ASSESSMENT OF SOCCER DEMANDS AND ELEMENTS TO ITS DEVELOPMENT

Jose Antonio Asian Clemente

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I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

Chapters 2 through 7 of this thesis represent six separate papers that have either been published, have been submitted, or will be submitted to peer-reviewed journals for publication.

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"The important thing in science is not so much to obtain new data,

but to discover new ways of thinking about them."

William Lawrence Bragg

" Sports science, without question, is the biggest & most important change in my lifetime. It has moved the game onto another level that maybe we never dreamt of all those years ago. Sports Science has brought a whole new dimension to the game."

Alex Ferguson

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This work is only a little piece of my love for my profession and life. Many years now, I started to understand that it is not important what the people think that it is better or what our society think that it is the correct or suitable for us. What matter is what you love and feel inside you. When you guide your life and actions following what make you happy it is impossible to make it wrong. One day, in one of those erroneous steps that one young boy executes when it is looking for his destiny fate, a great person told me: ¨if this if what you love: go ahead¨. For this incredible advice I always will be grateful to you Mom. On that day you allowed me the opportunity to focus my life on training and soccer, so this text it specially yours. But this is not the uniquely reason whereby this PhD it is yours. There is another important issue, although this is shared with the other person that together with you have contributed to what I am today. The other person is your fellow traveller, so thank you Dad. Your taught me to be happy, to love the life, to work hard, to be humble and all the values that configure me. You are impressive and I love you.

I would also like to thank to my two sisters, because they always are with me and by my love for them.

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I also would like to express my sincere gratitude to my PhD directors because they showed me the way of the applied science to the training and they let me understand this world in a different way than I understood before to know them.

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ABBREVIATIONS

Abbreviations

Acc	Accelerations
ANOVA	Repeated-measures analysis of variance
ATM	Atlético de Madrid
BAR	FC Barcelona
CD	Central defenders
CHL	Champions League
D	Distance covered
Dec	Deceleration
Dist. In Possession	Distance covered when the team was in possession of the ball
Dist. Out Possession	Distance covered when the team was not in possession of the ball
ES	Effect size
FIFA	Federation International Football Association
FB	Full backs
HIR	High-intensity running
HR	Heart rate
HRM	Heart rate mean
HRmax	Heart rate maximal
GPS	Global position systems
Km	Kilometres
LMG	Lower Middle Group
$m \cdot min^{-1}$	Meters per minute

MF	Central midfielders
Min	Minutes
N_{wh}	Normal players without floaters
N_i	Normal players with internal floaters
N_e	Normal players with external floaters
N_z	Normal players with zone floaters
N_s	Normal players with square floaters
R	Relegation
RD	Relative distance
RMA	Real Madrid CF
RPE	Subjective perception of effort
S	Strikers
SD	Standard deviation
S_{max}	Maximal speed
SP	Semi professional players
TD	Total distance
UEFA	Union of European Football Association
UEL	UEFA Europe League
UMG	Upper Middle Group
U-17	Under-17
U-19	Under-19

MAS	Maximal aerobic velocity
Vmax	maximal speed
VT_1	Aerobic threshold velocity
VT_2	Anaerobic threshold velocity
WM	Wide midfielders
W:R Ratio	Work/rest ratio

RESEARCH

This work constitutes a Doctoral Thesis in sport sciences, specifically in soccer and it is composed by the next studies:

1. Is physical performance a differentiating element between more or less successful football teams?

Asian Clemente JA, Requena B, Jukic I, Nayler J, Hernández AS, Carling C. Sports (Basel). 2019 Sep 30;7(10). pii: E216. doi: 10.3390/sports7100216.

This study investigated the time-motion of Spanish first division teams, comparing them according to their competitive level. The results showed that the amount of distance covered in the analyzed variables were not related with the success / performance in soccer, and successful and unsuccessful teams presented the same amount of requirements at higher velocities. These findings provide valuable information about the physical demands and requirements of running of successful and unsuccessful teams according their final position in the Spanish 1st division final standings.

2. Influence of the tactical behaviour in the time-motion of the three best teams of a highly competitive and successfully soccer league (under review).

The aims of this study were to examine the influence of tactical behaviour (playing formation, playing style and tactics) on the physical performance top three teams of Spanish league and compare the differences in the physical demands of each individual positional role depending of the characteristics of these teams. Although tactical behaviour did not influence in time-motion global performance of the teams, it did in the individual physical performance of their players depending on the position. The results demonstrated that the demands of each soccer player are influenced by playing formation, playing style and tactics of the teams where they are playing.

3. The examination of external load in competitive, non-competitive matches and small-sided games amongst elite soccer players (under review).

The aim of this study was to compare the external load of competitive and non-competitive matches in addition with a modified-sided game in order to analyse differences between them. The results of this study show that, in comparison to official matches, training matches showed more distance covered at high speed (>25 $km \cdot h^{-1}$), accelerations and decelerations than official matches (except high accelerations), modified-sided games showed higher values in all accelerations and decelerations, modified-sided game and friendly matches elicit higher relative distances ($m \cdot min^{-1}$) and peak velocity was lower in all tasks analyzed.

4. Differences between distinct spatial orientations based on individual player profile. Jose Antonio Asian Clemente, Luis Suárez-Arrones, Salvador Sánchez Gil. Retos. 2019; 35: 3-6.

