THE EFFECT OF DEFENSIVE STRATEGIES ON THE PHYSIOLOGICAL RESPONSES AND TIME-MOTION CHARACTERISTICS IN SMALL-SIDED GAMES

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Abstract:

The purpose of this study was to investigate the effects of alterations in the defensive strategies on physiological responses and time-motion characteristics during 3 × 4 min small-sided games (SSGs) in young soccer players. Eighteen young soccer players (age 19.6±0.5 years, body height 178.3±4.6 cm, body mass 71.9±7.5 kg and VO_{2max} 49.51±2.44 ml·kg^{-1}·min^{-1}) voluntarily participated in SSGs with different defensive strategies (FP: free play, MM: man-marking, DMP: double-man pressure). Heart rate (HR) and total distance covered in different speed zones were monitored during all SSGs, whereas the session-rating of perceived exertion (session-RPE, CR-10) and venous blood lactate (La-) were determined at the end of the last bout of each SSG. The results demonstrated that DMP produced significantly higher La- (F=23.82, p<.05, η^2=0.58), HR (F=10.10; p<.05; η^2=0.37), $\%HR_{max}$ (F=81.11; p<.05; η^2=0.82), and session-RPE (F=215.63, p<.05, η^2=0.92) responses compared to FP and MM. Furthermore, significant differences were found between MM and FP condition. In addition, during the DMP, players covered greater distances in the high-intensity running zone (>18 km·h^{-1}) (F=13.67; p<.05; η^2=0.44) compared to MM and FP. The findings of this study revealed that the alterations in the defensive strategies brought about different physiological responses and time-motion characteristics during the course of SSGs. Therefore, the recommendation for coaches is to choose DMP or MM defensive strategies if they target higher physiological responses and time-motion characteristics during the SSGs.

Key words: *soccer, training regimens, aerobic endurance, heart rate, blood lactate, time-motion analysis*

Introduction

Soccer is a high performance sport that requires a combination of technical, tactical, physical and decision-making skills working together (Bangsbo, 1994; Dellal, Wong, Moalla, & Chamari, 2010; Iaia, Rampinini, & Bangsbo, 2009). In order to improve performance in soccer, these training variables have to be incorporated into training. Traditionally, coaches have adopted simple running drills to improve player performance (Little & Williams, 2007). These methods, however, in many cases have failed to address the important and complex training variables. In order to overcome the shortcomings of traditional methods, a small-sided game (SSG) training method was developed to address the complexity of performance factors in soccer and preserve the basic variability of game properties (Aguiar, Botelho, Lago, Maças, & Sampaio, 2012). Physical trainers and coaches frequently use SSGs to improve the technical, tactical (Jones & Drust, 2007) and players' physiological capacity (Hill-Haas, Dawson, Coutts, & Rowsell, 2009; Impellizzeri, et al., 2006).

While conducting SSG studies, the quantification of exercise intensity is generally accomplished via measuring: heart rate (HR), blood lactate concentration (BLC), and session-rating of perceived exertion (session-RPE). Furthermore, video recorders are used to assess technical demands and global positioning systems (GPS) are used to observe time-motion characteristics (Hill-Haas, Dawson, Impellizzeri, & Coutts, 2011).

Heart rate has been commonly accepted as a reliable indicator of physiological responses in previous studies on SSGs (Rampinini, et al., 2007; Dellal, et al., 2008; Hill-Haas, Coutts, Dawson, & Rowsell, 2010). In addition, Impellizzeri, Rampinini, Coutts, Sassi, and Marcora (2004) reported that the session-RPE can be considered as a good indicator of global internal load of soccer training. Aroso, Rebelo, and Gomes-Pereira (2004) investigated 3-v-3 SSGs using man-marking (MM) and small goals in a 30 × 20 m pitch size [600 m²]. A significantly higher RPE was found when the field of play was enlarged and the number of players decreased.

