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Research Article

Intermittent Training Regimen of Small-Sided Games Increases External Load in Female Soccer Players

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Abstract

The aim of this study was to analyse the behaviour of external and internal load in 4 vs. 4 SSG with three different bouts duration: a continuous format (SSG12: 1 x 12 minutes), a long duration intermittent format (SSG6: 2 x 6 minutes), and short duration intermittent format (SSG4: 3 x 4 minutes). Eight female semi-professional soccer players took part in this study. The results showed that players covered significantly higher total distance in SSG4 compared to SSG12 and SSG6 ($p<0.05$). Low intensity running was higher in SSG6 compared to SSG4 ($p<0.05$). Medium and high intensity running were higher in SSG4 than SSG6 and SSG12 respectively. A lower number of accelerations and power score during SSG12 in comparison with SSG6 and SSG4 was reported ($p<0.05$). The resulting evidence suggests that the intermittent SSG format induces greater physical loads on players as compared with continuous SSG format.

INTRODUCTION

Soccer is characterized as an intermittent sport involving frequent actions of high-intensity activity (i.e., sprinting, jumping, tackling) interspersed with lower intensity actions (i.e., jogging and walking), where the aerobic and anaerobic systems are highly demanded [1]. Specifically, female players perform an average of 9200-10600 m of total distance, 1772-2917 m of high-speed distance (12.2-19.1 km/h^{-1}), and 50-417 m of sprint distance (>19.4 km/h^{-1}) [2]. Additionally, female soccer players completed ~376 high-speed runs and ~70 sprints during a match, with 14 s between high-speed runs, and 87 s between sprints [2]. Particularly, high-intensity efforts are crucial to matches' outcome as they relate to activities that are key to the final match result [3]. High intensity intermittent training and small-sided games (SSGs) are two training methods that allow the improvement of aerobic and anaerobic capacity of soccer players. However, currently, it is more common to use small-sided games (SSGs) in training, as they are thought to be more suitable than interval training since SSGs are in line with bioenergetic demands occurring in match [4].

Consequently, coaches or practitioners organize SSGs to achieve or maintain internal and external load elicited in a soccer match. Previous scientific evidence has been analyzed several methodological aspects of SSGs training in male soccer players [4]. Concretely, players' physical responses during SSGs have been demonstrated to depend on some variables such as the number of players [5], pitch size [6], number and duration of repetitions [7], type of rest between repetitions [8], inclusion of wildcard players [9], score-line [10], or the use of encouragement by the coach [11]. Moreover, important components during SSG like physical capacities [12], time-motion performance [13], and technical-tactical behavior [14] are significantly different between female and male soccer players. However, there is a lack of scientific literature analyzing these variables in SSGs with female soccer players.

According to previous research, SSGs with female players can be modified by coaches or strength and conditioning coaches changing the pitch size [15], the number of players [16], or the pitch surface [17]. Besides above-mentioned task constraints, training regimen is determinant for managing intensity. Previous studies have described that the performance of the SSGs could be altered using different training regimes [18,19]. The modification of this variable can be generally understood as continuous (i.e., without repetitions or rest intervals during the exercise) or intermittent (i.e., exercise performed repeatedly and with rest intervals between repetitions) methods.

