Differences in U14 football players' performance between different small-sided conditioned games

Diferencias en el rendimiento de los jugadores de fútbol sub14 entre los diferentes variantes y condiciones en juegos con espacios reducidos

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Abstract

The aim of this study was to determine the effects of different formats and task conditions in small-sided conditioned games (SSCG) on young soccer players' heart rate responses and time-motion profiles. Ten young male soccer players (age: 14.6 ± 0.8 years old; and years of practice: 4 ± 1.2) from a regional league were tested. Each player played in two different formats namely 1 versus 1 with another 1 neutral player (i.e., *1v1+1*) and 2 versus 2 with another 1 neutral player (i.e., *2v2+1*), and three task conditions (T1 – no goal, T2 – no goal but endline, T3 – goal. Each SSCG lasted for 3 minutes with 3 minutes of passive recovery between SSCG. The heart rate responses, distance coverage, speed and acceleration were recorded throughout all SSCG. Results show that the format ($F_{(4,5403)}$ = 509.025; *p-value* = 0.001; n^2_p = 0.274; *Power* = 1.000; moderate effect size) and task conditions ($F_{(8,10808)}$ = 33.714; *p-value* = 0.001; n^2_p = 0.024; *Power* = 1.000; small effect size) were both significant factors on performance variables. The different formats and task conditions used in this study enable coaches to carry out a more specific training, helping them to understand the real effects of each variable on players' performance.

Key words: soccer; small-sided games; task constraints; performance.

Resumen

El objetivo de este estudio fue determinar los efectos de diferentes variantes y condiciones en juegos con espacios reducidos (SSCG) en relación a las respuestas de frecuencia cardíaca en jóvenes jugadores de fútbol y los perfiles de tiempo-movimiento. Se analizaron diez jóvenes jugadores de fútbol de sexo masculino (edad: 14,6 ± 0,8 años; años de práctica: 4 ± 1,2). Los jugadores participaban en una liga de nivel regional. Cada jugador participó en dos juegos reducidos diferentes, 1 contra 1 con 1 jugador-comodín (es decir, *1v1+1*), 2 contra 2 con 1 jugador-comodín (*2v2+1*), y tres condiciones en la tarea (T1: sin objetivo, T2: sin portería, pero hay que atravesar una línea final, T3: con portería). Cada SSCG tuvo una duración de 3 minutos con 3 minutos de recuperación pasiva entre SSCG. Las respuestas de la frecuencia cardiaca, la distancia recorrida, la velocidad y la aceleración se registraron a lo largo de todos los SSCG. Los resultados muestran que el tipo de juego ($F_{(4,5403)}$ = 509,025; *p-value* = 0,001; n^2_p = 0,274; Power = 1.000; con un tamaño del efecto moderado) y las tareas analizadas ($F_{(8,10808)}$ = 33.714; *p-value* = 0.001; n^2_p = 0,024; Power = 1,000; con un tamaño del efecto pequeño) fueron factores significativos en las variables de rendimiento. Los diferentes juegos reducidos y las condiciones de las tareas utilizadas en este estudio permiten a los entrenadores diseñar entrenamientos más específicos, ayudándoles a comprender los efectos reales de cada variable sobre el rendimiento de los jugadores.

Palabras clave: fútbol; juegos en espacios reducidos; restricciones de las tareas; rendimiento.

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Introduction

The use of small-sided conditioned games (SSCG) in soccer training has been assumed a great interest by scientific and coaches communities (Haas, Dawson, Impellizzeri, & Coutts, 2011). By their large ecology, SSCG are training tasks that mimic the specific characteristics of formal soccer game, and allow simultaneous development of multiple contents (Owen, Wong, Paul, & Dellal, 2013) such as technical, tactical, physical, physiological and even sociological elements (Chow, Davids, Button, Shuttleworth, Renshaw, & Araújo, 2006). Moreover, SSCG improve the specificity of learning that is relevant to game performance (Clemente, Couceiro, Martins, & Mendes, 2012). Likewise, to increase the players' perception about the specific contents projected by coaches it is a necessary stimulus that augments the information and attracts the players for a specific behavior (Davids, Araújo, & Shuttleworth, 2005).