The purpose of this study was to verify the influence of the modification of the game spatial orientation (greater width or depth) on the internal and external load of soccer players based on their individualized physical profile and the performance of the players during different series. Higher running demands and accelerations were obtained when the depth was prioritized over the width. This study demonstrated the importance of programming adequate recovery times between series of SSG to maintain the physical demands, as well as it emphasizes the role of game spatial orientation as one of the elements that coaches can use to modify SSG physical demands.

5. Age-Related Differences in the Physical and Physiological Demands during Small-Sided Games with Floaters.

Alberto Rábano-Muñoz, Jose Asian-Clemente, Eduardo Sáez de Villarreal,

Jack Nayler and Bernardo Requena. Sports (Basel) 2019, 7(4), 79;

doi:10.3390/sports7040079

The purpose of this study was to compare the physical and physiological demands of three different age groups (senior, under-19 and under-17) in a typical small-sided game with floaters. Analysis of the data showed that the demands of the SSGs are determined by the age of the players and that the regular players have greater demands than floater players in the SSGs utilized.

6. Is the role of the floaters players determinant in the performance of the soccer tasks? (under review).

This examined the acute physiological responses and time-motion characteristics associated with five soccer-specific SSGs formats with floaters in different role. The analysis of data showed that the physical demands of the floater and normal players were conditioned for the role that floaters play in the task and that the normal players have greater demands than them in the most of variable studied.

SUMMARY

Summary/Resumen:

Antecedentes: La complejidad e incertidumbre del fútbol provoca que en la actualidad aún haya muchos aspectos relacionados con su competición y entrenamiento que son desconocidos. Los avances tecnológicos y de conocimiento permiten conocer en mayor medida estos aspectos, pero todavía son necesarios muchos estudios que permitan otorgar objetividad y rigurosidad a la práctica del fútbol. Por este motivo el análisis de la competición y las tareas de entrenamiento se antoja como una tarea fundamental para los entrenadores y preparadores físicos.

Objetivo: Analizar la competición de fútbol y crear nuevos recursos de entrenamientos a través de tareas y reglas que permitan entrenar de manera más efectiva a los jugadores.

Método: Se analizó una temporada de las más igualadas de la primera división española de la realizaron dos estudios: 1) Se determinó las diferencias físicas entre los equipos, dependiendo su posición final en la tabla de clasificación y 2) se valoró las diferencias físicas de los equipos más exitosos en función de su estilo de juego. Paralelamente a estos estudios se llevaron a cabo los otros estudios que componen esta tesis donde se evaluó el efecto de diferentes tareas de entrenamientos para determinar la influencia en las demandas físicas de los jugadores. En estos estudios se examinó: 3) La comparación entre partidos competitivos y no competitivos en jugadores de fútbol, 4) La modificación de la orientación del espacio de juego en los juegos reducidos para determinar la influencia en el rendimiento locomotor de los jugadores, 5) La utilización de juegos reducidos con comodines y su influencia en las demandas físicas de jugadores de fútbol dependiendo de su edad y 6) La ubicación de los jugadores comodines y como estos afectaban a las tareas de entrenamiento en fútbol.

Resultados: Los principales hallazgos son: 1) No existieron diferencias físicas entre los equipos más o menos exitosos en la primera división española, 2) las Demandas físicas de los jugadores durante el partido de fútbol estuvieron condicionadas por el estilo de juego del equipo, sus tácticas y la formación utilizada, 3) Los partidos competitivos, no competitivos y los juegos reducidos tienen demandas físicas diferentes, 4) Juegos reducidos priorizando superficies de juego más largas provocaron mayor cantidad de acciones a mayor velocidad y aceleraciones que los juegos reducidos priorizando campos más anchos, 5) Las demandas físicas en los juegos reducidos estuvieron condicionadas por la edad de los sujetos y 6) Los jugadores comodines en los juegos reducidos siempre tuvieron menores demandas físicas que los jugadores normales, aunque dichas demandas están condicionadas por la posición que ocupen en el juego, siendo el comodín interior la posición con situaciones más demandantes.

Conclusiones: Los resultados aportados por este trabajo aumentan el conocimiento tanto a nivel físico como sobre la concepción actual de la teoría del entrenamiento en fútbol. Aunque es considerado un deporte complejo y debe ser entendido como tal, estos hallazgos describen cuáles son algunos de los elementos que definen a los equipos de fútbol en función de su posición en la tabla, los aspectos que influyen en las demandas físicas de los jugadores y que existen varios recursos de entrenamiento que pueden provocar determinadas demandas físicas en los jugadores.

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OBJECTIVES

This work seeks to explain some aspects of soccer, providing new information that to help to coaches and strength and conditioning to guide their daily practice. The objectives of this doctoral thesis were:

General objective

To know the physical and physiological demands of soccer and to provide new resources to training in this sport.

Specific objectives

The general objective is divided in several specific objectives that they will be dealt throughout in each of the chapters. These specific objectives allow to know better the competition and the behaviour of the players and it provide new rules to modify the demands of the soccer players.

Specific objective 1: theoretical framework.

To stablish the actual question through the review of the published literature specialized in soccer and to define the existing knowledge about the main topics covered in the studies of this work.

Specific objective 2: Study 1.

To investigate the time-motion of the teams of Spanish first division, comparing their physical demands according to their competitive level: Champions League, Europe League, medium-high and medium-low levels in the classification and relegation.