Despite the importance of the training regimes in the planning of SSGs, a few studies [7,20,21] have analyzed the effect of different durations on the external load. Indeed, no studies were conducted on this topic with female players. Hill-Haas et al. [18], analyzing various SSGs formats with male players, showing that intermittent condition (4 x 6 min bouts with 1.5 min of passive rest) reported a higher number of sprints and distances at medium and high-intensity running compared to continuous condition (24 min). Likewise, Christopher et al. [22], examined whether manipulating the exercise to rest ratio (intermittent [2 x 4 min or 4 x 2 min] and continuous [8 min] formats) would affect the profile activity during SSGs. They showed that there was a tendency for more low-intensity running in the continuous format, while high-intensity running, and number of sprints were greater in large intermittent format (2 x4 min) in comparison with short intermittent format (4 x 2 min) and continuous format (8 min). Moreover, the shortest intermittent format reported a greater number of accelerations and decelerations. Conversely, one study with male amateur players revealed that higher increments in time motion responses (total, running and sprint distances), acceleration and deceleration values were reported in the shortest sets compared to longer sets duration [20]. Therefore, more research is needed to elucidate differences in external load between intermittent and continuous conditions. Additionally, no studies were conducted with female players to analyze the influence of different set durations on external load. Regarding internal load, Fanchini et al. [23], examined whether an increase in bout duration, using two, four and six minutes would affect exercise intensity during SSGs. Their results showed that an increase in bout duration resulted in a decrease in % HRmax. Besides, other studies revealed that continuous format induced higher rating of perceived exertion (RPE) and heart rate responses than intermittent conditions [18,22]. By contrast, Köklü et al. [21], showed that the RPE was higher in the short intermittent format in comparison with the continuous format.

To our knowledge, no studies have analyzed the impact of the manipulation of bout duration of SSGs on internal and external load in female soccer players. This topic has been examined previously in male both senior and young soccer players. In consequence, studies analyzing the effects of using continuous vs intermittent (longer or shorter) on internal and external load during SSGs are especially needed consider previous research with young and senior male players. Therefore, the aim of this study was to analyze the external and internal load in 4 vs. 4 SSG with three different bouts duration: a continuous format (SSG12: 1 x 12 minutes), a long duration intermittent format (SSG6: 2 x 6 minutes), and short duration intermittent format (SSG4: 3 x 4 minutes). Based on previous scientific literature [21], it was hypothesized that longer bout durations, keeping the total playing time constant at 12 minutes, would result in a reduced exercise intensity during the SSGs.

METHODS

Design

A crossover design was used to examine the differences between intermittent (3 x 4 minutes, 2 x 6 minutes) and continuous (1 x 12 minutes) distribution of the time in the 4 vs 4 + goalkeepers SSG and evaluating physical and physiological responses. Comparisons were performed examining female professional soccer players during competitive season 2020-2021. The study protocol took place in the mid-season (i.e. March to April).

Participants

Eight female semi-professional soccer players (age: 22.9 ± 4.0 years; height: 163.6 ± 5.8 cm; body mass: 59.7 ± 6.7 Kg) from a team playing for the Spanish third division took part in this study. However, due to problems with GPS' satellite connection or to the malfunction of it [24], one player had to be excluded for the final statistical analysis. All participants were classified as experienced soccer players, with 13.7 ± 5.0 years of systematic soccer training. Their standard training involved 3 sessions per week, each lasting for 90 minutes, and an official match at the weekend. All the players were notified of the research design and its requirements, as well as the potential benefits and possible risk associated with their participation in the study and the signed a written informed consent document. In the case of young players, their parents also gave their written informed consent. Research procedures were approved by Ethical Institutional Review Committee of the Faculty of Education and Sports Sciences (10–0721), in accordance with Declaration of Helsinki.