Coaches can manage such stimulus by using task constraints (Newell, 1986). The task constraints are specific variables that coaches use to exaggerate the reality and to stimulate the players' behavior for a given outcome (Tan, Chow, & Davids, 2012). Among the multiple task constraints, the format of game, pitch size, bout duration, technical or tactical specific missions, number of consecutive touches on ball or passes, goal location and size, use of goalkeeper or the specific coaches' encouragements are commonly used (Haas et al., 2011; Aguiar, Botelho, Lago, Maças, & Sampaio, 2012). Despite of these multiple constraints that can be managed in many ways concurrently, the majority of studies in SSCG have been performed using the format of games, pitch size and bout duration (Casamichana, Castellano, González-Morán, García-Cueto, & García-López, 2011). In regard of the format, it has been found that SSCG with a smaller number of players significantly increased heart rate response, blood lactate concentration, perceived exertion and distance coverage (Haas, Dawson, Coutts, & Rowsell, 2009; Dellal, Haas, Lago-Penas, & Chamari, 2011). Moreover, higher heart rate response, blood lactate concentration and perceived exertion have been reported in small-sided games played on larger pitch area (Rampinini, Coutts, Castagna, Sassi, & Impellizzeri, 2007; Casamichana & Castellano, 2010). In addition, SSCG without goalkeepers (Sassi, Reilly, & Impellizzeri, 2004; Aroso, Rebelo, & Gomes-Pereira, 2004; Casamichana et al., 2011) and less number of touches have been shown to increase the intensity (Dellal, Lago-Penas, Wong, & Chamari, 2011).

Despite the aforementioned research findings, few studies have considered an integration of different formats concurrently with the use of other task conditions such as different goals (Casamichana et al., 2011). Nevertheless, such approach can be very important to improve the success on specific learning content. It is usual in coaching training sessions that the regular goals are replaced by smaller goals or even by lines (Mitchell, Oslin, & Griffin, 2006). In fact, from the pedagogical viewpoint, it is very important to increase the specificity of tactical behaviors such as penetration principle or offensive coverage (Costa, Garganta, Greco, Mesquita, & Seabra, 2010). Moreover, the heart rate responses and time-motion profile during such training are also very important but have not been massive studied.

In a study conducted by Castellano, Casamichana, & Dellal (2013) three constraints it were used in 3vs.3, 5vs.5 and 7vs.7: a) collective possession; b) with goalkeepers and regulation goals; and c) wit a small goal per team. Fourteen semiprofessional male soccer players participated in this study. Results showed that possession play increased physiological and physical demands on players, although reducing the format only increases the physiological load (Castellano et al., 2013). Lowest values of %HRmean it were found in games with a

small goal. In other study conducted by Gaudino, Alberti and Iaia (2014) two conditions were used in 5vs.5, 7vs.7 and 10vs.10 formats: a) possession of the ball; and b) with goalkeepers and regulation goals. The main findings revealed that total distance, distances run at high speed as well as absolute maximum velocity, maximum acceleration and maximum deceleration increased with pitch size and SSG with regular goal and goalkeeper (Gaudino et al., 2014). In a similar study, Dellal, Chamari, Pintus, Girard, Cotte, & Keller (2008) it was found that in 8vs.8 format, the presence of goalkeeper statistically increased the physiological demands. Recently, Clemente, Wong, Martins, and Mendes (2014) conducted a research in amateur football players, which used a game without goal, a game with two small goals and one game with only one small goal in three formats (2vs.2, 3vs.3 and 4vs.4). The smaller format (2vs.2) induced significantly greater values of technical/tactical indexes, 3vs.3 induced higher %HRres and 4vs.4 induced a greater distance covered. In 2vs.2 and 4vs.4 formats the game with only one small goal had highest values of %HRres and only in 3vs.3 the task with two small goals per team had highest %HRres (Clemente et al., 2014).

