Original article (short paper)

The effect of the maintaining the ball possession on the intensity of games

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Abstract—The use of small-sided games (SSG) for soccer training has increased considerably in recent years. Tactical principles can influence the intensity and the movement of soccer players during training. The aim of this study was to evaluate the influence of maintaining possession of the ball on the intensity and the time of motion characteristics of players during training in games. Eleven athletes of the U-20 category of a professional club in São Paulo, Brazil, participated in this study. To check the influence of the tactical principle, we used a game control and an experimental game in three different field dimensions and number of players. The results show that possession of the maintenance rule influences the intensity of the games ($p<0.05$). However, it is concluded that the rule is fundamental for training through games.

Keywords: soccer, training, small-sided games.

Introduction

Soccer is one of the most popular sports in the world, despite its creation spanning over hundreds of years, there are still many doubts about its physiological, technical, biomechanical and psychological requirements. These questions may be explained by the fact that its initial training was influenced and developed through individual sports (Aguiar, Botelho, Lago, Macas, & Sampaio, 2012). However, with the technological and scientific developments applied to soccer, it has been recognized the need to develop training and evaluations that respect the principle of specificity (Bangsbo, Norregaard, & Thorso, 1991; Hoff, Wisloff, Engen, Kemi, & Helgerud, 2002; Kelly, Gregson, Reilly, & Drust, 2013; Kemi, Hoff, Engen, Helgerud, & Wisloff, 2003; Stolen, Chamari, Castagna, & Wisloff, 2005). In recent years, studies with small-sided games (SSG) have increased considerably; several studies point out the importance of the training of soccer players through SSG, since they are able to develop the technical, physical and tactical aspects in addition to respecting the specificity of the training (Bloomfield, Polman, O'Donoghue, & McNaughton, 2007; Dellal *et al.*, 2008; Eniseler, 2005; Hill-Haas, Dawson, Impellizzeri, & Coutts, 2011; Impellizzeri *et al.*, 2006; Rampinini *et al.*, 2007; Reilly, 2005; Scaglia, Reverdito.R., Leonardo, & Lizana, 2013).

In sports training, the monitoring of the training intensities is essential. Nowadays, it is possible to know the internal responses (heart rate and lactate concentration [La]) and the external responses, such as the distances covered in official games and in training (Gabbett & Mulvey, 2008; Hill-Haas, Rowsell, Dawson, & Coutts, 2009; Spencer *et al.*, 2004). Several studies have been examining the lactate concentration [La] to control the individual loads of athletes during research studies (Aguiar, Botelho, Goncalves, & Sampaio, 2013; Coutts, Rampinini, Marcora, Castagna, & Impellizzeri, 2009; Eniseler, 2005; Harrison, Gill, Kinugasa, & Kilding, 2013; Koklu, Sert, Alemdaroglu, & Arslan, 2013). However, it is known that lactate concentration, according to the studies of Bangsbo (1994), has a strong correlation with the latest efforts prior to blood collection. Thus, to assess the movement of the players on the field, the General Positioning System (GPS) is the most largely used tool in practices and well recognized in the research field because of its speed in data visualization (Hill-Haas, Coutts, Dawson, & Rowsell, 2010; Hill-Haas *et al.*, 2011; Hill-Haas *et al.*, 2009). On the other hand, methodological limitations exist since it is necessary to be careful with the data on collective activities with changes of direction and velocities above 20 km/h,

where the accuracy is not high for a critical analysis (Coutts & Duffield, 2010; Johnston *et al.*, 2012). Those speeds in small- and medium-sized games are often not reached, however, on official fields, these velocities are frequently reached.