Specific objective 3: Study 2.

To examine the influence of tactical behaviour on the physical performance top teams of Spanish league and compare the differences in the physical demands of each individual positional role depending of the characteristics of these teams.

Specific objective 4: Study 3.

To compare the external load of competitive and non-competitive matches in addition with a modified-sided game in order to analyse differences between them to test if they have similar demands.

Specific objective 5: Study 4.

To verify the influence of the modification of the game spatial orientation (greater width or depth) on the internal and external load of soccer players based on their individualized physical profile through a typical small-sided game.

Specific objective 6: Study 5.

To compare the physical and physiological demands of a small-sided game in three different age groups (senior, under-19 and under-17) belonging to the same academy and to contrast the physical and physiological profiles of normal and floater players during this task.

Specific objective 7: Study 6.

To examine acute physiological responses and time-motion characteristics associated with five soccer-specific small-sided game format where it is modified the role of the floaters players.

CHAPTER 1: THEORETICAL FRAMEWORK

1.1. Conceptual approach

Soccer is undoubtedly the most popular sport in the world, representing more than 200 million active players, of which 20% are women. Additionally, it is estimated that an equal number of unlicensed soccer players exist. One of the characteristic that become to the soccer in the most followed sport is that Soccer has rules, regulations, and a style of play that is unlike any other sport (Manning & Levy, 2006). In fact, this game is very complex because the pitch is substantially large (approximately 100 x 60 m), the ball is controlled with the feet and head and there may be interactions within eleven teammates and between eleven opponents, almost all with different roles in the game (Aguiar et al., 2012). The low line-score of the matches where they are decided by some details is another of the aspects that contribute to its great expectation because although a team can be superior during the most part of the match, the opponent only need a right action to obtain to gain one or three points.

This aspect, have provoked that soccer has been widely analysed, both by coaches and scientists, to fully understand and define the precise activity of soccer (Vigne et al., 2013), but it has not always been the case. The soccer world was traditionally viewed as being inappropriate for scientific investigations. Since the early 1990s, soccer environment was one in which the scientist was likely to be greeted 'at worst with suspicion and hostility and at best with muted scepticism' (Reilly & Gilbourne, 2003). But the need of strength and conditioning and coaches that have to train to their players during a long period, that could be extended until 10-11 moths (Silva et al., 2011), where the teams have to compete 1 or 2 times by week (Dupont et al., 2010) and in the case of international players, reaching 60 official matches by season (Dellal, Chamari, & Owen, 2013), has provoked a change in mentality of the soccer looking for new knowledge. The First World Congress of Science and Football in 1987 represented a major step forward in effecting a link between theory and soccer practice, being the first occasion when representatives of all the soccer codes came together for a common purpose (Reilly et al., 1988). Since then, the amount of scientific content linked to soccer it has never stopped growing. This has been developed in such way that, in the last years, many reviews have been published on soccer addressing issues such as: soccer biomechanics (Lees & Nolan, 1998; Lees et al., 2010), performance determinants (Bangsbo, Mohr & Krustrup, 2006; Bangsbo, Iaia & Krustrup, 2007), fatigue and recovery (Bangsbo, Iaia & Krustrup, 2007, Mohr, Krustrup & Bangsbo, 2005; Reilly & Ekblom, 2005; Reilly, Drust & Clarke, 2008; Nedelec et al., 2012; Nedelec et al., 2013), physiological characteristics of soccer players (Reilly & Gilbourne, 2003; Shephard, 1999; Stolen et al., 2005; Svensson & Drust, 2005), specific training-induced effects (Hoff & Helgerud, 2004; Hoff, 2005; Iaia, Rampinini & Bangsbo, 2009; Hill-Haas et al., 2011; Silva, Nassis & Rebelo, 2015) and periodization strategies (Silva et al., 2016). Despite of this volume of knowledge, there are still many uncertainties concerning the game's requirements that are necessary to solve (Abrantes et al., 2012; Aguiar et al., 2012; Siegle & Lames, 2012).

What it can be assumed, it is that the optimal performance is the results of a multi-skilled combination of movements that they emerge from the interaction between players' constraints (physiological, technical, or tactical capacities), relying upon teams and the environment (play conditions), mainly throughout a self-organization process (Araújo, Davids, & Hristovski, 2006; Bangsbo, 2014; Bangsbo, Mohr & Krustrup, 2006; Davids, Button & Bennett, 2008; Stølen et al., 2005). The search for optimal performance gave rise to new a new side in the soccer, the performance analysis. This area has been positioned as an integral part of the coaching process (Carling, Williams, & Reilly, 2005; Groom, Cushion, & Nelson, 2011; Hodges & Franks, 2005; Lyle, 2002; Stratton, Reilly, Williams, & Richardson, 2004) and it is considered as an approach that it will help to obtain a greater understanding of this sport and to provide more objective and practical knowledge to lead a better players training (Mackenzie & Cushion, 2013). The concurrent thinking has demonstrated soccer training should be considered as an integral approach which considering match demands by assimilating physical and technical-tactical data (Bradley & Ade, 2018). In the figure 1 it can be observed the idea of integrate approach. This paradigm defends that, to improve the soccer player's performance it is necessary to development the 3 areas. Although multi-requirements are necessary to obtain performance, physical demands have been studied in more depply (Bangsbo, Iaia & Krustrup, 2007) being the aspect considered more important by the specialized literature.