Recent technological developments permit detailed analysis of factors relating to physical match performance (Carling, Bloomfield, Nelsen, & Reilly, 2008). The GPS technology provides a practical method for recording time-motion characteristics during all forms of soccer training, including technical/tactical training drills and small-sided games (Hill-Haas, et al., 2009). Knowing the distance covered or the range of speeds attained can help in planning training sessions and developing suitable training programmes to improve the specific physical condition of participants (Castellano & Casamichana, 2010).

In order to achieve greater benefits from SSGs, coaches and researchers have been trying to develop and optimize the effectiveness of training in these games. To accomplish this, researchers strive to understand active parameters and their effects on the physiological, technical and tactical variables. Until now, studies have shown that manipulating playing area, presence of goalkeepers or goals, coach encouragement, either interval or continuous, manipulating the number of players, and application of specific game rules can have significant effects on the physiological, technical and tactical demands in SSGs (Casamichana & Castellano, 2010; Fanchini, et al., 2011; Köklü, 2012; Hill-Haas, Coutts, Rowsell, & Dawson, 2008; Mallo & Navarro, 2008; Rampinini, et al., 2007).

Alongside the physical requirements, technical ability and tactical awareness are likewise very important variables that can potentially affect the outcome of the game (Hill-Haas, et al., 2010). In order to train technical and tactical requirements, the application of soccer-specific rules, such as two touches (Sampaio, et al., 2007), man-marking (MM) (Aroso, et al., 2004; Ngo, et al., 2012) or zonal play areas (Hill-Haas, et al., 2010), has been proven to affect physiological and technical variables. Ngo et al. (2012) reported a 4.5% increase in heart rate response by using MM rule. In contrast, Sampaio et al. (2007) reported that MM and the two-ball-touch rule had no significant effect on physiological variables, but only on the RPE values. Both studies, however, failed to include time-motion data to observe the effects of specific rules on movement characteristics of players.

Rule modifications, like the two-ball-touch rule, have long been used to vary the physiological stimulus and tactical aims in SSG. In our study, a 3-v-3 design was adopted as modification since lower variability has been reported with fewer players (Little & Williams, 2007). Also, since the presence of goalkeepers and goals may cause players to stay in set defensive formats, they were excluded from this experiment (Ngo, et al., 2012). A soccer-specific stimulus similar to MM that players typically encountered in competitive matches is when the opponent applies pressure with two players (DMP). This creates a potential numerical disadvantage i.e a 1-v-2 situation. This can occur due to tactical changes, when being a goal down in the final few minutes of the game or after losing possession when the opponent immediately applies pressure to regain possession and disrupt the offensive build up. Coaches can create numerically disadvantaged teams to train specific technical and tactical requirements (Hill-Haas, et al., 2010). The principle of specificity dictates that the demands of a particular sport, or the demands of a task in which an athlete wishes to improve performance, will directly determine the manner in which the training should be performed (Flanagan & Comyns, 2008). Therefore, to increase specificity, the DMP condition should be incorporated into SSGs design. However, coaches should be wary of the physiological and physical demands of DMP condition prior to its application in SSGs.

Despite the abundance of SSGs research in the literature, to our knowledge no study has investigated time-motion characteristics of MM, and physiological and time-motion demands of DMP. Therefore the aim of this study is to investigate the effects of different defensive strategies (MM and DMP) on the physiological variables and time-motion characteristics in SSG training protocol. It was hypothesized that different defensive strategies (MM and DMP) during SSGs will induce a higher training intensity compared with FP. The likely outcome of this study is to open new venues in helping coaches to determine training intensity when adopting soccer-specific rules during SSGs training.

Methods

Subjects

Eighteen active soccer players (age 19.6±0.5 years, body mass 71.9±7.5 kg, body height 178.3±4.6 cm, and VO_{2max} 49.51±2.44 ml·kg^{-1}·min^{-1}), who participated in a national elite academy league, voluntarily participated in this study. The participants had six years of training experience on average. All participants provided written consent in accordance with the Declaration of Helsinki, after reading the verbal and written explanations of the potential risks of the study. The participants were informed about the procedure of the experiment and were told that at any given time they could voluntarily withdraw from the experiment.