Procedures

Players performed 3 SGGs training sessions 4 vs 4 + goalkeepers with different bout duration: continuous (1 x 12 minutes) or intermittent (2 x 6 minutes and 3 x 4 minutes) [19]. The SSGs were played after a 20 minutes standardized warm-up, which consisted of low intensity running, dynamic stretching and a ball possession game [25]. In each session, only one SSG regimen was implemented. The study was conducted during a week without competition. The study sessions were performed with more than 72 hours before or after the last match, and with 48 hours between them. Thus, in the first session, the 3 x 4 minutes (SSG4) regimen was performed, in the second session 2 x 6 minutes (SSG6) regimen was performed and in the third session 1 x 12 minutes (SSG12) continuous condition was completed [21]. The sessions occurred at 8:00 p.m. on artificial turf and with no rain. The pitch size was 30 x 25 m [26], with a relative pitch area of 94 m^2 per player (excluding goalkeepers) during all training regimes [10]. The recovery time between repetitions in the intermittent formats was established according to a work: rest ratio of 2:1 (that is, 2 minutes for SSG4 and 3 minutes for SSG6). The players were distributed by head coach into two teams based on skill level and fitness status to homogenize the competitive level. The teams did not change during the study. The teams were set up in a formation consisting of defenders, midfielders and attackers and they were given freedom to interchange freely within the game. Players were informed of the rules prior to the game, play restarted from the goalkeeper and the offside rule did not apply. The SSGs took place with coach and conditioning specialist encouragement. Additionally, the score-line during each bout were recorded by the coaching staff and the players were aware.

Data collection

The data corresponding to players' external load during the SSGs were collected using a portable 10 Hz GPS device

(Playertek, Catapult Innovations, Melbourne, Australia), which also incorporates a tri-axial 400 Hz accelerometer. The value of 10 Hz seems to be valid and reliable enough to measure position and speed in a sports setting [27], and they were used in previous studies with soccer players [10]. The running variables obtained from the GPS were the total distance covered (m), and the distance covered (m) at four different speed thresholds [15,28]: low-intensity running (0–6.9 $km \cdot h^{-1}$), medium-intensity running (7.0–12.9 $km \cdot h^{-1}$), high-intensity running (13.0–17.9 $km \cdot h^{-1}$), and sprinting (≥18.0 $km \cdot h^{-1}$). The total number of accelerations and decelerations above 2 $m \cdot s^{-2}$ were gathered [22,28]. Moreover, global load indicators were also included as variables: power score ($w \cdot kg^{-1}$), player load, work: rest ratio and high metabolic power (HMP). Power score measures the power output used per kilogram of your weight, the score is based on both the speed levels reached and the acceleration rates achieved throughout the session. Player load is a variable based on the instantaneous rate of change of tri-axial accelerometer measures. The work: rest ratio is the percentage of time that a player is running above 5.4 $km \cdot h^{-1}$, while the HMP is the number of the efforts exceeding 20 $W.kg^{1}$.

Rating of perceived exertion (RPE) was recorded immediately after each SSG repetition using Foster's 0–10 scale to quantify the players' internal load [29]. Players rated the effort individually as to not hear or be influenced by other teammates' responses. The responses were written on a paper and then they were recorded in software. All participants were familiarized with the use of this RPE scale, as they had used it throughout the season in their teams' training sessions (Table 1).

Statistical analysis

All statistical analyses were conducted using the statistical package IBM SPSS 21.0 for Macintosh (version 25.0. Armonk, NY: IBM Corp). Results are reported as means and standard deviations (mean ± SD). A one-way repeated measure analysis of variance (ANOVA) with post-hoc Bonferroni test was performed to compare SSG training regimes (SSG12: continuous format; SSG6: intermittent format 6x2'; SSG4: intermittent format 3x4'). In addition, the effect size (ES) was calculated using Cohen's *d*. According to Cohen et al. [30], the magnitude of standardized mean differences was classified as trivial ($d < 0.2$), small ($0.2 \leq d < 0.6$), moderate ($0.6 \leq d < 1.2$), large ($1.2 \leq d < 2.0$), very large ($2.0 \leq d < 4.0$), and near-perfect ($d > 4.0$). Additionally, the normal distribution of the residual was checked graphically without revealing specific problems. The homogeneity of variances was examined using Levene's test. For all analyses, the significance level was established at $p < 0.05$.

Table 1: Characteristics of the small-sided games.