The specificity principle of the training, which promote that greater benefits are achieved when the training replicate and overload the competitive requirements/demands of competition and therefore, more similar is the training to the competition (Al Haddad et al., 2018; Gonçalves et al., 2017; Di Salvo et al., 2007), it could be one of the main responsible of the extensive analysis of the competition, in order to design soccer training models/theories to train according to official match demands. There are some limitations that have difficult the fully understanding of soccer demands during official games.

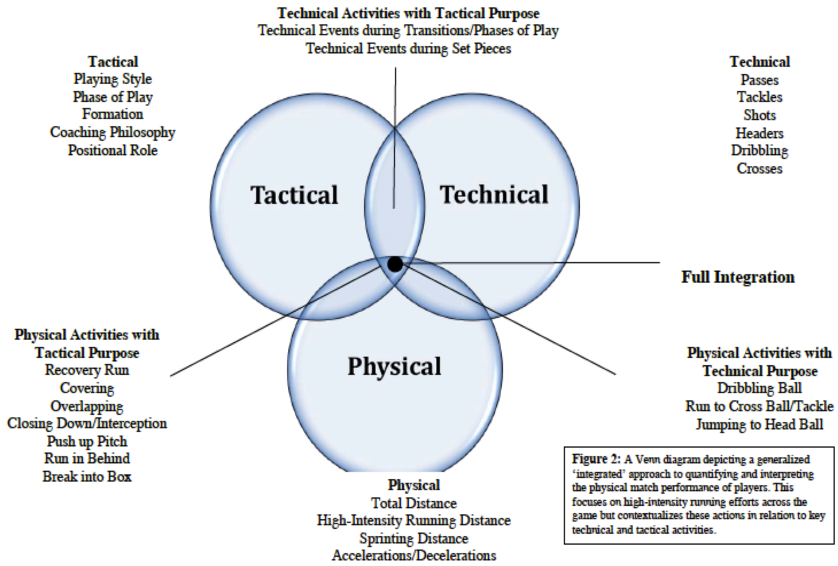

Figure 1. Current vision of the training in soccer (Bradley & Ade, 2018)

The first, it is that the soccer match is development under an unpredictable and indiscrete scenario, where it is unknown what it going to happen and nobody can affirm how a match will evolve (Randers et al., 2010). The randomness that exist when two teams compete is so great that some authors consider the soccer match as a stochastic process impossible to know with certainty (McKenzie and Cushion, 2013; Yue et al., 2008).

Another limitation it is that during a uniquely match it is possible that players not acquire their fully efforts. Contextual variables of moment (variables: match status, match location, opponent level and match half) and the tactical role required in each situation could explain that determined players not perform to their maximal ability (Castellano, Blanco-Villaseñor & Alvarez, 2011; Buchheit et al., 2010). During matches, soccer players attempt to provide an answer to problems technical-tactical issues arising without considering the physical behaviour. As consequence of this, in many cases, players finish matches with a suitable technical-tactical performance but without to apply their maximal physical ability. This feature typical of soccer is linked soccer player's performance profile, which is not uniquely conditioned by required demands of the match, but it is also influenced by the pacing effect of them (Buchheit et a., 2010; Gregson et al., 2010). When a player participates in a match, does not know what will really happen, so always he can try to be as practical and effective as possible. They can spare effort to possible and frequents situations of soccer as a possible red card, introduction of a substitute, match in the next days, etc.

The last element to consider is that there is not a gold standard way to know soccer activity demands (O'Donoghue, Robinson, 2009; Redwood-Brown, Cranton & Sunderland, 2012; Randers et al., 2010). This has provoked different outcomes depending of the tool used to evaluate the movements of players (Carling et al., 2008; Randers et al., 2010). Over the past 20 years, the technological advances have allowed new methods of assessing movement in soccer; such as multiple camera methods (Di Salvo et al., 2007, Rampinini et al., 2007a; Rampinini et al., 2007b), global positioning systems (GPS) (Coutts & Duffield, 2008; Edgecomb & Norton, 2006; Kirkendall, Lenard & Garrett, 2004) and systems using microprocessor technology (Frencken, Lemmink & Delleman, 2010). The time-motion through cameras and GPS have been the most used in the literature and also in professional soccer clubs (Torreño et al., 2016). In the Table 1 it can be observed advantages and disadvantages of both methods.

In the next chapter it will be analyzed physical demands of soccer players that has been published in the specialised journals to be considered the most studied element of performance of soccer (as has been mentioned previously). To describe physical requirements to play to soccer, data will be described independently of the method used while it has been registered through GPS or cameras.

Multi-camera system
Advantages / Disadvantages
• It is non-invasive, so it is not necessary to place any device on the soccer player. • The soccer players are evaluated, without them noticing. • Camera system provides more complex / integral information than GPS (video-analysis, technical-tactical information, etc.). • When National Football Leagues offer own systems data, clubs can receive information of their teams and their opponent. So coaches can compare their performance with opponents performance.
Global position system
Advantages / Disadvantages
• It can be used in both training sessions and official matches • Some stadiums present problems to collect data because their structures affect the signal of the GPS and registered data. • It offers some information about the external load (acceleration and deceleration) and internal load (heart rate (HR)). • The GPS are portable, so it can be used anywhere.