Procedures

The two-week pre-season training period served as a familiarization period for the participants with the SSG formats and with the Yo-Yo Intermittent Recovery Test level 1 (YYIR1) (Bangsbo, Iaia, &

Krustrup, 2008). At the conclusion of pre-season training, players underwent the YYIR1 to determine their fitness levels and were ranked according to the distance covered in this test. Players' VO_{2max} ($ml \cdot kg^{-1} \cdot min^{-1}$) was indirectly estimated from their distances covered in the YYIR1 using the formula (VO_{2max} = YYIR1 distance [m] x 0.0084 + 36.40) (Bangsbo, et al., 2008). The scores gained on the YYIR1 were as follows: players who covered the least distance were given a score of 1 and those who covered the most ground were given a score of 5. For example, those who covered between 1800 and 2280 meters were stratified in groups with scores 4 and 5. However, the final judgment on stratification was made by the coach subjectively, depending on team compatibility based on the requirements of different positions (i.e. defense, midfield and forward). A subjective analysis of the players' technical and tactical skill levels were determined by 6 experienced soccer coaches on a 5 point scale (from 1 – 'poor' to 5 – 'excellent') (Köklü, 2012). The coaches assigned to the study were the current coaches of the participants and had 5 to 7 years of coaching experience in the elite academy leagues. The total score for each player was the sum of his technical/tactical skill and YYIR1 scores. In an attempt to avoid skill and fitness mismatches and a consequent imbalance in opposing SSG teams, each team was then balanced in terms of the players' skill and fitness rankings (Köklü, Albayrak, Keysan, Alemdaroğlu, & Dellal, 2013).

The data collection was conducted over a two-week period. On the first day**,** YYIR1 and anthropometric (body mass and height) measurements were collected. In three-day bouts, the SSG protocols were applied in a randomized order. Each defensive strategy (FP, MM and DMP) was performed in three sets of four minutes, with five-minute passive recovery duration. All SSGs were performed between the same times of a day (16:00-19:00) to avoid circadian influences, and were performed on a grass soccer field. SSGs sessions were preceded by a standardized fifteen minute warm-up, which consisted of jogging, sports specific dynamic stretching and 3 x 20 m sprints.

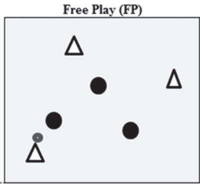
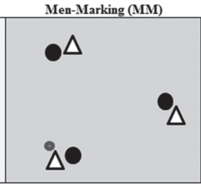
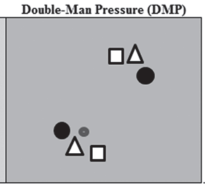
The Yo-Yo intermittent recovery test level 1 (YYIR1)

The YYIR1 is considered a useful tool for evaluating fitness levels in intermittent sports (Bangsbo, et al., 2008). After completing a standardized warm-up of 10 minutes, the players performed the YYIR1, which consisted of repeated 2 x 20 m shuttle runs with a 10-second active recovery period between runs, controlled by audio beeps. Running speed was gradually increased. If subjects fail to reach the finish lines on two occasions, their test is terminated and the distance covered is recorded in metres. Throughout the test, HR values were recorded and stored for further analysis.

Small-sided games

Table 1 displays the adopted SSGs characteristics used in this study. It shows the number of bouts, bout duration (min), total time (min), pitch dimension (length x width), and relative pitch size (m^2) for the SSGs with different defensive strategies (free play – FP, man-marking – MM, double-man pressure – DMP). Relative pitch size was calculated by using the following formula: relative pitch size = (length × width) / number of players. Each SSG bout session was kept at four minutes, and the passive recovery duration between bouts of SSGs was five minutes. For the MM rule, each player was matched with an opponent and instructed to stay with that player throughout each session. For the DMP rule, each team was given a blue, red and yellow training vest and matched with players wearing different colour vests. When the blue player had the ball, the matched red and yellow opponents teamed up and applied immediate defensive pressure while the other red and yellow player applied defensive pressure to the free blue player, potentially creating a 2-v-4 situation. If possession was intercepted by a red player, then the matched blue and yellow players applied defensive pressure while the other blue and yellow players match-up with the free red players. Extra balls were placed in the goals and along the side lines surrounding the entire pitch to ensure that there were no breaks in play (Table 1).