Despite of these reported studies, the majority of the research in SSCG it is performed in amateur or professional players and not in youth football players. For that reason, aim of this study is to determine the effects of format of game and task conditions on heart rate response, distance coverage, speed and acceleration profile in SSCG played by young soccer players. It was hypothesized that the heart rate response, distance coverage, speed and acceleration are greater in the smaller format SSCG. Furthermore, it was also hypothesized that SSCG with goals lead to lower intensity than those without a goal. Such rationale can be performed by previous studies that compared reduced size of goals with goals with goalkeeper.

Methods

Experimental Approach to the Problem

In this study, each young soccer player participated in two formats of SSCG (1v1 and 2v2) with three different task conditions (T1 – no goal, T2 – no goal but endline, T3 – goal). This study was carried out in 4 consecutive weeks, 3 SSCG was performed in each session. During the first and third weeks the players performed SSCG of 1 versus 1 with another 1 neutral player (i.e., *1v1+1*) in three different task conditions (i.e., T1, T2 and T3). On the second and fourth weeks they performed 2 versus 2 with another 1 neutral player (i.e., *2v2+1*) in three different task conditions. Therefore, each SSCG with same format and same task condition was repeated twice. The HR response and time-motion variables were recorded throughout all SSCG for further analysis. Specifically, data collection was conducted on Thursdays in order to ensure the best recovery between the matches. There was no training session on Wednesdays to further ensure 24 hours of recovery prior to data collection. All SSCG were conducted under similar weather condition: temperature ranged between $15°C$ and $19°C$, and relative humidity between 67% and 78%. All SSCG was performed in the same time of the day, in order to avoid any potential effects of circadian variation on players as recommended in previous studies (Dellal et al., 2008; Clemente et al., 2014). No problem it was verified with the satellites of GPS.

Subjects

Ten young male soccer players from Portuguese youth regional league (that no compete in national championship, but only in proximity to their town) voluntarily participated in this study. Players' age, years of practice, height, body mass, maximal aerobic capacity and resting heart rate were 14.6 ± 0.8 years old, 4 ± 1.2 years, 165 ± 6.3 cm, 58 ± 3.4 kg, 39.77 ±

4.62 ml.kg^{-1}.min^{-1}, 67.66 ± 8.12 bpm. Four defenders, three midfielders and three forwards constituted the sample. All players' parents signed the Free and Clarified Consent Form respecting the Helsinki Declaration. The study took place in October of season 2013-2014. Before the study, players had been training for 2 months period, carrying out soccer-specific training lasting between 70 and 80 minutes, 3 times a week with 1 match every week. All participants were informed that they were free to withdraw from the study at any time without any kind of penalty. The participants did not have any kind of physical or psychological diseases during the study period. Players were told to maintain normal daily food and water intake during the period of study. All players were familiarized with the experimental procedures and the requirements of the games before the commencement of study. In all testing sessions, players were allowed to take part in testing only if they had no signs of injury, illness or severe fatigue.

Small-sided Games

All SSCG had the same duration, which was lasted for 3 minutes. For each session, SSCG were conducted with the same format (i.e., same number of player) but using three different task conditions. During each training session, 3minutes of recovery were used between the three SSCG each performed with one task condition. The SSCG with *1v1+1* were played with field dimensions of 20x15m, whereas the *2v2+1* SSCG were played on 28x18m field. The field area per player was approximately $100m^2/player$ in all SSCG. In all SSCG the neutral player (+1) only provided coverage to the team with ball possession.