Table 1: Advantages and disadvantages of the main systems to collect time-motion data used in soccer (Aslan et al., 2012; Di Salvo et al., 2009; Dwyer & Gabbett, 2012; Torreño et al., 2016).

1.2. Physical demands of soccer

The monitoring of match running performance using time–motion analysis is an indispensable work in professional soccer clubs. The information obtained through of this method can primarily be used 1) to determine key elements of soccer and to discriminate between successful and unsuccessful teams and players (Di Salvo et a., 2009; Lago-Peñas & Dellal, 2010; Rampinini et al., 2009; Sarmento et al., 2014; Vigne et al., 2013), 2) to know different individual and collective requirements produced in soccer (Baptista et al., 2018; Barros et al., 2007; Carling et al., 2008; Castagna, D'Ottavio & Abt, 2003; Buchheit et al., 2010; Mendez-Villanueva et al., 2013), 3) to understand all specific aspects that can affect to player's movements during the match (Bradley et al., 2011; Bradley et al., 2013; Bloomfield, Polman & O'Donoghue, 2007; Randers et al., 2010; Rampinini et al., 2007; Schuth et al., 2016) and 4) to decision making to design and prescribe training according to the specific context which the coaches are working (Carling, 2013; Dellaserra, Gao & Ransdell, 2014; Palucci Vieira et al., 2019).

1.2.1. Collective physical performance of team and their influence in the final position in the table.

To the date, there are an important volume research in soccer to explain the key elements that better discriminate between the success and failure in this sport (Schmidt-Millard, 2003). These variables are known as performance indicators and they help the coaches to achieve the success with their teams (Hughes & Barlett, 2002). The study of the successful teams set new trends in terms of training and playing style. A great number of managers and strength and conditioning coaches tend to imitate the resources and methods employed by winning teams, seeking to master those aspects of performance which are deemed to underlie their success (Hughes and Franks, 2005). These kind of analysis have been carried out in competition with national teams (Castellano, Casamichana & Lago 2012; Shafizadeh, Taylor & Lago-Peñas, 2013; Liu, et al., 2015; Winter & Pfeiffer 2015), international club competitions (Lago-Peñas, Lago-Ballesteros & Rey, 2011) and high level European leagues (Armatas et al., 2009; Rampinini et al., 2009; Lago-Peñas et al., 2010; Liu, Hopskins & Gómez, 2015).

In soccer, it has been stablished that the performance indicators that better difference between to win or to lost are related with the goal scoring and the ability to attack (Lago-Peñas et al., 2010). Various authors defend that total number of shots and the shots to goal are elements that higher linked maintain with the final result of the match, so they affirm that teams that score greater amount of them are the most successful teams (Armatas et al., 2009; Catelllano, Casamichana & Lago, 2012; Lago-Peñas et al., 2010; Lago-Peñas, Lago-Ballesteros & Rey, 2011; Liu et al. 2015a; Liu et al. 2015b, Rampinini et al., 2009).

Likewise, there is another set of variables that have been identified to the successful in soccer, although it is true that they have lower scientific evidence level than previous. These variables are: assistances (Liu et al. 2015a, Liu, Hopkins & Gomez,2015c), passes (Liu et al. 2015a; Liu et al. 2015b; Liu, Hopkins & Gomez,2015c; Rampinini et al., 2009), tackles (Liu et al. 2015a; Rampinini et al., 2009), aerial duels (Liu et al. 2015a, Liu, Hopkins &

Gomez,2015c), crosses (Lago-Peñas et al., 2010; Lago-Peñas, Lago-Ballesteros & Rey, 2011) and dribbling (Liu et al. 2015b, Rampinini et al., 2009). Another technical-tactical variable widely studied, and that it should be considered in the case of successful in soccer, is the ball possession. It can be affirmed that the successful teams have more time the possession of the ball than those less successful (Catelllano, Casamichana & Lago, 2012; Lago-Peñas et al., 2010; Lago-Peñas, Lago-Ballesteros & Rey, 2011; Liu et al. 2015a; Liu, Hopkins & Gomez,2015).

Despite the greater amount of literature related with the physical aspect in comparison with the technical-tactical, physical elements that better discriminate between successful and unsuccessful teams are not widely known and studied. Time–motion analyses of match running activity in relation to position in the final league standings at the end season have been used to provide an indication of the extent to which physical performance can influence the ‘success’ of teams (Carling, 2013).

To date, only two studies have described the relationship between physical performance and a team’s final position in the standings of European competitive national leagues. Using Premier League data collected from 2003/2004 to 2005/2006, Di Salvo et al. (2009) found that players from less successful teams, covered more sprint, high intensity running and high intensity running without possession of the ball than highest-ranked team players. In contrast, the authors did not observe any relationship between the position in the standings and the amount of high intensity running with possession of the ball. In the 2nd study, conducted in the Italian Serie A League (1^{st} division), Rampinini et. al (2009) compared the physical performance of the top five vs last five teams in the 2003/2004 season. Players in the lower-ranked teams accumulated more total distance, high intensity running and very high intensity running, while the higher-ranked teams accumulated more distance covered in all variables related to possession of the ball: total distance with the ball, very high intensity running with the ball and high intensity running with possession.