Table 1. Established characteristics of free play, man-marking and double-man pressure

	Free Play (FP)	Men-Marking (MM)	Double-Man Pressure (DMP)
Playing Formulation			
Bout Duration and Number of Bouts	4 min x 3	4 min x 3	4 min x 3
SSG Testing Order	Day 1 Group A (FP), Group B (MM), Group C (DMP)	Day 2 Group A (DMP), Group B (FP), Group C (MM)	Day 3 Group A (MM), Group B (DMP), Group C (FP)
Total Time (min)	12 min	12 min	12 min
Pitch Dimension (length x width) (m)	20 x 35	20 x 35	20 x 35
Relative Pitch Size (m^2)	1:116	1:116	1:116
Coach Encouragement	Yes	Yes	Yes
Goalkeeper	No	No	No

Heart rate monitoring

Heart rate (HR) is the most common measure of exercise intensity in many sports and, in several studies, HR has been proven to be a valid indicator of exercise intensity in soccer (Hill-Haas, et al., 2011). Participants' HR values were recorded at five-second bouts via individual short-range telemetry HR monitors (Polar Team Sports System, Polar Electro Oy, Finland) during SSG conditions and YYIR1. Maximal HR (HR_{max}) was recorded as the highest HR value achieved during the YYIR1. Game HR (HR) for each SSG was calculated by taking means from each bout session played. The $\%HR_{max}$ for each SSGs bout was calculated by using the following formula: $\%HR_{max}$ = (Average HR / HR_{max}) × 100

Time-motion characteristics

The physical movement patterns of the participants were recorded and stored by using a portable GPS device (SPI-Elite; GPSports, Canberra, Australia), and the stored data was transferred to computer for further analyses (SPI-Elite; GPSports, Team AMS software). This model provides reliable and acceptable accuracy for determining player motion (MacLeod, Morris, Nevill, & Sunderland, 2009) and has been used in previous SSG studies (Casamichana & Castellano, 2010). Total distance covered (TD) and distances covered in different speed categories were created for further analysis. The speed categories were: 0-6.9 $km{\cdot}h^{-1}$ (walking/stationary), 7.0-12.9 $km{\cdot}h^{-1}$ (low-intensity), 13.0-17.9 $km{\cdot}h^{-1}$ (medium-intensity) and >18 $km{\cdot}h^{-1}$ (high-intensity). These zones were also adopted in previous SSG studies (Casamichana & Castellano, 2010; Hill-Haas, et al., 2009; Impellizzeri, et al., 2006).

Blood lactate concentration (BLC)

Blood for BLC level determination was collected pre-testing and within 5 minutes after each bout session. Blood samples were collected from the finger tips, stored and analyzed immediately after testing (EKF Diagnostics, Biosen C-Line Sport). Before the tests, the analyzer was calibrated according to the manufacturer's instructions. BLC has been extensively used as an indicator of exercise intensity in soccer (Hill-Haas, et al., 2011), but it can be misrepresentative of exercise intensity due to the intermittent nature of soccer (Krustrup, Mohr, & Steensberg, 2006).

Session-rating of perceived exertion (session-RPE)

The session-RPE, as a good indicator, was employed to determine the global internal load of the players in SSGs (Impellizzeri, et al., 2004). At the end of each session, participants pointed at the approximation score that, in their opinion, best reflected the SSGs workload, by making use of Borg's CR10 scale (Borg, Hassmen, & Langerstrom, 1985). Also, at the end of all three SSG sessions, all participants were asked to state their mean session-RPE approximately 10 minutes after the game to represent the whole games (Ngo, et al., 2012). The data collection from each participant was done in isolation, away from the other participants. The mean perceived exertion was calculated by using post-bout ratings. During the two-week pre-season training, all participants were asked the same standardized question on their session-RPE to ensure they were familiar with this measure.