The three different task conditions were: T1: the aim was to maximize the ball possession time (Figure 1a) and there was no goal; T2: players was asked to cross the endline of opponents with the possession of the ball and there was no goal (Figure 1b); and T3: a small goal (2m of width and 1m of height) was placed on the team's end line and the aim was to score (Figure 1c).
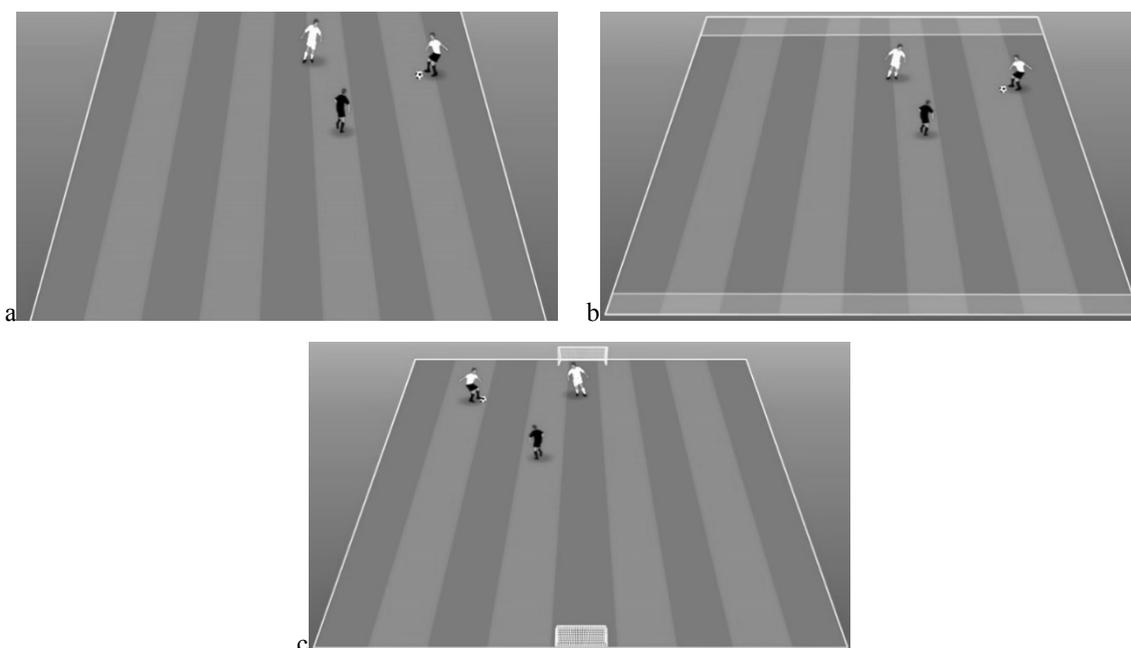
Legend: Player with white shirt and black shorts represents the neutral player

Figure 1. Three different task conditions used in this study: a) T1; b) T2; and c) T3.

All SSCG were preceded by a standardized warm-up period of 15 minutes followed by 3 minutes of passive recovery. During this period, players were informed to consume only water if needed. A large number of soccer balls were placed on the sideline to minimize the interruption of the SSCG. The heart rate levels it was checked during recovery in order to avoid the fatigue effect. During the three minutes it was ensure a decreasing in heart rate until 60% HRmax. Moreover, in order to avoid the fatigue effect for the data treatment, the sequence of tasks were made in random. It was executed a variance analysis between the results obtained in the random way and the one-way ANOVA showed no statistical differences ($F_{(2, 9)}$ = 0.798; *p-value* = 0.734; η^2 = 0.020; small effect size).

Heart Rate and time-motion measurement

The Yo-Yo intermittent recovery test (level 1) was used to estimate the HRmax of the players. The test consisted of 20-m runs repeated twice, which were back and forward between the starting, turning, and finishing lines, and progressively increased speed was controlled by audio beeps from a tape recorded (Köklü, Asçi, Koçak, Alemdaroglu, & Dündar, 2011). The test was performed in groups of 5 players. The heart rate was measured using the wireless heart rate transmission system (Polar RC3 GPS, Polar Electro, Finland) throughout the test at 1-second interval. The maximum heart rate achieved by each player in this test was collected. The maximal aerobic capacity was estimated from the Yo-Yo intermittent recovery test using the formula suggested by Bangsbo et al (1991). For the measure of resting heart rate, players rested comfortably during the recording for at least 10 minutes in a supine position and 7 minutes in a standing position in a quiet, semi-dark room, ensuring at a temperature of $20\ to\ 22°C$ (by using air conditioning system) as adopted by Gamelin, Berthoin, and Bosquet (2006). From this procedure the mean of three lowest heart rate values achieved by each player was collected by the wireless heart rate transmission system and considered the resting heart rate of the player.

