This is a non-final version of an article published in final form in *Sports Health: A Multidisciplinary Approach* (SAGE Publications):

Elba Díaz-Serradilla, **Daniel Castillo**, José Antonio Rodríguez-Marroyo, Javier Raya González, José Gerardo Villa Vicente, Alejandro Rodríguez-Fernández (2023). Effect of different non-starter compensatory strategies on training load in female soccer players: a pilot study. *Sports Health: A Multidisciplinary Approach*, *15*(6), 835-841.

Official URL: https://journals.sagepub.com/doi/10.1177/19417381231176555

DOI: https://doi.org/10.1177/19417381231176555
PMID: 37249238

Abstract

Background: The day of the week with a greater external load in soccer training is match day (MD), showing starters (> 60 min per match) higher levels of physical fitness and seasonal high-intensity loading. Therefore, determining training strategies to reduce these differences are necessary. The aim of this study was to analyze and compare the external load of different training compensatory strategies on match external load in nonstarter female soccer players. **Hypothesis:** the strategy combining small sided games (SSG) and running based drills (RBD) would reproduce match demands, since RBD leads to higher High intensity distance and SSG leads to a greater number of accelerations and decelerations.

Study design[Au: This is not design.]: Training and match external load of fourteen female players belonged to the same reserve squad of a Spanish First Division Club (Liga Reto Iberdrola) were registered.

Level of Evidence: Level 4

Methods: On the first session after the match (MD+1), nonstarter players (< 60 min in the match) performed one of the three different compensatory strategies: RBD, SSG, and a mixed intervention combining the previous strategies (RBD+SSG). Starter players carried out a recovery session.

Results: A marked difference in load was observed between different compensatory training strategies and MD. While RBD showed greater high-intensity and sprint distances and lower acceleration, SSG showed less high-intensity and sprint distances and peak velocity and greater acceleration, and RBD+SSG registered lower accelerations, in comparison to MD. In addition, nonstarters covered higher high-intensity and sprint distances in RBD and higher accelerations in SSG.

Conclusions: RBD and SSG compensatory strategies could be recommended to nonstarters female soccer players during the MD+1 in order to compensate the match external load deficits.

Clinical Relevance: This study provides comprehensive information on the compensatory exercises of female soccer players, which can be useful for strength and conditioning coaches when developing recovery strategies during microcycle.

Key words: Compensatory training**,** women, football, load.

Introduction

Women's soccer has increased in popularity at all levels [33] and is experiencing incredible growth in terms of media impact, competitiveness and physical development of the players [29]. Proof of this is that in the 2019 Women´s World Cup, distances covered at high intensity (HID, 19-23 km/h) increased by 15%, while the distance covered in sprinting (SPRD, >25 km/h) increased by approximately 29% [6] in comparison to the 2015 Women´s World Cup. To manage these higher match external loads, it is necessary to optimize training periodization through the adjustment of volume and intensity in training sessions within the training microcycle [41], and apply training methods that reproduce the match external load. This becomes even more important with nonstarters players [31,40].

Due to growth in terms of competitiveness, physical development and minutes played in match day, starters covered more total distance (22%), HID (47%), and SPRD (74%) that nonstarters, support a greater seasonal load; these players also report a higher perceived load (29%) [2,25]. Additionally, the main characteristic of starters versus non-starters is greater participation (i.e. minutes) during competition, allowing them to accumulate higher physical and physiological loads during the microcycle. Moreover, it has been demonstrated that match-play is an important stimulus to improve CMJ performance in starter players in comparison to nonstarters [34]. Jajtner et al. [23] found that female starter players in the national collegiate female division I presented improved speed after an 8-week line drill test, with no changes in the nonstarter players. Therefore, due to potential imbalances between players (starters and nonstarters), coaches and practitioners need to manage player workloads because these players participate in matches for different periods [12]. According to the above, it may be necessary to apply compensatory strategies with nonstarter players in order to improve/maintain their training status [31]. To achieve this aim, several training strategies (e.g. high-intensity interval, small-sided games or plyometric training) have been applied in female soccer populations [15,36,38]. However, the impact of these strategies on training demands, differentiating between starters and nonstarters, has not been considered in previous studies.

