was created for each athlete using a validated method proposed by Samozino et al. (2016). The method requires split times of 5m, 10m, 15m, 20m, 25m, and 30m during a 30 m linear sprint which was recorded and analyzed using a validated and reliable smartphone app (i.e., My Sprint app) (Romero-Franco et al., 2017) installed in on an Apple iPad 8th generation (Apple Inc., California, USA) with a 120-Hz high-speed camera at a quality of 720 p. The testing protocol was based on the procedure described in the study (Romero-Franco et al., 2017).

2.3. Statistical Analysis

Statistical analyses were performed using IBM SPSS (version 20.0.0, New York, USA) software. Data are presented as mean ± standard deviation (SD). Normality was assessed using the Shapiro-Wilk test. In case of violation of normality assumptions, non-parametric equivalent tests were used. The difference between baseline and half time were evaluated using paired t-test or Wilcoxon signed-rank test. The percentage change score for each variable in each group was calculated using the equation: $[(\text{mean}_{\text{post}} - \text{mean}_{\text{pre}}) / \text{mean}_{\text{pre}}] \times 100$. Effects sizes were calculated as Hedge's *g* to assess changes between baseline and follow-up testing in each group. The magnitude of effects for Hedge's *g* was interpreted as trivial (<0.2), small (0.2-0.6), moderate (>0.6-1.2), large (>1.2-2.0), very large (>2.0-4.0) and extremely large (>4.0) (Hopkins et al., 2009). Statistical significance was set at $p \leq 0.05$.

3. RESULTS

The mean ± SD for the dependent variable is presented in Table 2, with individual data shown in Figure 3. Statistical outcomes for each dependent variable are also provided in Table 2. Paired t-tests and Wilcoxon signed-rank tests revealed no statistically significant pre-to-post differences (p = 0.12 to 0.65) in any dependent variable among the players. Effect sizes were also trivial to moderate, while percentage changes ranged from 0% to 3.7% (Table 2).

Table 2. Statistical comparisons for changes in F-V values between baseline and post half time (i.e., 45 minutes) using SAFT 90 simulation

F-V Variables	**Pre-SAFT**	**Post-SAFT (45 minutes)**	***p*-value**	**Effect size g (95 CI)**	**Δ%**
	Mean±SD				
Time (30 m)	4.44±0.20	4.48±0.23	0.23	-0.18 (-1.25 – 0.90) Trivial	0.9
Vmax	8.91±0.38	8.99±0.48	0.46	-0.17 (-1.25 – 0.90) Trivial	0.9
F0 (N)	511.98±66.27	497.49±120.93	0.60	0.14 (-0.93 – 1.21) Trivial	-2.8
F0(N/KG)	8.19±1.41	7.97±2.26	0.63	0.11 (-0.96 – 1.18) Trivial	-2.7
V(0)	9.30±0.42	9.41±0.58	0.43	0.77 (-0.34 – 1.89) Moderate	1.2
Pmax (W)	1190.19±162.93	1163.52±257.81	0.60	0.12 (-0.96 – 1.19) Trivial	-2.2
Pmax (W/KG)	19.03±3.33	18.64±4.87	0.65	0.09 (-0.98 – 1.16) Trivial	-2.0
DRF	-0.08±0.01	-0.08±0.02	0.62	0 (-1.07 – 1.07) Trivial	0

FV	-55.16±7.59	-53.33±14.54	0.62	-0.15 (-1.22 – 0.92) Trivial	-3.3
RF10m	0.33±0.01	0.33±0.01	0.12	0 (-1.07 – 1.07) Trivial	0
RFpeak	0.54±0.05	0.52±0.06	0.30	0.34 (-0.74 – 1.42) Small	-3.7

Note: F-V – force velocity, CI – confidence interval, Δ% - percent change, g – Hedges g