Heart rate was continuously monitored during the SSCG at 1-second interval. After each testing session, all heart rate data were downloaded to a computer using the dedicated software (Polar WebSync and Polar Pro Trainer 5.0 software) and stored for further analysis. Intensity of SSCG was represented as percentage of heart rate reserve (%HRres) using the Karvonen's method (Janssen, 2001).

Time-motion characteristics were measured by the GPS system (Polar RC3 GPS, Polar Electro, Finland) during all SSCG. The total distance coverage (km) and the speed (m/s) were recorded at 1-second interval. Moreover, player's acceleration (m/s^2) was also calculated using the regular formula for such method reported in previous study (McGinnis, 2013). It was used the average of acceleration. Polar RC3 GPS training computer measurement accuracy is +/- 2% for distance and +/- 2km/h for speed.

Statistical Analyses

Data are mean (SD). The main and interaction effects of "format" and "task condition" on the %HRres, total distance coverage, speed and acceleration were examined by using two-way MANOVA after validation of normality and homogeneity assumptions. When MANOVA detected significant statistical differences between the two factors, two-way ANOVA for each dependent variable were then used. Tukey's HSD was used for post hoc comparisons. The following scale was used to classify the effect size (partial eta square) of the test (Lakens, 2013): small, 0.2-0.49; moderate, 0.50–0.79; large, 0.80–1. All of the statistical analysis was

performed using *IBM SPSS Statistics* (version 21), and statistical significance was set at p<0.05.

Results

Descriptive statistics of heart rate responses and time-motion profiles during 2 formats and 3 task conditions were reported in Table 1 and 2. A graphical representation can be observed in the Figure 2.
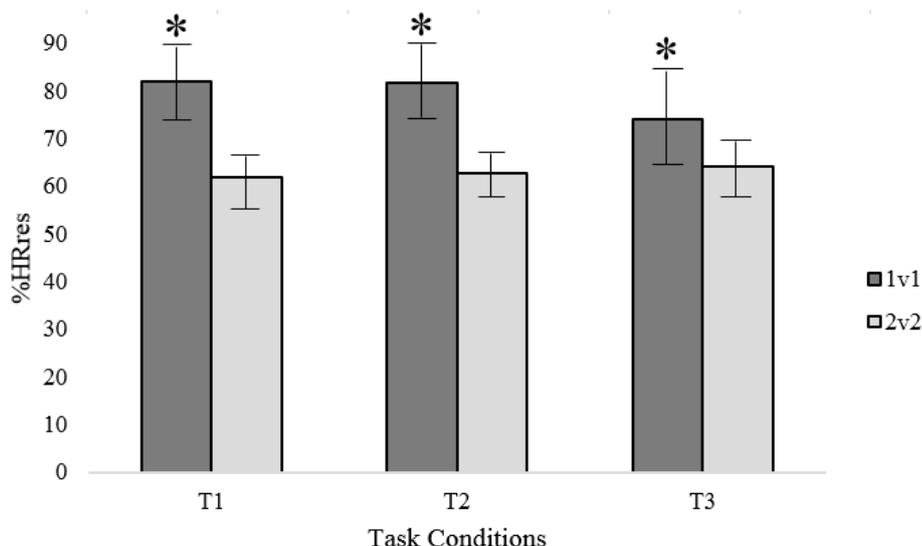
* Significantly higher than 2v2 (p-value = 0.001)

Figure 2. Comparison of heart rate responses between formats and task conditions

Two-way MANOVA results revealed that the format had significant main effects and moderate effect size (*Pillai's Trace* = 0.274; $F_{(4,5403)}$ = 509.025; *p-value* = 0.001; η_p^2 = 0.274; *Power* = 1.000) on heart rate responses and time-motion profiles. The task conditions had a significant main effects and a small effect size (*Pillai's Trace* = 0.049; $F_{(8,10808)}$ = 33.714; *p-value* = 0.001; η_p^2 = 0.024; *Power* = 1.000) on heart rate responses and time-motion profiles. Finally, significant interaction effects between the two factors on heart rate responses and time-motion profiles were observed (*Pillai's Trace* = 0.030; $F_{(8,10808)}$ = 20.634; *p-value* = 0.001; η_p^2= 0.015; *Power* = 1.000).