Statistical analysis

The data was interpreted in terms of means and standard deviations (M±SD). The Shapiro-Wilk's test was used to verify normal distribution, and Levene's test was applied to assess the homogeneity of variance. A one-way repeated measures analysis of variance (ANOVA) was used to test significance for HR, $\%HR_{max}$, BLC, session-RPE, TD and speed categories between FP, MM and DMP. The *post-hoc* Bonferroni test was also applied whenever any significant difference was found between FP, MM and DMP. For each ANOVA, partials eta squared were calculated as measures of effect size. Effect size values of 0–0.19, 0.20–0.49, 0.50–0.79, and 0.80 and above were considered to represent trivial, small, medium and large differences, respectively (Cohen, 1988). All statistical analyses were performed using SPSS 20.0 for Windows and the level of statistical significance was set at $p<.05$.

Results

Table 2 displays the average session-RPE values for the FP, MM and DMP conditions. There were significant differences between the FP, MM and DMP conditions in terms of session-RPE ($F=215.63$, $p=0.001$, $\eta^2=0.92$). Furthermore, *post-hoc* analysis indicated that the average session-RPE values for DMP were significantly ($p<.05$) higher than for the FP and MM, and the MM condition was also significantly ($p<.05$) higher compared to FP.

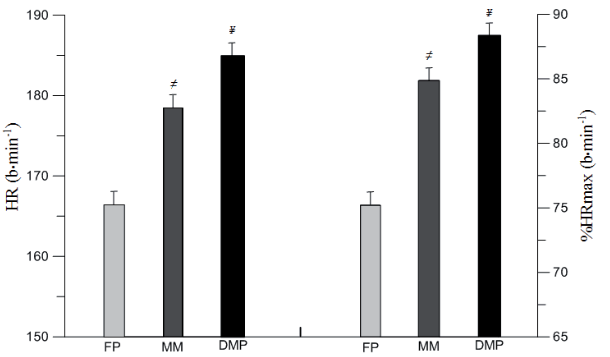
Table 2 displays HR and $\%HR_{max}$ values for the FP, MM and DMP conditions. Significant differences were found between the FP, MM and DMP in terms of HR ($F=10.10$; $p=0.001$; $\eta^2=0.37$) and $\%HR_{max}$ ($F=81.11$; $p=0.001$; $\eta^2=0.82$). Post-hoc analysis indicated that HR and $\%HR_{max}$ values for the DMP conditions were significantly ($p<.05$) higher than for the MM and FP conditions, and values for the MM condition were significantly ($p<.05$) higher than for the FP condition, as shown in Figure 1.

Table 2 displays the average BLC level for the FP, MM and DMP conditions. There were significant differences between the FP, MM and DMP conditions in terms of BLC ($F=23.82$, $p=0.001$, $\eta^2=0.58$). *Post-hoc* analysis indicated that the average BLC levels for DMP were significantly

Table 2. Average physiological values and time-motion characteristics of the soccer players in different small-sided game formats