1.2.2 Individual physical performance of players according to their position.

Soccer is an acyclic sport where the players have to dominate a large amount of technical movements through an intermittent activity characterized by high intensity actions (high intensity, sprint, etc.) and low intensity periods (standing or walking) (Bloomfield, Polman & O'Donoghue, 2007; Ingebrigtsen et al., 2012; Krustrup et al., 2009). The main physical actions in soccer imply: sprints, changes of direction, jumps, tackles, and skill-based activities, with the ball, over 90 min of play, in a dynamic and unpredictable environment and at different intensities (Bangsbo, 2014; Sarmento et al, 2014). It has been demonstrated that a top-class player performs 150 to 250 of these brief intense actions during a game (Bangsbo, Iaia & Krustrup, 2007; Bangsbo, Mohr & Krustrup, 2006), and currently a professional male soccer players cover on average 9–12 km per match, (Mohr, Krustrup & Bangsbo, 2003; Barros et al., 2007; Mohr, Krustrup & Bangsbo, 2005; Thatcher & Batterham, 2004) whilst some players may attain distances of around 14 km (Fernandes, Caixinha & Malta, 2007). Although it should consider that player's demand outcomes can be different according to the methodologies used to obtain data (Carling et al., 2008), these data are very general. To really understand soccer player's physical demands, and to create precise and specific training, an accurate and objective quantification of the players' match activities is needed (Bradley et al., 2010; Dwyer & Gabbett, 2012; Johnston et al., 2012; Rebelo et al., 2012). Also to consider the specific playing position is needed, because it is the most influential element in the match activity of the players.

Positional role where the players are placed influence in their physical, physiological and bioenergetics requirements and hence on total energy expenditure in a match (Bangsbo, Norregaard & Thorso, 1991; Baptista et al., 2018; Di Salvo & Pigozzi, 1998; Mohr, Krustrup & Bangsbo, 2003; Rampinini et al., 2004; Reilly & Thomas, 1976; Reilly, 1997; Rienzi et al., 2000; Stolen et al., 2005; Torreño et al.,2016; Tumilty, 1993).

Although available literature is variable depending of methodological factors (sample, used, tools or other methodological aspects), it can be affirmed that midfielders are most demanding than defenders and forwards in relation to the total distance covered, whereas forwards elicited the highest values for sprinting and walking activity (Bangsbo, 1994a; Bangsbo, 1994b; Dellal et al., 2011a; Dellal et al., 2011b; Di Salvo at al., 2007; Vigne et al., 2010). When positions are defined with greater precision, differentiating between internal and external players, it can be affirmed that 1) central defender is the position with lower physical requirements of total distance, high intensity running and sprint, 2) midfielders (central and wide) are the positions that cover more total distance and 3) wide-midfielders and full-backs have the greater amount of high intensity running and sprint distance (Ade, Fitzpatrick & Bradley, 2016; Bloomfield, Polman & O'Donoghue, 2007; Bradley et al., 2009a; Bradley et al., 2009b; Bush et al., 2015; Dalen et al., 2016; Dellal et al., 2011c; Di Salvo at al., 2007; Di Salvo at al., 2009; Rampinini et al., 2007; Torreño et al., 2016).

In the last years, some authors that consider insufficient the categorization of the match activity through of the classical speed thresholds ranging from standing to maximal sprinting (Akenhead et al., 2013; Akenhead, Harley & Tweddle, 2016; Dalen et al., 2016; Dalen et al., 2019) because underestimate the real load of the players. This method does not include some essential and specific movements of football (turns, accelerations and decelerations, etc.) that together appear numerous times during every match and may cause significant physical fatigue and stress on the players (Bangsbo et al., 1994b; Dalen et al., 2016). Some authors have demonstrated that the 16% of total player load is configured by accelerations and decelerations. They have also described that full-backs and wide-midfielders accelerated significantly more often that central-defenders, central-midfielders and attackers, while that in the case of deceleration, central-defenders and central-midfielders achieve less decelerations compared with full-backs, wide-midfielders (Dalen et al., 2016, Dalen et al., 2019). In contrast to these works, other authors have found in a Premier League Club that, in training sessions, central-midfielders achieve a greater amount of meters accelerating than central-defenders, wide-midfielders and forwards (Akenhead, Harley & Tweddle, 2016). Although this new paradigm defends that related variable with accelerometry might be more sensitive than high speed running distance to evaluate the performance at high intensity of soccer players, more studies are necessary to make conclusions.

1.2.3. Other factors that influence in the physical demands of soccer.

As described above, it can be assumed that player's physiological responses and technical-tactical requirements will be conditioned by positional role or the position of the team in the final league standings. But these are not the uniquely elements that influence in the time-motion of them. Coaches and strength and conditioning coaches should consider other aspects that they also will modify the running demands.