Table 1. Comparison of heart rate responses and time-motion profiles between formats. Values are average of the three task conditions.

	1v1+1	2v2+1
%HRres	79.20 (18.71)[b]	62.96 (13.14)[a]
Distance Coverage (km)	0.28 (0.09)	0.22 (0.09)[a]
Speed (m/s)	1.53 (0.84)[b]	1.21 (0.73)[a]
Acceleration (m/s^2)	0.19 (0.63)[b]	0.16 (0.25)[a]

Significantly different compared to 1v1+1[a]; and 2v2+1[b] at p<0.05

After observing the significance of the format and the task conditions in MANOVA, an univariate ANOVA analysis and relevant post hoc comparisons were performed for each dependent variable. As compared to 2v2+1 (Figure 2), significant higher values were found during 1v1+1 for %HRres ($F_{(1, 5406)}$ = 1452.119; *p-value* = 0.001; η^2 = 0.212; *Power* = 1.000; moderate effect size); speed ($F_{(1, 5406)}$ = 225.178; *p-value* = 0.001; η^2 = 0.040; *Power* = 1.000; small effect size); and acceleration ($F_{(1, 5406)}$ = 5.002; *p-value* = 0.025; η^2 = 0.001; *Power* = 0.609; small effect size). No significant differences were found between the two formats in distance coverage ($F_{(1, 5406)}$ = 0.000; *p-value* = 0.947; η^2 = 0.000; *Power* = 0.050; very small effect size).

Table 2. Comparison of heart rate responses and time-motion profiles between three task conditions. Values are average of the two formats.

	T1	T2	T3
%HRres	70.80 (17.67)[c]	71.07 (17.23)[c]	68.89 (18.52)[a,b]
Distance Coverage (km)	0.23 (0.07)[b,c]	0.25 (0.10)[a,c]	0.26 (0.09)[a,b]
Speed (m/s)	1.25 (0.62)[b,c]	1.38 (0.79)[a]	1.42 (0.93)[a]
Acceleration (m/s^2)	0.11 (0.20)[b,c]	0.18 (0.56)[a,c]	0.23 (0.52)[a,b]

Significantly different compared to T1[a]; T2[b]; and T3[c] at p<0.05

Comparison of heart rate responses and time-motion profiles between three task conditions were indicated in Table 2. Significant differences were found in between the three task conditions for %HRres ($F_{(2, 5406)}$ = 23.285; *p-value* = 0.001; η^2 = 0.009; *Power* = 1.000; very small effect size); distance coverage ($F_{(2, 5406)}$ = 58.850; *p-value* = 0.001; η^2 = 0.021; *Power* = 1.000; small effect size); speed ($F_{(2, 5406)}$ = 20.088; *p-value* = 0.001; η^2 = 0.007; *Power* = 1.000; very small effect size); and acceleration ($F_{(2, 5406)}$ = 31.817; *p-value* = 0.001; η^2 = 0.012; *Power* = 1.000; small effect). There are higher values of %HRres in T2 and lowest in T3 (*p-value* = 0.001). It was also found that higher values of distance coverage in T2 and lowest in T1 (*p-value* = 0.003). Moreover, the higher values of speed and acceleration were performed in T3 and the lowest in T1 (*p-value* = 0.001).

Discussion

The aim of this study was to examine the effects of different formats and different task conditions during SSCG on the HR responses and time-motion profiles in young soccer players. This study found that the smaller formats (i.e., 1v1+1) significantly increased the heart rate responses. In addition, higher values in speed and acceleration were observed with the presence of goal as compared with no goal.