Another tool used to assess the movement of the players is the video analysis through shooting with digital cameras (Gabbett & Mulvey, 2008). According to Barros (2007), the kinematic analysis for soccer players can offer useful information on their movement in games. Thus, the videogrammetry, because of its accuracy of data, has been reported to be an excellent tool for the study of the movement of players (Figueroa, Leite, & Barros, 2003). One of the most studied variables is the total distance covered. However, it is not enough to know only the total distance, but rather at what intensity they are covered, since athletes can cover the same distance at different intensities (Bangsbo, 1994; Gabbett & Mulvey, 2008). Consequently, it is believed that the Ventilatory Threshold (VT) of each athlete is a great variable to characterize individually the intensity of different games. Through the videogrammetry and the functions developed in the Matlab system, we can know the velocity ranges that athletes travel during games and, when correlating them with the ventilatory threshold (VT) test proposed by Lourenço *et al.*,(2011), individually establish four different intensity ranges (low intensity, moderate intensity, moderate/high and high intensity). Without knowing the velocity of the VT (VVT) of each athlete, it becomes difficult to carry out a controlled individualized training, since for some players the effort can be of high intensity, while for others, only of moderate intensity.

Several studies point out that the rules, the size of the field, the absence of goalkeepers and the number of players directly influence the intensity and time motion characteristics of the athletes during the SSG (Brandes, Heitmann, & Muller, 2012; Castellano, Casamichana, & Dellal, 2013; Coutts *et al.*, 2009; Hill-Haas, Coutts, Rowsell, & Dawson, 2009; Hodgson, Akenhead, & Thomas, 2014; Kelly *et al.*, 2013; Koklu *et al.*, 2013). However, there are many variables in a single game, it is difficult to identify which directly interferes in the intensity and movement of the players. Therefore, the aim of this study was to examine the influence of the rules, with the tactical principle of maintaining ball possession, in the control of the intensity of efforts and time motion characteristics of players during training in small-, medium- and large-sided games. The application of this work is to determine the effect of the rules change on the intensity and time motion characteristics of soccer players, since the manipulation of these rules should be well planned by the coaching staff to avoid negative adjustments on the team.

Methods

Experimental design

The design protocol lasted 12 days for each set of experimental analysis. In the first and second days, anthropometric assessment and the incremental treadmill test to determine the VT proposed by Lourenço *et al.*, (2011) were assessed. In the third, fourth, fifth and sixth days, the athletes went through a period of familiarization to the games used in the research, they practiced the games for ten minutes before the training sessions. In the seventh and ninth days, in the afternoon, the athletes were submitted to 3x3+G and 6x6+G SSG only with the official FIFA rules. In the eighth and tenth days, following the same schedules as the previous collections, the 3x3+G and 6x6+G SSG happened, respectively, with the effort rule to promote the tactical principle of maintaining possession (MP). In the eleventh and twelfth days, the 10x10+G control and 10x10+G experimental games were carried out. The control and experimental games were placed on alternate days avoiding an adaptation of the athletes to the MP rules. The game collections occurred in the first two days of the week allowing a resting period to the athletes to the championship game that happened on Saturday mornings.

Subjects

Eleven junior soccer players of the U-20 category (age 18±1.2) belonging to a federated Club in São Paulo, Brazil, all with a minimum of five years of experience in the sport, accepted to participate in the study. The measures of body mass (BM) and height (HT) were performed in a digital scale equipped with stadiometer, brand Welmi®. For fat percentage (F%), we chose to register the subscapular, tricipital, biceptal, pectoral, suprailiac, midaxillary, abdominal, thigh and calf skinfolds using an adipometer (brand Lange®). The calculations were done through the Jackson and Pollock Protocol (1978). The characterization of the sample can be seen in Table 1. This study was approved by the Research Ethics Committee of the School of Medical Sciences of UNICAMP, on 11/Feb/2012 (Opinion No. 208.298 and CAAE: 10855212.2.0000.5404).

Table 1. Characterization of the sample.