Different compensatory training strategies to avoid compromising nonstarter players' physical performance may be used. Ade et al. [1] observed that soccer players covered greater distance at high-intensity and sprint in running-based (RBD) compared with small-sided game (SSG) drills, although more accelerations and decelerations were registered during SSG. In addition, when nonstarter players were supplemented with SSG in the first session after a match (MD+1), greater total distance covered, higher average metabolic power, accelerations and decelerations were recorded, but high-intensity and sprint qualities were not developed [31]. Therefore, studies analyzing training strategies that simulate match demands and compensate weekly load for nonstarter players are necessary, particularly as there are no studies in this area on female soccer players.

The aim of this study was to analyze and compare the external load of different training compensatory strategies (i.e., RBD, SSG, and a mixed intervention combining the previous ones) on match external load in nonstarter female soccer players. Secondly, the microcycle load between nonstarters vs. starters was compared, taking into account the compensatory strategies applied. Based on previous studies [1,31] we hypothesized that a strategy combining SSG and RBD would reproduce match demands, since RBD leads to higher HID, and SSG leads to a greater number of accelerations and decelerations.

Methods

Subjects

Fourteen female soccer players (age: 21.7 ± 1.7 years; height: 164.3 ± 5.1 cm; body mass: 55.8 ± 6.9 kg; and body mass index: 20.7 ± 1.6 $kg \cdot m^{-2}$) participated in this study. Data were recorded during the 2020–2021 competitive season during the mid-season period and all participants belonged to the same reserve team of a Spanish First Division Club (Liga Reto Iberdrola). Goalkeepers were excluded from the subsequent analysis due to their specific role. Players who had suffered an injury in the previous two months and who did not complete all of the intervention sessions were not included in the analysis. Before beginning the study, participants were informed of the study's objectives, risks, and benefits before they signed informed consent forms. The study was conducted according to the requirements of the Declaration of Helsinki and was approved by the ethics committee of ***for blinded purposes*** code: 005-2021.

Design

This study compared the training load generated by three different interventions (RBD, SSG and RBD + SSG) in nonstarters. During MD+1 the female soccer players were assigned to a Recovery Group (starters) or a Compensatory Group (nonstarters) according to the minutes played in the previous match (Recovery Group = >60 minutes; Compensatory Group <60 minutes) [31]. The intervention consisted of supplementing nonstarter female soccer players with three different training strategies (RBD, SSG, or RBD + SSG), each performed independently on MD+1 for three consecutive weeks. Each week of the intervention period was composed of four training sessions (i.e., MD+1: the first session after the previous match without a recovery day, MD-3, MD-2, and MD-1: three, two, and one session before the next match respectively), and an official match-day (MD) session. The usual distribution of the week during the competitive season in the 3 previous months was as follows: recovery or compensatory, endurance, tactical and activation in MD+1, MD-3 and MD-1 respectively [8]. During MD+1 intervention period the starters performed a recovery session (MD+1) consisting of a 15-min technical drill followed by a 4 vs. 4 SSG on a surface of 10 × 15 m for 8-min, finishing with regeneration exercises (e.g., foam roller, mobility). Measures of external load and the rating of perceived exertion (sRPE) were collected during each session, as well as a wellness questionnaire before the MD-3 session. Training sessions were conducted on the same playing surface (third-generation artificial turf) at the same time (7:30 p.m.). Matches were played on three pitches with similar dimensions (100 × 64 m) and artificial surfaces.

Procedures

Compensatory strategies. In addition to the normal training, nonstarters completed one of the following interventions each consecutive week: RBD, in which players performed a speed endurance drill consisting of 2 × 6 × 20-s *all out* sprints with 90-s of active recovery and after 5-min of recovery a repeated sprint drill, consisting of 2 × 5 × 25-m sprints followed by a goal shoot with 25-s of passive recovery. In SSG, players performed a 4 vs. 4 SSG (25 × 20-m, individual interaction space = 62.5 m^2) consisting of 3 bouts of 4-min separated by 90-s of passive recovery and 4 vs. 4 with goalkeepers (20 × 15 m) consisting of 2 bouts of 8-min and 120-s passive recovery. In RBD+SSG (mixed intervention), players performed a combination of parts of both strategies: first a repeated sprint drill consisting of 2 × 5 × 25-m with 25-s of recovery between repetitions and 5-min between sets, and second after 5-min of recovery the same small game that in the SSG strategy [4 vs. 4 SSG (25 × 20-m, individual interaction space = 62.5 m^2) consisting of 3 bouts of 4-min separated by 90-s of passive recovery].