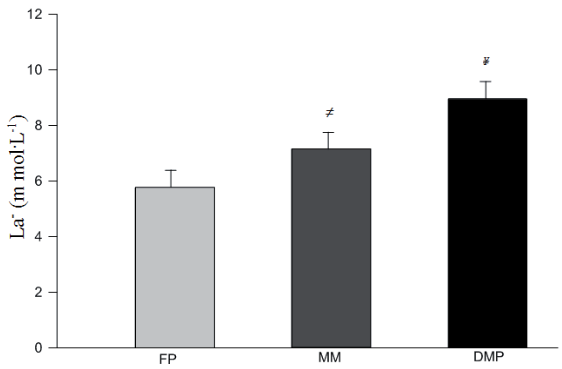
	Free play (FP)	Man-marking (MM)	Double-man pressure (DMP)	Post-Hoc Bonferroni test summary
HR ($b•min^{-1}$)	166.39±25.53	178.44±14.82≠	184.89±9.89¥	DMP>MM, FP; MM>FP
$\%HR_{max}$	75.00±7.34	84.83±4.73≠	88.50±2.28¥	DMP>MM, FP; MM>FP
Session-RPE	2.00±0.59	4.33±0.76≠	7.16±1.24¥	DMP>MM, FP; MM>FP
BLC ($mmol•L^{-1}$)	5.75±1.97	7.13±1.91≠	8.96±2.57¥	DMP>MM, FP; MM>FP
TD (m)	1612.25±140.78	1751.31±203.47≠	1783.55±192.12§	DMP>FP; MM>FP
DS/W 0-6,9 $km•h^{-1}$(m)	454.98±57.30	405.23±71.55	441.85±54.61	----
DLIR 7-12,9 $km•h^{-1}$(m)	795.03±134.16	834.31±104.30♯	731.71±95.03	MM>DMP
DMIR 13-17,9 $km•h^{-1}$(m)	314.55±87.34	437.60±182.10≠	484.86±168.73§	DMP>FP; MM>FP
DHIR >18 $km•h^{-1}$(m)	47.69±37.75	74.17±42.03≠	125.13±69.34¥	DMP>MM, FP; MM>FP

Values are given as means and standard deviations (±). HR: heart rate; %HRmax: percentage of maximum heart rate; Session-RPE: session-ratings of perceived exertion; BLC: blood lactate concentrations; TD: total distance covered; DS/W: distance stationary/walking; DLIR: distance low-intensity running; DMIR: distance medium-intensity running; DHIR: distance high-intensity running.
¥ significantly greater than MM and FP at p<.05.
♯ significantly greater than DMP at p<.05.
§ significantly greater than FP at p<.05.
≠ significantly greater than FP at p<.05.
> significantly greater at p<.05.



¥ significantly greater than MM and FP at p<.05.
≠ significantly greater than FP at p<.05.

Figure 1. Average heart rate (HR) and the percentage of maximum heart rate ($\%HR_{max}$) values for the soccer players during free play (FP), man-marking (MM) and double-man pressure (DMP) conditions.

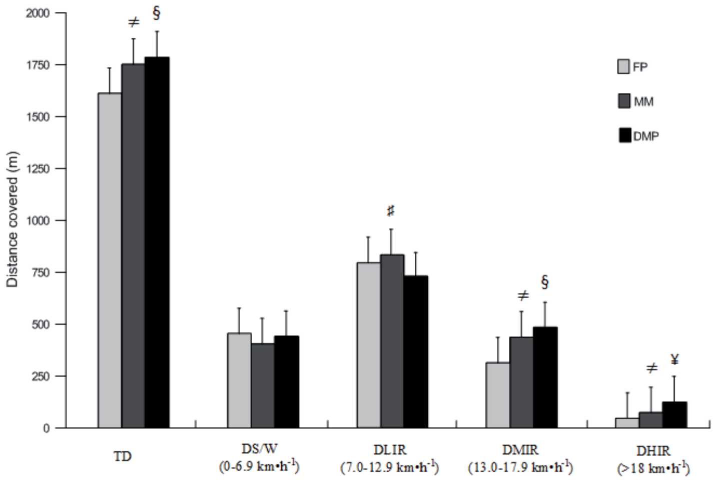


¥ significantly greater than MM and FP at p<.05.
≠ significantly greater than FP at p<.05.

Figure 2. Average blood lactate concentration (BLC) values for the soccer players during free play (FP), man-marking (MM) and double-man pressure (DMP) conditions.

(p<.05) higher than for FP and MM, and for the MM condition BLC was also significantly (p<.05) higher than for FP, as shown in Figure 2.