Subjects (n=11)	Body mass (Kg)	Height (cm)	Fat mass (%)	Vel. Vo2max (Km/h)	Vel. Threshold (Km/h)
Values	66.58± 7.75	174.04 ± 6.93	10.90 ± 2.90	16.50± 1.19	10.82± 3.22

Procedures

Description of the small-sided games: For the analysis of the games, we adopted two fields: control and experimental, with different sizes and number of players. The formats of the games used are described in Table 2. The games on the control field were carried out without external rules, only with the FIFA ones, including the offside rule; in the experimental field, some external rules were inserted to facilitate the tactical principle of maintaining the ball possession. They are:

- Only two touches on the ball, and every extra touch means a point to the opponent;
- Taking the ball from one sideline to the other one means one point;

- Exchanging five passes in the offensive field (after the midfield) means two points;
- Goal (only allowed after the exchange of five passes) means eight points.

The rule that limits the number of touches on the ball, despite being a rule that contrasts with that one which determines the number of passes required for shot on the opponent's goal (Almeida, Ferreira, & Volossovitch, 2012), when used together in a game, do not mischaracterize the prevalence of positional attacks, where teams tend to maintain the ball possession, as can be seen in the study of Lizana *et al.*,(2015). The dynamic of soccer matches has increased over the last years; therefore, the teams and players must seek not only maintain ball possession, but also search to quickly circulate the ball for the purpose of unbalancing the defense organization of the opponent´s team.

Table 2. Format of the fields where the games took place.

	Format		
	3x3+G	**6x6+G**	**10x10+G**
Size	27x18m	32x52m	105x64
Total Area	486m	1664m	6720m²
Area per player	61m²	119m²	305m²
Goal	Official	Official	Official
Game Time	30min	30min	30min

G - indicates the presence of goalkeepers.

Among the different matrices games proposed by Scaglia *et al.* (2013), the conceptual games allow manipulation of the structural references (ball, size of the field and targets) and functional (operational principles and rules of action). These changes emphasize the training of tactical principles, technical aspects and the various physical and physiological responses proposed by the coaching staff within the pedagogical and organizational planning previously, and so it could not faithfully respect the logic of the competitive game.

Therefore, coaches and/or members of the coaching staff must understand how the handling of certain constraints in low games, the rules may influence the modeling of specific tactical behavior, taking into account the playing style defined by the coach (Clemente, Couceiro, Martins, Ivanova, & Mendes, 2013). In this study the conceptual games were used to emphasize the tactical principle of maintenance of ball possession (Bayer, 1994).

The teams were separated by the coaching staff so that the teams were balanced in relation to player positions (defense, midfield and attack) and also in relation to the technical and physical quality of the players. To reduce the variability between subjects, the same teams faced each other in the control and experimental field on the three field dimensions. Altogether, twenty field athletes participated in the research study; however, we have considered only the players who participated in all games for the statistical analysis. To ensure that there was no interference in the intensity of the games, a statistical analysis was made in relation to the total distance covered between the voluntary players and the sample. No significant difference was found between the groups (p<0.05).

Incremental treadmill test: Ventilatory Threshold was determined by the incremental treadmill test proposed by Lourenço *et al.* (2011), in which, at the beginning of the test, the athletes performed a three-minute warm-up running at 8–8.5 km/h on the treadmill (Inbrasport ATL, 2000). The initial speed was 9 km/h and slope of 1%. The increase was 0.3 km/h every 25 seconds. The test was performed until voluntary exhaustion, during which it was continuously monitored the variables: heart rate (Polar RS100), oxygen consumption (VO_2), carbon dioxide production (VCO_2) and respiratory exchange ratio (RER). The cardiorespiratory parameters (VO_2, VCO_2 and RER) were measured breath by breath through a gas analyzer (CPX/D Med Graphics, St. Paul, MN). Immediately after exhaustion, the participants underwent a recovery test, in which the speed of the treadmill was decreased every minute to 60%, 55%, 50%, 45% and 40% of the maximum velocity reached.