External load quantification. External load was recorded individually for each player using an 18-Hz Global Positioning System (GPS) with an integrated 100-Hz triaxial accelerometer (WIMU PRO, RealTrack Systems, Almería, Spain). This technology has previously been used in soccer research on activity-demand profiles

[20,35] and reported high levels of validity and reliability (%TEM: 1.47) [5]. The GPS units (70 g; 81 × 45 × 16 mm) were activated 15 min before the start of each session in accordance with the manufacturer's recommendations, and were harnessed in a tight-fitting vest worn by the female soccer players during the experimental study. To avoid inter-unit variability, each player wore their assigned unit in all the training sessions and matches [5]. Following each training session and match, GPS data were downloaded onto a personal computer using the specific software package (WIMU SPRO, Almería, Spain) and exported for further analysis. Absolute (meters: TD) and relative (meter per minute: RD) values for total distance, high-intensity distance (HID ≥ 19.0 $km \cdot h^{-1}$), sprint distance (SPR ≥ 23.0 $km \cdot h^{-1}$), high intensity acceleration (ACC > 3 $m \cdot s^{-2}$), high intensity deceleration (DCC > -3.0 $m \cdot s^{-2}$), and peak velocity (PV) were recorded. These are similar ranges to those used in previous studies with female soccer players [7]. The average number of satellites registering data during the measurements was 10.1±1.0 and horizontal dilution of precision was 0.96.

Internal load and wellness quantification. A 0-10 category ratio scale was used to register players' perceived effort 30 min after each training session [17]. Furthermore, each individual sRPE value was multiplied by the training session duration to quantify players' training load [20]. All participants were familiar with the category ratio scale as they use it regularly in their training sessions and matches. In addition, the female soccer players completed a wellness questionnaire each morning on MD-3. The items of the questionnaire included sleep quality, stress, fatigue, and muscle soreness on a 7-point Likert scale [19,39]. Players rated on the scale how much they agree (1-strongly agree) or disagree (7-strongly disagree). The sum of the four ratings was used to calculate Hooper's index [19,39].

Statistical Analysis

Results are presented as mean ± standard deviation (SD). Normality was verified using Shapiro–Wilk's test. A one-way ANOVA was conducted to compare all studied variables among the training strategies (RBD, SSG, and RBD+SSG) and MD. Pairwise comparison was performed using Bonferroni's post hoc test. In addition, an independent *t*-test was used to analyze the external load differences among starters and nonstarters in each training microcycle and training session. The standardized difference or effect size (ES, 90% confidence limits) in the selected variables was calculated using the Cohen's d with values of <0.2 (trivial), ≥0.2 and 0.49 (small), ≥0.5 and <0.79 (medium) and ≥0.8 (large) [11]. Significance level was set at $p < 0.05$. Statistical analysis was conducted using SPSS version 25.0.

Results

Table 1 presents the results of the external load of each intervention and match day. In the SSG and SSG+RBD interventions, players covered significantly ($p < 0.05$) less RD than MD (ES = 3.9 and 4.6 respectively). In RBD, players covered significantly ($p < 0.05$) more absolute and relative HID and SPRD than MD (ES = 3.9 and 2.0 respectively). Less ($p < 0.05$) HID and SPRD was covered than MD in the SSG (ES = 4.1 and 1.6 respectively). However, in the RBD+SSG, similar HID and higher ($p < 0.05$) SPRD was covered than MD (ES = 1.1). Only the SSG intervention reached a similar ACC to the MD (ES = 1.1). In RBD and RBD+SSG players significantly ($p < 0.05$) covered more HID and SPRD and reach more PV than in SSG.

Table 1 near here

When RBD was performed, nonstarter covered significantly more HID & SPRD and less ($p < 0.05$) total ACC and DCC than starters (Table 2). Nonstarters covered a lesser ($p < 0.05$) TD and ACC than starter when SSG was performed. Similarly, a lesser ($p < 0.05$) TD was covered by nonstarters in the RBD+SSG.