Results of the present study were in line with previous studies performed in professional soccer players (Owen, Twist, & Ford, 2004; Williams & Owen, 2007; Dellal et al., 2011). In fact, previous studies reported that SSCG with small number of players induced values of around 90%HRmax (Little & Williams, 2007) or between 80% and 90%HRmax (Haas et al., 2009; Köklü, 2012) in professional players. In the present study the values ranges between 61 - 82%HRres. Such differences could be attributed to the different technical levels and physiological conditions of young players as compared with professional or amateur players, as well as the difference between %HRmax (Haas et al., 2009; Köklü, 2012) and %HRres (Dellal et al., 2011) being used in various studies

Our results were also in line with the literature (Allen, Butterfly, Welsh, & Wood, 1998; Jones & Drust, 2007; Romero, Paredes, Sancho, & Morencos, 2012) in that higher distance coverage, speed and acceleration were found in SSCG with smaller format, i.e., 1v1+1. Despite few studies (Allen et al., 1998; Romero et al., 2012) have shown statistical differences, in general the mean values of such time-motion variables were greater in the smaller games (Aguiar et al., 2012). In this study, the speed and acceleration were significantly higher during the 1v1+1 SSCG as compared to 2v2+1. Such result can be associated with the greater individual participation during the SSCG in 1v1+1. In this regard, it has been found that higher intensity and more movements such as turns, jumps, accelerates and brakes were performed when smaller number of players were used in SSCG (Aroso et al., 2004).

In this study, we also examined the effects of three common task conditions. Usually, task conditions are used during SSCG to incorporate the tactical content for young players (Mitchell, Oslin, & Griffin, 2006). In that sense, one task condition was given to each SSCG. The use of one neutral player in all SSCG aimed to increase the offensive successfulness that is one of the common methods in coaching session. Higher values of %HRres and distance coverage were achieved in T2 that endline rather than goal was used. Despite of few number of studies that inspected such task condition, it was possible to compare with the study of Mallo and Navarro (2008). In their study it was concluded that the inclusion of goal and goalkeeper decrease the heart rate responses and distance covered in comparison with games performed without a goal. Similar results were found by Casamichana et al. (2011). In other study using three types of goal, Duarte et al (2010) also showed that the games without goal increased the heart rate stimulation and their variability in comparison with games with reduced size of goals. Therefore, in this study using young players, the results of heart rate responses with different task constraints were in line with similar studies using different goals (Mallo & Navarro, 2008; Duarte et al., 2010; Casamichana et al., 2011). The speed and acceleration were higher in T3, *i.e.*, with a goal. These values can be explained by the higher number of movements such as turns, breaks and accelerations that increase the variability of speed (Aroso et al., 2004).

This study had some limitations based on the small sample used. In the future it is important to add a bigger range of players in order to generalize the conclusions. Another limitation it was the GPS, which it was not possible to confirm the number of satellites per each data collecting, what can represent a small variance in the positional data. Another limitation of this study it was not to inspect the technical and tactical performance of players. Using such information would be possible to identify why physical and physiological changes based on technical and tactical profile of players. A study that cross physiological, physical and technical/tactical analysis in young football players will help to better understand the real effects of different task constraints in small-sided an conditioned games.

Conclusion

In this study using young soccer players, it was found that a smaller format increases the heart rate responses as well as the time-motion profiles in SSCG. Moreover, SSCG without a goal increase the intensity of action measured by heart rate responses. Such results can be important and useful to optimize soccer training, particularly in young players. The use of smaller formats of game increases the heart rate possibly due to the higher individual participation of each player. Therefore, coaches of young players need to pay more attention on the fatigue signals, mainly when the major content of game is to develop specific tactical

behavior or technical action. Nevertheless, if the main purpose is to develop the anaerobic fitness of players, coaches can use formats such as 1v1 or 2v2 without goal to increase the intensity of exercise. In this study, the goal in the form of endline induced the highest heart rate responses. The use of endline decreases the defensive organization, increasing the individual attempts to finalize the offensive process. Therefore, in the context of young football players such activities makes this task one of the most intense for players by the rapid movements of tactical behaviors and technical actions.

Acknowledgments

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