For the visual determination of the VT, we used the V-slope method, which consists in the characterization of VT by loss of linearity of VCO_2/VO_2. The respiratory compensation point (RCP) was also determined by visual inspection, which consists in the loss of linearity of the VE/VCO2 ratio. Therefore, we collected the variables Ventilatory threshold (VT), Velocity of the ventilatory threshold ($_V$VT), Heart rate of the ventilatory threshold (HRvt), VO2max, Velocity of VO_2max ($_V VO_2$max), VO_2max heart rate (VO_2maxHR), which allows us to establish four training ranges, stratified by the low intensity below the Threshold, the moderate intensity between VT1 and peak respiratory compensation (PRC), the moderate/high between PRC and Ventilatory Threshold2 and the high intensity above the Ventilatory Threshold2 (VT2).

Data collection and kinematics analyses: The footage of the games was recorded with digital video cameras, with the NTSC standard and 30 Hz of acquisition rate. The cameras were positioned on the highest point of the bleachers, in a fixed position during the entire game, in order to fit the entire playing field. After filming, the sequences of images from each camera were transferred to the computer's hard drive (computer Intel® Core ™ i7-2600k, 3.40GHz, RAM memory, 16 GB, video card NVIDIA GeForce 9500 GT). The file format used is the AVCHD (Advanced Video Codec High Definition) with the resolution of 1080 lines per 1980 columns.

The study of the movement of the soccer players was carried out independent of the size of the body or rotational movements hence it is important that the description of the position of the player is made from the location of a single point (Misuta, Menezes, Figueroa, Cunha, & Barros, 2005). Obtaining the position of the player on the field consists primarily in knowing the relationship between the screen coordinates (x, y) and the reference system associated with the field. Thus, the calibration of each camera was made from at least four known points in the coordinate system associated with the field and their corresponding coordinates in the image. The calibration and two-dimensional (2D) reconstruction method used was proposed by Abdel-Aziz, Karara (1971), named DLT (Direct Linear Transformation).

Through this screening, it was obtained the physical variables: total distance covered, maximum velocities and partial

distance, divided into velocity ranges according to the assessment of VT. The functions to determine the physical variables were developed in the Matlab 7.0 system.

Statistical analysis

The Matlab 7.0 system was used for the elaboration of the functions related to the physical variables, such as total distance covered, maximum velocities, intervals between high intensity efforts, amount of high intensity efforts and distances covered at different velocity ranges according to the assessment of the VT of the athletes. The values are expressed as mean and standard deviation. The distribution of the data normality was verified by the Shapiro-Wilk test. After confirming that the data was parametric, we used the *t*-Student test and the value of $p<0.05$ was considered statistically significant. The data were analyzed paired, comparing the variables within the same field size.

Results

Ventilatory Threshold

Figure 1 illustrates a significant difference between the control and experimental fields; on the 3x3+G control games, the athletes covered an average of 141.5±55.3m at high intensity, and just 101.6±55.6m on the experimental games. In the 6x6+G games, the total distance covered at high intensity was 389±179.6m (on the control field) and 175.8±65.3 m (on the experimental field). For the 10x10+G fields, it was found that the average of the total distance covered at high intensity was 560.5±165.9 m for the control field and 361±135.1 m for the experimental field. The distances covered below the VT, regarded as of low intensity, were significantly increase between the 10x10+G control and experimental games, in which the athletes covered 2182.8± 169.3m in the control field and 2302.8±203.1 m in the experimental field.

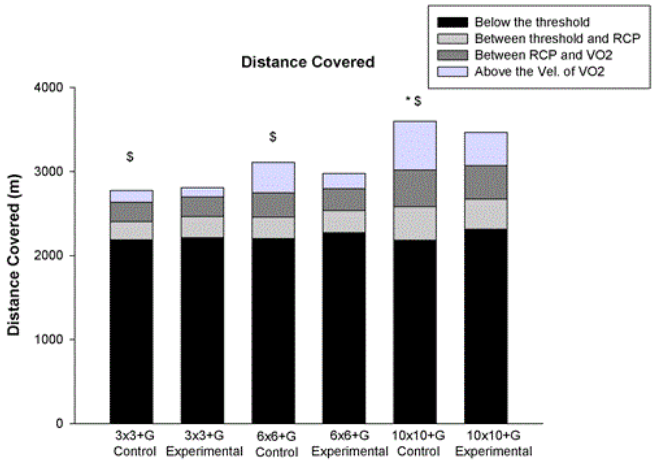

Figure 1. Comparison between the distances covered at different velocity ranges between the control and experimental fields.