Table 2 near here

Nonstarters who performed MD+1 training compensatory strategies showed a higher ($p < 0.05$) TD (ES = 9.6, 6.8 and 4.2 to RBD, SSGs and RBD+SSG) and PV (ES = 4.7, 1.6 and 1.9 to RBD, SSGs and RBD+SSG) relative to match load than starters in all training strategies (Figure 1). In addition, nonstarters performed a higher ($p < 0.05$) HID and SPRD in RBD (ES = 1.5 and 5.3 respectively), DCC in SSG (ES = 1.7), and HID, SPRD and ACC in RBD+SSG (ES = 1.9, 2.8 and 2.1respectively). No significant differences were found between starters and nonstarters in the perception of wellness in any of the three interventions (~ 14 AU).

Figure 1 near here

Discussion

This is the first study that compares different compensatory training strategies with the aim of replicating competition requirements and reducing the gap of weekly training load between starter and nonstarter female soccer players. Our results showed that players were exposed to higher total distance, decelerations and sRPE in matches than in training sessions. However, RBD allowed players to reach higher high-intensity and sprint distances, boosting the weekly accumulation of these variables. Similarly, SSG involved a higher weekly accumulation of accelerations.

Match-play represents the highest stimulus for professional soccer players [34] in terms of external and internal load, which seems to be relevant because starters cover more high-intensity and sprint distance than nonstarter players [2,13], which may affect their physical fitness (i.e. adaptations in skeletal muscle) [16]. Therefore, compensatory strategies should be applied with nonstarter players to maintain or increase their physical fitness level [31]. Our results showed that female players covered significantly more HID and SPRD during RBD compared to MD and the other training strategies (SSG and RBD+SSG). In speed endurance production (1 vs 1, 8 bouts of 30-s with 120-s of recovery) and maintenance (2 vs 2, 8 bouts of 60-s with 60-s of recovery) running drills, players covered more distance in high-intensity running parameters (i.e., distance at 19.9–25.2 $km \cdot h^{-1}$) compared with the respective SSG [1]. In addition, the RBD+SSG strategy led female soccer players covering significantly more HID than SSG strategy. Possibly this circumstance caused that sRPE in RBD was significantly higher than the SSG strategy. The greater high-intensity and sprint distances covered make RBD a useful tool for high-intensity and sprint training. In this sense, Lupo et al. [26] and Arslan et al. [4] reported that training including a running-based training program could be more effective in improving soccer players' sprint performances (i.e., 20-m) and speed-based conditioning than soccer-specific drills in young soccer players. These results are in agreement with a recent Meta-Analytical Comparison that conclude favoring effect of running-based HIIT over SSG-based interventions in sprinting performance in soccer players [9].

Sprint ability is required by female soccer players in order to gain an advantage in attacking and defensive situations [14]. In addition, exposure to maximal velocity running reduces the risk of injury to players, [28] so they require regular exposure to periods of sprinting during training environments [18]. RBD and RBD + SSG require similar peak velocity to that demanded on the MD (~25 $km \cdot h^{-1}$), as also reported for youth women soccer players (23-26 $km \cdot h^{-1}$) [42]. Therefore, these interventions stimulate match peak speed. In addition, RBD presented significant positive effects for linear sprinting and COD performance compared to SSG, [9] so this training intervention could be used on MD+1 and may reduce the differences between starters and nonstarters, aiding the maintenance of squad physical fitness.

Furthermore, our results showed that the SSG compensatory strategy did not stimulate high-intensity actions (i.e. HID or SPRD) in nonstarter players. Köklü et al. [24] showed that, when substituting 60-s of SSG for running drills (15 + 15-s), players covered significantly greater distances in high intensity speed zones (>14.4 $km \cdot h^{-1}$)

regardless of the number of players (3 vs 3 and 4 vs 4). As such, the smaller the dimensions of the field of play, the greater the technical-tactical requirements and the ceiling effect that consists of those players with higher physical fitness experiment lower external load, limit to reach the speed thresholds to register high-intensity running [22]. This could explain why players do not reach high-intensity values in SSG similar to match external load and the other two compensatory strategies. The peak velocity reached in the SSG intervention was significantly lower than that reached in RBD, RBD + SSG, and MD. Implementing SSG with larger spaces might allow players to reach a higher speed [21], cover greater HID [10] and decrease these differences.