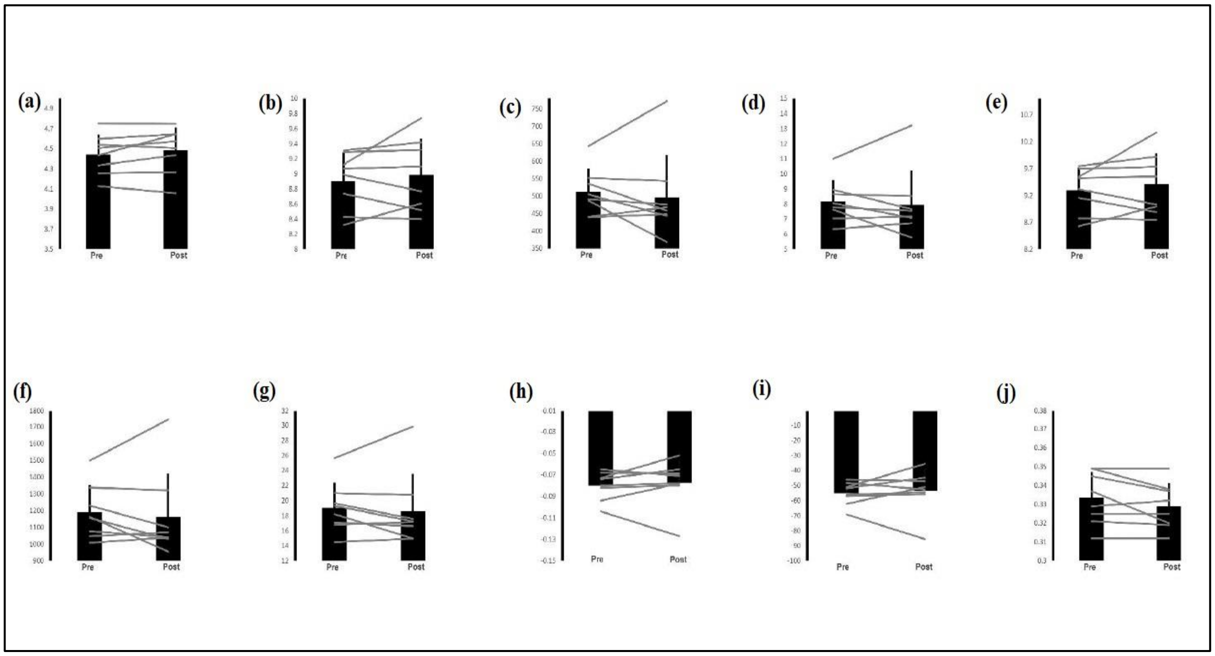

Figure 2. Mean (column) ± standard deviation (error bar) along with individual responses (grey lines) for (a) 30 m sprint time, (b) Vmax, (c) F0 (N), (d) F0 (N/kg), (e) V (0), (f) Pmax (W), (g) Pmax (W/kg), (h) DRF, (i) FV, and (j) RF 10 prior to and following the SAFT protocol

4. DISCUSSION

Although the results suggested no statistically significant changes (p>0.05) in sprint kinematics after the half-time period, trivial to small changes (Δ% from 0% to 3.7%) were observed in sprint kinematics variables following half-time match play.

The findings of our study are in line with the literature, which suggests decrease in sprinting ability in soccer athletes after half-time match play. Previous studies have shown that physical performance (e.g., sprint time) is reduced at the end of the half-time/match (Edholm et al., 2014; Huthöfer et al., 2020; Nagahara et al., 2016). Edholm et al. (2014) conducted a study on elite male soccer players and observed a 3% reduction in 10m sprint performance (p<0.05) from pre 1st Half to Post 1st Half. Another study by Huthöfer et al. (2020) conducted on professional soccer players reported large effects for maximal sprinting velocity(V0) and a significant impairment by 3.7% from the first to the 45th minute illustrating the influence of soccer specific fatigue on Maximal Sprinting Velocity. Nagahara et al. (2016) also reported impaired maximal horizontal power after half-time and altered maximal velocity capability during the match among university male soccer players.

One of the reason for this decrease in sprinting kinematics could be due to lower in functional capability of the hamstring post half time match-play as soccer specific fatigue causes reduction in eccentric knee flexion force (Greig, 2008), knee extension angle, and maximal hip flexion (Small et al., 2009). The eccentric hamstring muscle contraction is responsible for the fast backward swing of the leg before the foot-strike during high-speed sprinting (Dorn et al., 2012). Therefore, a fatigued hamstring resulting in weakened eccentric hamstring muscle contraction capacity may also impair the horizontal force generation capability. In addition, sprint performance can also be reduced during the maximum velocity phase accompanied by a significant reduction in maximal voluntary contraction of the quadriceps in both isometric and concentric contractions (Robineau et al., 2012).

Our findings show a 2.8% decrease in maximal horizonal force production, which may be explained by the reduction in hamstring’s functional capability as state above. In addition, there was only an increase of 0.9% in 30 m sprint time, suggesting that fatigue during soccer specific movement probably impairs only specific aspects of sprint kinematics (i.e., high-speed sprinting capabilities). However, the actual difference in sprint time (i.e., 0.04 s) could still be decisive in one versus one duels, allowing players to generate enough difference with the opponent (e.g., approximately 0.3 m) in actual soccer match (Haugen et al., 2014).

Another reason for the impairment in sprint kinematics may be possibly due to the variation in substrate availability for adenosine triphosphate (ATP) replenishment. Creatine phosphate is one of the substrate of ATP resynthesis during initial acceleration (Hirvonen et al., 1987). Although creatine phosphate can be re-synthesized within a short period of time (30 s) during intermittent exercise (Gaitanos et al., 1993), muscle glycogen is the substrate responsible for ATP replenishment when approaching maximal velocity (Hirvonen et al., 1987). Therefore, decrease in the muscle glycogen towards the end of half time (Krustrup et al., 2006) may be one of the factors that impairs the sprinting kinematics.

Hence, a performance decrement at the end of the first half could be explained by the repetition of explosive-type efforts and soccer-specific actions, such as, change of direction, accelerations, decelerations, etc. A horizontal sprinting power is the product of horizontal force and running speed, and the value of both F0 and V0 in this study have shown to decrease (though not significantly) after half-time. Thus, relatively small magnitudes of impairment in both capabilities of maximal horizontal force production and maximal velocity sprinting from the end of the first half would lead to a decrement in Pmax. Whereas the decrement in sprint performance was small to trivial, the actual difference in time could still be decisive in one-on-one duels, allowing players to generate enough difference with the opponent, in the actual soccer match.

5. LIMITATIONS

Due to the pilot feature of the study, there are several limitations to the generalizations of our findings. Although within the range of the previous studies on effect of half-time simulated soccer match on sprint kinematics, the number of the participants was rather low (n=18). The subject included in the study were also amateur soccer players and the experiment was performed during the pre-competitive phase of the tournament.

6. CONCLUSIONS

The findings of this study suggest that half-time simulated soccer matches negatively affect sprint kinematics in amateur-level soccer players. Further studies should verify whether similar results are obtained under different conditions (e.g., larger sample sizes, different periods of the season, female athletes, etc.).

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AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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