$ points to a significant difference in the distances covered at hight intensity between the control and experimental fields ($p<0,05$).
*demonstrate significant differences in the distances covered at low intensity between the control and experimental fields ($p<0,05$).Insert here Figure 1

Figure 2 presents the significant increase in the distance of the high intensity efforts between the 6x6+G control and experimental games, in which the distance of the efforts was 10.7±1.15m in the control field and 9.4±1.0m in the experimental field ($p<0.05$). Similarly, we found in the 10x10+G games, in which the distance was 14±1.71m in the control field and 11.8±1.56m in the experimental field. In the 3x3+G games, no significant difference was seen in the distance of the high intensity efforts. At maximum velocity, there is a significant increase between the 3x3+G control and experimental games, in which the maximum velocity was of 7.15±0.4m/s in the control field and 6.4±0.3m/s in the experimental field. Higher maximum velocity was also found in the 6x6+G games for control field, which was 8.2±0.7m/s and 6.9±0.6m/s in the control field and in the experimental field, respectively. In the 10x10+G games, no significant difference was found for the maximum velocity.

In relation to the amount of high intensity efforts, we can verify a significant increase between the control and experimental fields for the 3x3+G and 6x6+G games. The athletes performed on average 29.2±9.4 high intensity efforts in the 3x3+G control game, and 23.4±10.4 in the 3x3+G experimental game ($p<0.05$). This difference was also verified in the 6x6+G games, in which the athletes performed on average 45.8±18.5 high intensity efforts in the control field and 31.8±9.3 in the experimental field ($p<0.05$). In the 10x10+G fields, no significant difference was found regarding the amount of high intensity efforts. There was no significant difference between the intervals of high intensity efforts and the total distance covered in any of the games analyzed.

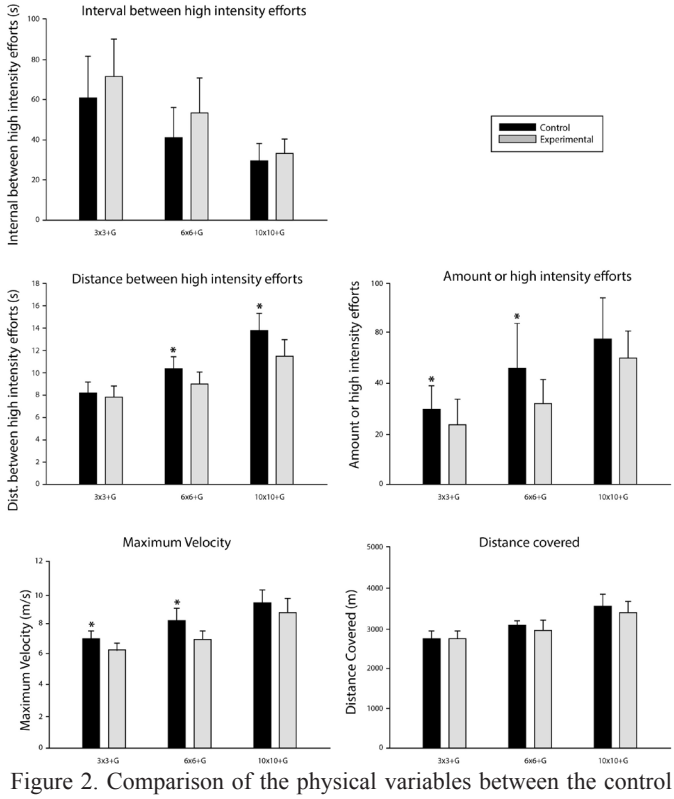

Figure 2. Comparison of the physical variables between the control and the experimental fields in the same field size.

*significant differences between the control and experimental fields ($p<0,05$).