Table 2 displays total distance covered and the speed category values (0–6.9 $km·h^{-1}$, 7.0–12.9 $km·h^{-1}$, 13.0–17.9 $km·h^{-1}$ and >18 $km·h^{-1}$) for the FP, MM and DMP conditions. Significant differences were found between FP, MM and DMP in terms of TD (F=7.21; p=0.01; η^2=0.29). *Post-hoc* analysis indicated that TD covered during the MM and DMP conditions was significantly (p<.05) higher than during the FP condition; however, no significant difference was found between MM and DMP conditions. No significant effect was detected between FP, MM and DMP for stationary/walking distances (F=3.44; p=0.43; η^2=0.16), but a significant difference was detected for low-intensity running (F=4.67; p=0.01; η^2=0.21), medium-intensity running (F=7.60; p=0.02; η^2=0.30) and high-intensity running (F=13.67; p=0.01; η^2=0.44). Low-intensity running was significantly (p<.05) higher in the MM condition than in DMP and FP and no significance was found between the FP and DMP conditions. Values for medium-intensity running were significantly (p<.05) higher in DMP and MM conditions than the FP condition, however no significant difference was found between the MM and DMP conditions. Values for high-intensity running were significantly (p<.05) higher in the DMP condition than in MM and FP, and in the MM condition they were also significantly (p<.05) higher than in FP, as shown in Figure 3.



¥ significantly greater than FP and MM at p<.05.
♯ significantly greater than DMP at p<.05.
≠ significantly greater than FP at p<.05.
§ significantly greater than FP at p<.05.

Figure 3. Total distance covered (TD) and distance covered in different moving speed categories (DS/W: distance stationary/walking, 0-6.9 km˙h-1; DLIR: distance low-intensity running, 7.0-12.9 km˙h-1; DMIR: distance medium-intensity running, 13.0-17.9 km˙h-1; and DHIR: distance high-intensity running, >18 km˙h-1) for the soccer players during free play (FP), man-marking (MM) and double-man pressure (DMP) conditions.

Discussion and conclusions

The main aim of this study was to investigate physiological strain and physical demands of soccer-specific rules (MM and DMP) during SSGs training sessions. The results of this study demonstrate that adopting tactical rules such as MM and DMP in SSG protocols significantly increases the physiological and physical load imposed on the participants.

Rule changes are frequently used in SSG designs to achieve greater exercise intensity (Casamichana & Castellano, 2010) or develop technical (Dellal, Lago-Penas, Wong, & Chamari, 2011) and tactical ability (Owen, Twist, & Ford, 2004; Impellizzeri, et al., 2006; Jones & Drust, 2007; Hill-Hass, et al., 2011). Likewise, changing factors such as the number of players, the rules of the game, the size of the pitch, and coach encouragement affect the results of SSG training designs (Aguiar, et al., 2012; Casamichana & Castellano, 2010; Coutts, Rampinini, Marcora, Castagna, & Impellizzeri, 2009; Hill-Haas, et al., 2008, 2009; Impellizzeri, et al., 2006; Jones & Drust, 2007; Little & Williams, 2007; Owen, et al., 2004; Rampinini, et al., 2007). To our knowledge, no existing research has observed physiological load and time-motion characteristics of DMP, a frequently occurring scenario that creates outnumbered situations in competitive soccer games.

This study has demonstrated that DMP imposes greater physiological strain on the players than MM and FP. During the DMP condition, HR, $\%HR_{max}$, BLC and session-RPE values were significantly higher than during MM and FP. The significant increase in the physiological load on the players could be due to multiple causes. In general, the findings indicate that the reduction of the number of players increases average heart rate, the concentration of lactic acid and the RPE values (Brandes, Heitmann, & Muller, 2012; Rampinini, et al., 2007). This can be explained by the fact that, in small groups, each player takes more initiative and that can cause increases in physiological indicators. Another important factor mentioned above is the coach encouragement. In order to maintain motivational levels, consistent coaching encouragement was present during the SSG sessions (Rampinini, et al., 2007). It is suggested that direct supervision and coaching with active and consistent encouragement increases training intensity and performance measures (Hill-Haas, et al., 2011). For example, Rampinini et al. (2007) reported higher values for HR, BLC and RPE with consistent encouragement and Sampaio et al. (2007) found a significant increase in RPE due to verbal encouragement by the coach. In our study, consistent coach encouragement was used throughout all games in order to maintain this variable constant and to achieve the maximum player performance. In this way, the discrepancies among player performances in different games were minimized.