Players' acceleration ability may help to optimize on-field performance and prevent injury [30]. The number of accelerations performed by female players in this study was lower than that reported by previous studies [30,32]. This might be due to the different levels of the players (elite vs reserve team) or the acceleration threshold considered (>2.26 $m \cdot s^{-2}$ or >2. $m \cdot s^{-2}$ vs >3 $m \cdot s^{-2}$). Only the SSG intervention reproduced the number of accelerations that the players experience on MD. These results are in agreement with Ade et al., [1] who reported that a greater number of accelerations are performed during sprint endurance production or maintenance training via SSG than in the respective running drills. Accelerating is more energetically demanding than constant-velocity movement [37]. Therefore, despite the greater distance covered at high intensity and sprinting in RBD and RBD+SSG, coaches and physical trainers should include accelerating in the prescription and distribution of training tasks.

Previous studies reported that microcycle external load is conditioned by the number of matches [3] or moment of the season [27], but to our knowledge this is the first study to analyze the microcycle load between starters and nonstarters according to a compensatory strategy applied to female soccer players. Anderson et al. [2] did not find differences in the season-long external load between starters and nonstarters, but starters displayed lower external load than nonstarters in training sessions and more distance covered in high-intensity zones. Our results show that the compensatory strategy used with nonstarter players can condition the weekly training load. The greater HID and SPRD in the RBD compensatory session is not compensated by the starters' match demands and the remaining weekly training sessions, causing a higher external load (i.e., HID and SPRD) in the nonstarters' microcycle load. Since training load predicts in-season injury and illness risk in female youth soccer players [43], coaches and practitioners need to take into account the strategy used.

Finally, this study has many limitations that should be considered by practitioners. The comparison between starters and nonstarters in the different weeks as also some boundaries. As example, in one of those weeks the match performed by the starters [that has a great variability (may range from 16-30% and more pronouncedly in high-intensity categories] could influence comparisons in favor of starters and in other week in favor of the compensatory strategy applied duo to the inherent match-variability. In addition, it was carried out on a sample with specific characteristics (elite reserve team female soccer players), so we need to be careful when applying it to players with other characteristics (i.e. age and level) or genders (i.e. male soccer players). Furthermore, although the intervention length was acceptable, a larger number of intervention sessions may be necessary to confirm the present results. Finally, no randomization in compensatory training strategies was established due to the application of each strategy depends on whether the female soccer player participates as starter or non-starter in the previous match.

Conclusion

As the match constitutes the main external load of the microcycle nonstarters and starters players show different total microcycle load, being necessary to implement strategies to equate them. The reduction in the differences obtained in nonstarter external load depends on the compensatory strategy employed. The RBD + SSG intervention was one that exposed the players to match-like demands. The compensatory strategy used in the MD+1 session in nonstarter players can condition the accumulated load during the microcycle. Given the differences reported between starters and nonstarters it is necessary to implement strategies for load compensation, otherwise nonstarter players will present worse fitness levels and have a greater risk of injury when they compete. Futures studies, can analyze different strategies, using SSG with different format (i.e. spatial, temporal or different number of players) and implementing SSG with larger spaces might allow players to reach a higher speed and cover greater HID.

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Table 1: Comparison of external load of each compensatory strategy and match day.

	MD	RBD	SSG	RBD+SSG
TD (m)	8257±1229	5463±149*	4385±300*	3614±277*†
RD ($m \cdot min^{-1}$)	94.6±8.0	90.9±4	69.4±5.0*†	62.9±6.0*†
HID (m)	281.3±99.6	964.5±233.3*	4.9±5.7*†	202.7±28.0†‡
HID ($m \cdot min^{-1}$)	3.5±1.5	16.1±3.9*	0.1±0.1*†	3.5±0.5†‡
SPRD (m)	45.8±41.6	147.1±59.4*	0.0±0.0†*	112.2±57.2*‡
SPRD ($m \cdot min^{-1}$)	0.6±0.5	2.5±0.9*	0.0±0.0†	1.9±0.9*‡
ACC HI (nº)	23.9±5.6	12.0±3.8*	17.0±6.4	16.1±3.7*
DCC HI (nº)	44.9±10.9	10.7±4.2*	28.0±8.9*	20.5±6.2*
ACC HI ($nº \cdot min^{-1}$)	0.3±0.1	0.2±0.1	0.3±0.1	0.3±0.1
DCC HI ($nº \cdot min^{-1}$)	0.5±0.1	0.2±0.1*	0.4±0.1†	0.4±0.1†
PV ($km \cdot h^{-1}$)	24.6±1.9	25.9±1.5	19.5±1.5*†	24.4±1.8‡
sRPE (AU)	555.3±175.3	495.0±57.4	261.0±31.8*†	330.8±31.5*