Discussion

The aim of this study was to evaluate the influence of a single variable, i.e. the rule with the tactical principle of maintaining ball possession, in the control of the intensity of efforts and time motion characteristics of players during training in small-, medium- and large-sided games. The results indicate that there is a significant increase in the total distance covered at high intensity in the control field in relation to the experimental field in all fields evaluated, and they also point to significant increase in the distances of high intensity efforts, maximum velocity, and also in the number of such efforts. It is important to note that every time we refer to high intensity actions, we are analyzing the sprints; however, as the literature conceptualizes them above 18 km/h (Hill-Haas, Dawson, Coutts, & Rowsell, 2009; Koklu *et al.*, 2013), we prefer to classify the efforts according to the threshold test. Thus, every effort above the velocity of VO_2max was classified as a high intensity effort. For a better understanding and discussion of the results, we have adopted the 3x3+G games as small-sided games, the 6x6+G games as medium-sided games, and the 10x10+G games as large-sided games (Hodgson *et al.*, 2014; Owen, Wong D, Poul, & Dellal, 2013). Unlike the studies of Hill-Hass *et al.*,(2010), who used the rules to intensify the games, we believe that they have a key role in the development of the game model adopted by the coach and, thus, cannot simply be used to obtain physical results. They should establish the work with games, since the mere performance of these games, without the knowledge of the rules, can lead athletes to negative adjustments in the physical, technical and tactical aspects.

The physical, physiological, technical and tactical demands arising from the manipulation of the rules should be in accordance with the objectives proposed by the coaching staff. The stipulated rules must be designed to encourage and emphasize the aims of each training session. Thus, each of the small-sided games can provide different answers (technical, tactical, physical and physiological) due to the handling of certain rules. In addition, the rules often need to be modified during training to keep athletes in high state of concentration to the game, and ensure that the technical, tactical, physical and physiological objectives previously established are achieved.

Through conceptual games, the rules are intended to model the tactical behavior of the players and team. However, when considering the game as a complex environment, those rules will also influence the emergence of different physical and physiological stimuli to the players. Therefore, the coaching staff needs to be aware of the importance of training control leading to achieve all the objectives in an integrated manner.

The importance of the rules in the control of the physical variables could be observed, for example, on the amount of high intensity efforts, in which we can observe a significant difference between the medium-sided games, in which the athletes performed on average 45 high intensity efforts on the control field and only 31 on the experimental field. It is important to highlight that, although no significant difference was found on the interval between the high intensity efforts in the control fields, the interval between these efforts is an important variable in the effort/pause ratio and should be considered, as the smaller the interval time between one effort and another, the greater the physiological intensity of the athletes.

In the literature, it is well described the importance of the games for soccer training, because of their specificity in training, as well as the seamlessly development of the physical, technical and tactical aspects (Dellal *et al.*, 2012; Eniseler, 2005; Impellizzeri *et al.*, 2006). However, for a practical and scientific advancement, it is important to know the intensities in different games. That is why the control of training loads must be conducted individually. Since it is not enough only to know the distances covered, but rather at which intensities they are carried out, as the distance may not change in different games by several factors, but the intensities can be different. In this study, when analyzing the total distance covered in small-, medium- and large-sided games between the control and experimental fields, we did not find significant differences. However, when dividing the total distance covered into intensity ranges, we can note that there is a significant difference in the distances covered at high intensity between the control and experimental fields in the three field sizes studied. These results corroborated with the studies of Hill-Haas *et al.*,(2009); although the author evaluated the influence of the field size. He found no difference in the total distance covered, but the intensity of the efforts was significantly different, since the distances covered above 18 km/h were higher in medium fields in relation to small fields. That is why it is essential to evaluate the intensity of the efforts and not only the distances covered. The author in his experiments used an external rule to intensify the games, in which the whole team needed to walk past the midfield to validate the goal. With this rule, the game automatically becomes more positioned, less individualized and more collective; by becoming a collective team, the athletes remain closer and more compressed and therefore do not need to run long distances to perform an offensive or defensive effort.