The present study findings indicate that MM and DMP rules lead to significant increases in HR, $\%HR_{max}$ and BLC regardless of the pitch size. Our study differs from other studies that relied on pitch size alterations such as the study that was conducted by Köklü et al. (2013) with changing pitch sizes. Their findings concluded that "an increased pitch size per player results in increased physiological responses during SSGs". Playing on larger pitches increases the pitch ratio per player and the run distance. In our study, the pitch size was not altered. Therefore, the increases in HR, $\%HR_{max}$ and BLC were thus caused solely by MM and DMP, which gave the same effect of covering more area and distance. In short, applying intensive marking during SSGs can eliminate the need of altering the pitch size. Nevertheless, the nature of modern football mostly limits play to small areas on which the players "are frequently required to make decisions under pressure and fatigue conditions" (Ngo, et al., 2012). The session-RPE values are also consistent with these findings. The results of our study further support the findings of other studies that demonstrated that the MM rule significantly increases the physiological load on the players in SSGs (Aroso, et al., 2004; Ngo, et al., 2012). Although these findings are in contrast with the findings of Sampaio et al. (2007), who reported that the MM rule significantly increased the perceptual variables, showing no significant effect on HR, Ngo et al. (2012) stated that the MM rule caused the defensive team to frequently close down the opponent, which resulted in fewer ball touches and attackers having to run more and perform quicker movements, potentially leading to a higher physiological load.

Although no significant effect was observed for stationary/walking distances between the groups, this study demonstrated that medium-intensity running was greater in the DMP and MM conditions than in FP. However, high-intensity running during the DMP condition was greater when compared to MM and FP. Therefore, the DMP and MM rules have a greater impact on medium-intensity running, yet, the DMP rule significantly increases high-intensity running compared to the MM rule, potentially leading to a higher physiological load than the MM and FP rules. Due to the intensity of the defensive pressure in the DMP rule, the players are forced to perform extra movements in an attempt to lose their markers and create space, thus possibly accounting for the increase in the physiological load. In a similar SSG study, it was reported that time-motion characteristics were not significantly different among the members of the numerically disadvantaged teams (Hill-Hass, et al., 2010). In this study, the application of any defensive pressure rules during the outnumbered condition could not be observed. Therefore, creating a numerical disadvantage may not increase time-motion characteristics unless defensive game rules are applied.

There was no significant difference between MM and DMP in TD covered; however, in both conditions TD values were significantly greater than in FP. Hill-Haas et al. (2010) attempted to increase high-intensity running and physiological load during SSG training by using artificial rules that made participants sprint around the pitch in order to increase work intensity. According to Casamichana and Castellano (2010), secondary emphasis should be on increasing work intensity and primary interest should be on technical and tactical aspects of the drill. The principle of specificity dictates that training environments are required to match competitive situations. This study has shown that DMP can be used as a soccer-specific rule in order to significantly increase intensity in SSGs drills while preserving specificity.

In conclusion, the present study revealed that the application of different defensive strategies during the small-sided games resulted in different physiological responses and time-motion characteristics in the games. In other words, when defensive pressure is intensified during SSGs, this significantly increases the physiological response and time-motion characteristics, especially high-intensity running. Therefore, the altered version of defensive strategies can also aid in improving aerobic and anaerobic development in a specific way. The application of these rules significantly increases total covered distance, but medium-intensity running and high-intensity running as well. The DMP rule, notably, has a significant effect on the increased work intensity and high-intensity running compared to the MM and FP conditions. Therefore, coaches and trainers can use the findings of this study to modify work intensity during SSGs training and further increase training specificity with the aid of soccer-specific rules.

This study excluded the use of goalkeepers, therefore future studies can probably observe the effects of defensive strategies on work-rate during SSGs different playing areas, different number of players and with the inclusion of goalkeepers.

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