Training session	1	2	3
Training regimen	Intermittent	Intermittent	Continuous
Total duration	12 min	12 min	12 min
Duration of each repetition	4 min	6 min	12 min
Number of repetitions	3	2	1
Duration of rest period	120 s	180 s	-
Work:rest ratio	2:1	2:1	-
Distribution	SSG 4 min Rest 120 s SSG 4 min Rest 120 s SSG 4 min	SSG 6 min Rest 180 s SSG 6 min	SSG 12 min
Presence of targets	Yes	Yes	Yes
Pitch size	30x25	30x25	30x25
Relative pitch area per player	94 m^2	94 m^2	94 m^2

* SSG: small-sided game; min: minutes; s: seconds

RESULTS

Table 1 presented the differences in players' internal load and external load according to the training regimen, Figure 1 depicts the standardized mean differences between training regimes and Figure 2 depicted the individual and mean data for each player in SSG12, SSG6, and SSG4 formats. The results of repeated measures ANOVA showed that players covered significantly higher total distance in SSG4 compared to SSG12 ($p = 0.037$, ES: 1.43, large) and SSG6 ($p = 0.016$, ES: 2.20, very large). The low-intensity running was significantly higher in SSG6 compared to SSG4 ($p < 0.001$, ES: 1.88, large). With regards to speed threshold of medium-intensity the distance covered in SSG4 was significantly higher than SSG6 ($p = 0.002$, ES: 2.25, very large), meanwhile the distance covered in high-intensity running was greater in SSG4 compared to SSG12 ($p = 0.010$, ES: 1.19, moderate). However, non-significant differences ($p > 0.05$) were obtained in sprinting speed threshold. In reference to the accelerations, the results showed a lower number of accelerations during SSG12 in comparison with SSG6 ($p = 0.018$, ES: 0.80, moderate) and SSG4 ($p = 0.029$, ES: 1.15, moderate). On the contrary, no significant differences ($p > 0.05$) in the number of decelerations were found between different training regimens. Players' power score showed significantly higher values during SSG4 in comparison with SSG12 (p = 0.002, ES: 1.14, moderate) and SSG6 ($p = 0.006$, ES: 1.23, large). Moreover, players showed a significantly higher work: rest ratio in SSG4 compared to SSG6 ($p = 0.018$, ES: 1.96, large). The player load was significantly higher during SSG4 than SSG12 ($p < 0.001$, ES: 1.61, large). However, non-significant differences ($p > 0.05$) were obtained for HMP, and RPE between different training regimes.

DISCUSSION

The aim of this study was to examine the acute physiological responses and time-motion profiles associated with intermittent and continuous SSGs regimes. Although many studies have reported information about the physical and physiological of different bout durations during SSGs, to the authors' knowledge, the present study was the first to examine the effects of bout duration on female soccer players. The main findings show that bout duration influences the external load measures in female players. Thus, the current results demonstrate that total distance covered, medium and high-intensity running were significantly higher SSG4 than SSG12 and SSG6 conditions. Additionally, accelerations were significantly higher during SSG4 and SSG6 formats compared to SSG12. Power score was significantly greater in SSG4 format than in the two other formats, and players'