The significant difference in the distances covered at low intensity in large-sided games is another important factor that reinforces the greater physiological intensity of fields without external rules. It reinforces that the intensity of the control field is greater than the experimental field, as the athletes covered less at low intensity, which means that they spent less time standing and or walking during the training. Therefore, they performed more moderate and high intensity efforts. This difference in the intensity of the efforts can be explained by the fact that the athletes do not have a game model in the absence of the effort rule, and even in the official field they play less positioned, making the game less structured and with a tactical disorganization. It is important to note that the position of the players on the field and their tactical behavior influence the physical variables (Clemente *et al.*, 2013; Costa, Garganta, Greco, & Mesquita, 2009; Dellal *et al.*, 2011).

The organization of the team is of the utmost importance for energy saving during the match; when observing the distances of the high intensity efforts, we can note that there is a significant increase for the medium- and large-sided games, between the control and experimental fields. Thus, we understand that the

rule induces the training of a more organized team, in which the athletes do not need to run long distances or spend energy to carry out an offensive or defensive action. In the studies of Dellal *et al.*,(2012), when comparing 4x4 games with 11x11 games, he noted that the rules of one or two touches on the ball increases the intensity of small-sided games in relation to the official game, precisely because this is a game with a lower amount of athletes and consequently has a greater number of efforts and movements. Unlike the official game with a greater number of athletes, the players remain tactically positioned and organized, therefore moving less.

In this study, by analyzing the maximum velocities reached between the control and experimental fields, we found that there was a statistically significant difference both in small-sided games and medium-sided games. The study of Koklu *et al.*,(2013) corroborates with our study in relation to the higher intensities of the efforts in less sophisticated games. When comparing the physiological responses and the intensity of the efforts in SSG with and without the presence of goalkeepers, the author found that the intensities of the efforts and the physiological responses are significantly higher in the games without the presence of the goalkeepers. Hill-Haas *et al.*(2010), although he found no physiological differences in some changes in rules and field, it was emphasized the importance of the rules on the intensity of efforts and the motivation of players. The motivation of the players is of paramount importance to ensure that the objectives are achieved, and the rules need to be well prepared and often changed during training for this end. Corroborating the importance of the motivation during training with games, Scaglia *et al.*,(2013) use the term "State of play", which means that the athletes are in a state of maximum concentration and complete involvement, because only this way they can be certain that they are offering their maximum in every effort. However, the author points out that the complexity of the rule can withdraw the athlete from the state of play; thus, it is important for the coaches to know the effort rules to not influence negatively the physiological responses, as well as to not generate negative adjustments on the game model of the team.

However, we conclude that the effort rule, with the principle of maintaining ball possession, is able to control directly the intensity of the efforts and the time motion characteristics of the players on the field. We believe that the variables that were not significantly different between the control and experimental fields can be explained by the increase in size and number of players, but other studies need to be conducted to verify the influence of field size and number of players on the intensity of the efforts and the movement of players in training conducted through games.

We believed that this study allows researchers and football coaches to understand the effect of the effort rules on the preparation of games. The elaboration of small-sided games, without the knowledge on the rules – disregarding the periodization of workloads – and also on the game model that is going to be adopted which could lead players to negative adjustments, both in physical variables and in technical and tactical variables. The coaches need to be aware of which game to apply, as well as which rule to use to intensify the training. Another important factor is to check the training intensity individually and not only the total distance covered, since athletes can cover the same distances, but at different intensities. As limitation of the study, we can highlight the use of biochemical or rating of perceived exertion (RPE) to ensure the different intensities of the applied games.

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ERRATUM

In the article **"Athletic Identity Measurement Scale": Translation, Adaptation and Validation for Brazil**, published in volume 22, number 1, 2016.

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Should read:

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In the article **"The effect of the maintaining the ball possession on the intensity of games"**, published in volume 22, number 1, 2016.

René Brenzikofe

Should read:

René Brenzikofer

page 56, second column, lines 30-31:
"Ventilatory Threshold2" and "Ventilatory Threshold2 (VT2)" **should read** "VO2"