In elite football one of the most concern is the goal scoring and their related variables because different reason: It is the main aim of all the teams (Katis et al. 2013), it affects to the tactical (Hughes & Franks, 2005), it is the key of the most of the succesfull teams (Cachay & Thief, 2000) and it is the difference between to win or to lose (James, Jones, y Mellalieu, 2004). To score a goal influence in the match status of the match (to be ahead, behind or drawing in the in the score) and it is accepted that will affect the behaviour of the teams (Bloomfield et al., 2005; Taylor et al., 2008). Although, it has been demonstrated that players cover less high intensity running when the teams are winning than when they are losing or drawing, and also when the teams are losing players cover higher total distance at different velocities (Bloomfield et al., 2005; Castellano et al., 2011; Lago-Peñas et al., 2010; Lago-Peñas, Lago-Ballesteros & Rey, 2011; O´Donoghue & Tenga, 2001; Rey et al., 2011; Shaw & O´Donoghue, 2004) a recent published study carried on during 2 season (2013-2014 and 2014-2015) and 52 official games of a professional team (Moalla et al., 2018) has shown different demands according to the period of the time chosen: final match status, half match status and partial 15-min intervals. In 90 minutes, winning teams covered greater total distance and low-intensity running than when they were losing or drawing, while when they were losing covered more distance in sprint and high intensity running; taking into account only 45´of matches and periods of 15´, players covered more distance for all speed intensities winning than to losing and drawing. Independently the obtained result by these authors (they are conditioned by the different methodological aspects), it can be assumed that soccer players always not perform their maximal physical ability during the matches (Carling et al., 2008; Rampinini et al., 2007). In addition, physical demands are not only the result of fatigue described by the classic theory of fatigue (Tucker, 2009) but also due that the match status and the player's ability to manage the effort consciously or not (Gabbett, Walker & Walker, 2015; Edwards & Noakes, 2013).

Soccer is a team sport where two opposing teams dynamically interact in order to gain advantage over the other team (McGarry et al., 2002), so the opponent should will influence in the tactical behaviour of soccer teams and it will be reflected in their physical demands (Rampinini et al., 2007). The existing literature indicates that the total distance and the high intensity running are greater playing against worst opponent than playing against a best one (Bloomfield et al., 2005; Lago et al., 2010; Rampinini et al., 2007). So, it could be affirmed that, depending of level opponents, soccer players could modify their physical patterns running more or less distance and distance at different speeds.

Other aspect considered in the literature, that has effect in the physical requirements of soccer players, is the place where the match takes place: home or away. The phenomenon of the ‘home advantage’ is well-established within many sports in that teams typically perform better when playing at their home venue than at an away venue (Fothergill, Wolfson & Neave, 2017), These teams score more goals and win more games at home (Bray, 1999; Courneya, & Carron, 1992; Liardi & Carron, 2011; Neave & Wolfson, 2004; Nevill & Holder, 1999; Schwartz & Barsky, 1977). Currently, the is not clear enough if the teams run more or run less when they play at home or away, because there are methodological differences in the published studies. García-Unanue et al. (2018) did not reveal significant differences when teams of the Spanish third division played home or away in the analyzed variables (high intensity running, high intensity accelerations, sprint time and sprint distance), except in the total distance covered in the second part of the matches, where layers playing away showed a greater distance covered. Vescovi & Falenchuk (2019) didn’t found different physical demands between home and away matches in female professional soccer players. However, Aquino et al. (2017) described greater maximal and mean velocity and high-intensity actions in the Brazilian fourth division when the players played at home.

Despite that the advantage obtained by the home teams, and their greater performance as a result of the home crowd, familiarity with the stadium and its playing surface, physiological aspects (higher testosterone production), away team’s travel and fatigue and referee bias in favour of the home team (Neave & Wolfson, 2004; Allen & Jones, 2014), more studies analysing physical demands differences should be carried out to obtain conclusions.

1.3. Soccer training.

Although research is increasing and there is an emergence of new knowledge, methods or training theories, there is a consensus in sport science that the most effective training for preparing athletes for competition is the one than more simulates / replicates competitive performance conditions (Di Salvo et al., 2007). Particularly in soccer, this aspect it is more important due to some features that characterize it (Aguiar et al., 2012; Alves et al., 2010; Köklü et al., 2015; Rampinini et al., 2009; Taïana, Gréihaigne & Cometti, 1993):

- In the soccer, as already described, the dimension of the pitch is bigger than in other sports, it is played with the foot (what increase the difficulty) and it is played by 22 players with different role and some substitutes (what difficult their interaction and relationship), so it is a very complex sport.

- Its analysis shows that numerous factors might affect performance (e.g., technical, tactical and physical factors), and it should be work on all of them to achieve top performance during matches.

- Soccer player's performance is also conditioned by their physical characteristics, besides of their positional role played. Depending of their role and characteristics they have determined demands so they should receive an individual attention.

- In soccer schedules, the amount of training sessions is limited by a high number of matches. This provoke a busy schedule with larger and more intense seasons. The preseasons are shorter (with less time to improve the fitness) and the competitive period phases include more games (with less time to recover between efforts, time to the recovery between session and higher fatigue).

Taking this into account, technical staff should maximize the player's and team's performance by designing specific training to obtain the highest benefits. The specific principle of training defends that the greatest improvements are achieved when the training exercise are more similar to the competition, in terms of the same physical and physiological, biomechanical and making-decision (Di Salvo et al., 2007; Rampinini et al., 2009; Stone, Plisk & Collins, 2002; Torreño et al., 2016), so most similar to soccer competition drills must be used. In the last years there has been a substantial growth in research related to specific training methods in soccer, with a strong emphasis on the effects of small-sided games (SSGs) (Aguiar et al., 2012). These tasks are a specific training method because they allow to manage and replicate the majority of the competitive match's demands (Fontes et al., 2007; Gabbett, 2008; Gabbett, Jenkins & Abernethy, 2009; Reilly, Morris & Whyte et al., 2007; Rodrigues et al., 2007; Sampaio, Abrantes & Leite, 2009).