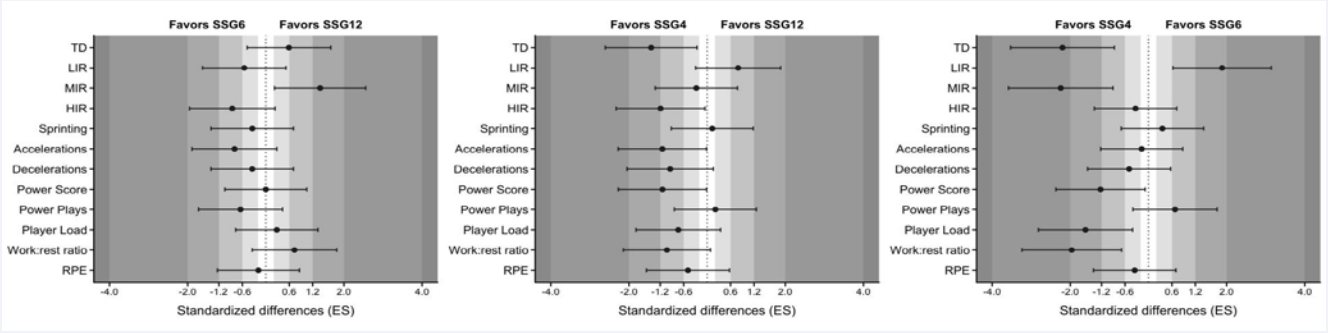

Figure 1 Standardized difference (Cohen) between bout durations.
TD: total distance; LIR: low intensity running; MIR: medium intensity running; HIR: high intensity running; RPE: rating of perceived exertion

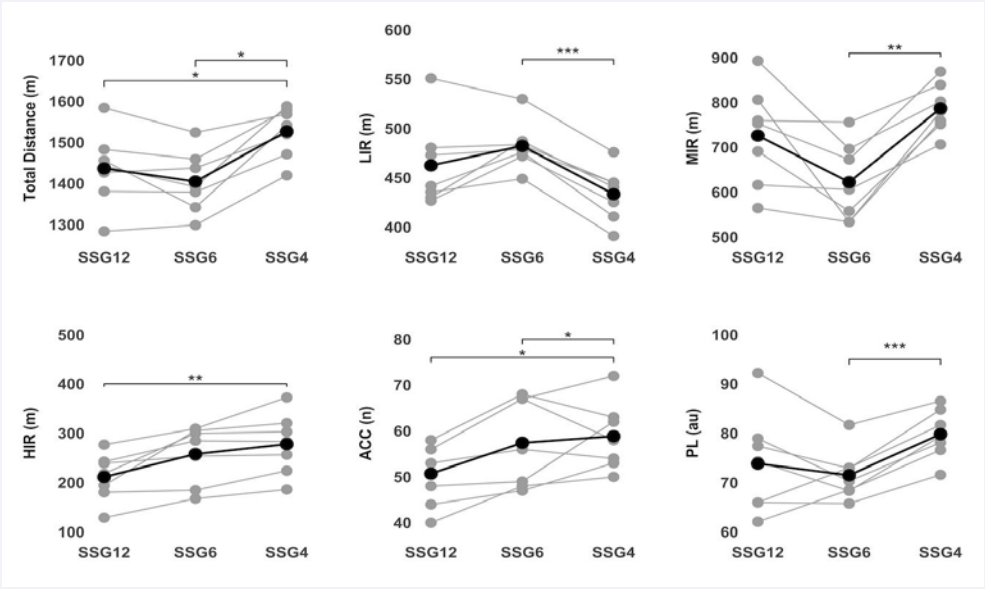

Figure 2 Depicted the individual and mean data for players in SSG12, SSG6, and SSG4 formats. Grey-filled circles indicate individual and mean data for each format, while black-filled circles displayed mean data for each format. *Significant differences between conditions $p < 0.05$; **Significant differences between conditions $p < 0.01$;
***Significant differences between conditions $p < 0.001$.

Table 2: Differences in players' internal load and external load according to training regimes (mean ± SD). SSG12 = Continuous (1x12 min); SSG6 = Intermittent format (2x6 min); SSG4 = Intermittent format (3x4 min). [a]$p < 0.05$; [b]$p < 0.01$; [c]$p < 0.001$.