MD = Match day; RBD = running basic drills; SSG = small sided games; TD = total distance; RD = relative distance; HID = high intensity distance (> 19.0 $km \cdot h^{-1}$); SPRD = sprint distance (> 23.0 $km \cdot h^{-1}$); ACC HI = high intensity accelerations (> 3 $m \cdot s^{-2}$) DECC HI = high intensity decelerations (> -3.0 $m \cdot s^{-2}$); PV = peak velocity, sRPE (session rating of perceived exertion). * = denotes difference from MD; † = denotes difference from RBD; ‡ = denotes difference from SSG. $p < 0.05$

Table 2: Comparison of accumulated external loads during microcycle between starters and nonstarters female soccer players.

	RBD			SSG			RBD+SSG		
	S	NS	ES	S	NS	ES	S	NS	ES
TD (m)	25603±2995	22513±1752	1.5	25308±1988	20689±1620*	2.6	25986±1275	21312±2861*	2.2
RD ($m \cdot min^{-1}$)	65.7±5.3	69.6±4.4	0.8	66.6±5.1	66.7±6.4	0.0	69.3±4.9	66.8±8.3	0.4
HID (m)	730.5±281.2	1165.3±521.5*	1.1	545.3±181.5	365.1±209.4	0.9	705.1±272.4	624.5±125.0	0.4
HID ($m \cdot min^{-1}$)	1.9±0.7	3.6±1.6*	1.4	1.5±0.5	1.2±0.7	0.5	2.1±0.7	1.9±0.3	0.4
SPRD (m)	86.8±55.3	170.9±54.7*	1.6	89.4±73.9	55.8±50.5	0.5	137.7±92.5	179.4±96.4	0.5
SPRD ($m \cdot min^{-1}$)	0.35±0.2	0.7±0.4	1.1	0.2±0.2	0.2±0.2	0.0	0.3±0.2	0.6±0.3	1.0
ACC HI (nº)	91.3±24.3	58.6±8.7*	1.9	104.0±22.3	80.2±8.9*	1.4	97.5±22.4	83.6±31.5	0.5
DCC HI (nº)	0.2±0.1	0.2±0.0	0.0	0.3±0.1	0.3±0.0	0.0	0.3±0.1	0.3±0.1	0.0
ACC HI (nº$\cdot min^{-1}$)	136.0±21.2	94.8±25.8*	1.8	146.8±19.9	123.4±43.0	0.7	157.1±21.8	116.0±46.2	1.2
DCC HI (nº$\cdot min^{-1}$)	0.3±0.1	0.3±0.1	0	0.4±0.1	0.4±0.2	0.0	0.4±0.1	0.4±0.1	0.0
PV ($km \cdot h^{-1}$)	21.9±1.0	22.9±0.8	1.1	22.4±0.8	23.0±1.9	0.4	22.6±1.5	22.5±1.2	0.1
sRPE (AU)	1671.1±388.4	1587.4±193.1	0.3	1594.5±369.1	1471.4±254.1	0.4	1708.4±429.0	1518.5±195.1	0.6

RBD = running basic drills; SSG = small sided games; S = Starters; NS = Nonstarters; ES = effect size Cohen's *d*; TD = total distance; RD = relative distance; HID = high intensity distance (> 19.0 $km \cdot h^{-1}$); SPRD = sprint distance (> 23.0 $km \cdot h^{-1}$); ACC HI = high intensity accelerations (> 3 $m \cdot s^{-2}$) DECC HI = high intensity decelerations (> -3.0 $m \cdot s^{-2}$); PV = peak velocity; sRPE (session rating of perceived exertion). * = denotes difference from starters. $p < 0.05$