	SSG12	SSG6	SSG4	ANOVA		
				F	p-value	Post-hoc
Total Distance (m)	1462.3 ± 68.6	1422.5 ± 65.2	1544.8 ± 43.9	15.839	<0.001	SSG4 > SSG12[a], SSG6[a]
Low-intensity running (m)	462.6 ± 44.2	482.3 ± 24.4	433.4 ± 27.4	15.617	<0.001	SSG6 > SSG4[c]
Medium-intensity running (m)	726.2 ± 112.2	622.2 ± 87.7	786.7 ± 55.1	12.309	<0.001	SSG4 > SSG6[b]
High-intensity running (m)	211.5 ± 48.6	257.9 ± 59.1	278.0± 62.2	14.488	<0.001	SSG4 > SSG12[b]
Sprinting (m)	36.5 ± 11.5	42.49 ± 21.6	33.8 ± 26.8	0.146	0.866	
Accelerations (n)	50.7 ± 6.8	57.4 ± 9.7	58.9 ± 7.5	7.467	0.008	SSG12 < SSG6[a], SSG4[a]
Decelerations (n)	57.9 ± 6.8	61.1 ± 11.1	66.6 ± 11.1	3.730	0.055	
Power score (score (w·kg^{-1})	9.8 ± 0.7	9.8 ± 0.6	10.6 ±0.7	25.920	<0.001	SSG4 > SSG12[b], SSG6[b]
High metabolic power (n)	6.6 ± 2.3	8.4 ± 3.2	5.9 ± 4.1	2.581	0.117	
Player load	73.8 ±10.3	71.5 ± 5.2	79.8 ± 5.1	6.763	0.011	SSG4 > SSG6[c]
Work:rest ratio (%)	59.4 ± 6.6	54.7 ± 6.2	65.1 ± 4.2	18.87	<0.001	SSG4 > SSG6[b]
RPE	6.9 ± 1.2	7.1 ± 0.9	7.4 ± 0.8	1.241	0.324	

load and work:rest ratio were higher during SSG4 compared to SSG6.

Overall, the continuous and large intermittent formats (SSG12 and SSG6) seem to present less physical impact on the time-motion profiles compared to the short intermittent method (SSG4). The current results showed that intermittent format of 3 x 4 minutes produce a significant increase in total distance, medium and high-intensity than other formats. These results are in line with those reported in previous research with young and senior male players [21,22]. These findings could be related to a lower physiological recovery including phosphocreatine resynthesis, the removal of metabolic products and an increase potassium accumulation in the muscle interstitium [31] during both large intermittent and continuous formats. When comparing the three formats, it can be inferred that, for low intensity, the continuous format and large intermittent format presented higher values. These results are in line with previous studies [21,22], which showed a higher walking distance (0–6.9 $km \cdot h^{1}$) during continuous and large intermittent SSGs formats. Possibly, the lack of recovery periods and large bout duration induce a greater players' fatigue during these SSGs and consequently, more walking movements and less relative distance are performed. Moreover, it could be suggested that players anticipate longer bout and continuous durations regulating their efforts with rest periods during the SSGs [20]. Considering these results, if female' soccer coaches or practitioners want to design SSGs with greater physical responses, they should use short intermittent formats.

In the present study, the results obtained did not show significant differences in sprint distance between continuous and intermittent SSG formats. The absence of differences in sprint distance could be due to the relative pitch area per player applied in our research design. Specifically, the SSGs presented a relative pitch area per player of approximately 94 m^2, being a small pitch relative area per player to elicit sprinting actions [28,33]. Contrary to our results, Hill-Haas et al. [18], and Köklu et al. [21], revealed that number of sprints and sprint distance were higher in intermittent (bouts of 6 minutes) than in continuous formats during various SSGs in male soccer players. However, the large gender differences in match and SSGs performance [13,33], could explain the differences between studies. Perhaps, default speed thresholds could underestimate the distance covered at higher speed thresholds in female players [33]. Therefore, future research should individualize speed thresholds to analyze different training regimes' physical and physiological responses.

In terms of neuromuscular performance, the present results showed significantly higher accelerations during intermittent formats than continuous format. In addition, power score and player load were higher during SSG4 than SSG6 and SSG12 format. To the best our of knowledge, only two previous studies analyzed neuromuscular parameters according to the bout duration with male young and senior players [20,22]. Our results are in line with those reported by the two investigations mentioned above. Similarly, Clemente, Nikolaidis, et al. [20], showed that both accelerations and decelerations were greater when the bout duration is reduced. It seems that playing without rest implies lower neuromuscular requirements during SSGs [22], that could be explained by the effect of accumulated fatigue during the SSGs, probably due to the accumulation of H^+ that contributes to reduce muscle pH, which impairs the cellular process that produces energy and muscle contraction [34]. These findings could be useful for female's soccer coaches in appropriately planning the bout duration of SSGs during the microcycle.

To our knowledge, no study has reported information about work: rest ratio according to training regimes. The results of the current study showed that players spent a higher time percentage above 5.4 $km \cdot h^{-1}$ during SSG4 compared to SSG6. In this sense, factors related to fatigue such as glycogen depletion, dehydration or insufficient Ca^{2+} could explain these results [35,36]. In addition, if players perceive an activity to be easier or with more rest, they may be more motivated to increase their running intensity and consequently, reduce walking time [22]. Thus, players could be likely to perform higher intensities during SSGs with anticipated shorter duration, while they establish a lower pacing strategy during the game-based activities of an anticipated longer duration [37].

Regarding internal load, non-significant effects of bout duration were found for the variable RPE. These results are agreement with previous findings in amateur and professional male players [23], which showed that RPE was not affected by SSG' bout durations. Conversely, other authors revealed significant differences in RPEbetween training regimes with young soccer players [18,21,22]. Different tendencies were observed between these studies. Christopher et al. [22], and Hill-Haas et al. [18], concluded that RPE was higher with continuous condition, meanwhile, Köklü et al. [21], indicated that short bout durations induced greater RPE responses. Therefore, more research is needed to elucidate how physiological responses vary according to the bout duration SSGs.

The interpretations and implications of the current findings must be understood within the limits of data collection undertaken. First, a larger sample of players would be more appropriate to obtain more representative values. Although the number of participants in the present study was similar to other studies that examined different training regimes' physical and physiological responses, this sample size could be considered relatively small. Additionally, more bout durations should be analyzed in order to know how internal and external load vary taking into account this topic. As another important limitation, the RPE was the only analyzed variable regarding players' internal load. This fact did not establish a clear relationship between training regimen and internal load during SSGs training. Finally, this study focused on a single SSG format, and for that reason, the occurrences of sprinting distances were scarce. Therefore, the analysis of larger or different formats could provide a much more in-depth insight into the variations between training regimes.

In conclusion, the within-regimen analysis revealed that continuous and large intermittent format induced to increase low intensity distance. However, short intermittent condition contributed to increasing distances covered at medium and high intensity. Additionally, considering the neuromuscular performance, accelerations, decelerations, and player load were higher in the shortest bout duration format. These results suggest that shorter sets can be beneficial to enhance external load demands without resulting in significant increases in the perceived exertion.

PRACTICAL APPLICATIONS

The results of this study could help coaches and conditioning coaches to periodize the content of their microcycles by either increasing or decreasing the intensity according to bout duration during SSGs played by female soccer players. The manipulation of the regimes format (intermittent or continuous) during SSGs had significant effects on the external load. Therefore, coaches should use one of them according to the objectives of the training session. It suggested that when match day approached continuous condition seem to more adequate due to lower physical demands reported. In contrast, the training sessions that are far from the match day intermittent formats could be used since they increase the physical demands during SSGs. Intermittent conditions with smaller periods of work, a greater number of sets, and larger rest can be recommended to ensure higher responses of external load demands since it seems to contribute to optimize the energy systems that support these types of efforts. Additionally, female's soccer coaches may manage the training load according to quality opposition and match location. When playing away against strong opposition, a reduction of the training load seems appropriate, in consequence, training continuous format could be used to reduce physical responses. Coaches have now valuable information providing different possibilities to apply the SSGs in different formats.

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