1.3.1. Small-sided games in training soccer.

SSGs are being increasingly used by coaches in the context of team sports (Gabbett & Mulvey, 2008), Although they were considered as an alternative to the traditional methods (Allen et al., 1998; Hoff & Helgerud, 2004), currently in soccer they are the most used training method. SSGs are modified games played on reduced pitch areas, often using adapted rules and involving a smaller number of players than traditional football games (Hill-Haas et al., 2011) and they also are called skill-based conditioning games (Gabbett, 2008) or game-based training (Gabbett, Jenkins & Abernethy, 2009). The popularity of these drills has been increased as consequence of various reasons:

1) SSGs have aloud to simultaneously improve technical, tactical, and physical aspects of players' performance, under specific decision-making conditions (Hill-Haas et al., 2008; Hill-Haas et al., 2011; Impellizzeri et al., 2006; Köklü et al., 2015; Little, 2009 Rampinini et al., 2007).

2) They have a flexible nature that allows to change the intensity, manipulating variables such as the playing area, number of players, the use of coach encouragement, the inclusion of floaters, training regimen, presence/absence of goalkeeper and goals, game duration and rules modifications of the SSGs (Burnley & Jones, 2007; Brandes et al., 2012; Castellano, Casamichana, & Dellal, 2013; Dellal et al., 2008; Dellal et al., 2012; Dellal, Drust & Lago-Penas, 2008; Fanchini et al., 2011; Hill-Haas et al., 2011; Hoff et al., 2002; Lacome et al., 2017; Mallo & Navarro, 2008; Rampinini et al., 2007; Sanchez-Sanchez et al., 2017).

Despite of these advantages, SSGs have other important limitations that must be considered:

1) They have higher inter and intra player variability compared with traditional methods, that increases in higher intensity actions (Dellal et al., 2008; Hill-Haas et al., 2010).

2) SSGs do not cover all the physical variables of the matches. Particularly, in official

competition maximal speeds achieved are higher than in SSGs (Casamichana, Castellano & Castagna, 2012; Gabbet & Mulvey, 2008; Gómez-Carmona et al., 2018)

The lack of consistency in SSG design (player fitness, age, ability, level of coach encouragement and playing rules) in each of these studies, makes difficult to get accurate conclusions on the influence of each of these factors separately (Aguiar et al., 2012). So, more studies analysing soccer SSGs demands carried out and comparing them with official games should be performed to increase the knowledge of these activities and to improve the efficacy of them.

In summary, it could be affirmed that nowadays soccer is a complex sport in which there are still a lot of uncertainty aspects to control by the technical staff. To be more efficient it is necessary look for the more specific drills, being the modified-sided games the better task to improve the player's performance due to the similarity with the competition and their ability to train the technical, tactical, physical and psychological aspects under specific making decisions. Although there are several contextual factors that modify soccer payer's demands, physical key elements that characterize to the most successful teams are not well known yet.

CHAPTER 2: STUDY 1

Is physical performance a differentiating element between more or less successful football teams?

Abstract

This study investigated the time-motion characteristics of football teams in the Spanish first division, in relation to their final competitive level as defined by league position (Champions League, Europa League, Upper mid-table, lower mid-table and relegation). Match observations (n = 9641) were collected using a multiple-camera computerized tracking system during the 2013–2014 competitive season. The following match parameters were analyzed: total distance, relative distance ($m \cdot min^{-1}$), distance < 14 $m \cdot min^{-1}$, >14 $m \cdot min^{-1}$, between 14–21 $m \cdot min^{-1}$, >21 $m \cdot min^{-1}$, and >24 $m \cdot min^{-1}$. Total distance and distance at different velocities (>14, 21, and 24 $m \cdot min^{-1}$) in and out of ball possession were also analyzed. A repeated analysis of variance and a comparison of effect sizes were carried out to compare the performance of the teams. The analysis of the data showed differences in physical performance characteristics between competitive levels. The volume of distance covered in the variables analyzed did not relate to success in soccer. Both successful and unsuccessful teams presented the same running requirements at higher velocities. These findings provide valuable information about the physical demands of the running requirements according to their final position in the league table.

Keywords: Time-motion; match analysis; training; monitoring; demands

Introduction

Over the past two decades, there has been a substantial increase in the knowledge of the running demands of professional soccer match play, through the use of time-motion analysis [1–6]. This can be associated with increased interest in this topic from coaching staff and the rapid development of computerized time-motion analysis systems. Indeed, contemporary time-motion analysis enables collection of valid, impartial, and objective information to aid monitoring and evaluation of the running performance of soccer players [7–9]. Traditionally, the amount of total distance covered, distance covered per minute or relative distance ($m \cdot min^{-1}$), distance covered in different speed zones, and the amount of accelerations and decelerations, have been used to assess the physical performance of soccer teams [2,3,9–15]. The scientific literature suggests that there are different physical requirements between teams, depending on various factors. For example, when a team plays against better-quality opponents, its players cover a greater total distance and distance covered above 14.4 $km \cdot h^{-1}$ in comparison to matches against lesser-quality opponents [15]. Similarly, different physical demands have been demonstrated when compared to competitive performance levels. In a study that analyzed the two best English leagues, it was found that teams in the English Football League Championship (2nd division) covered a greater total distance, distance covered above 19.8 $km \cdot h^{-1}$, and distance above 25.2 $km \cdot h^{-1}$, than their highest-level counterparts in the English Premier League (1st division) [12]. The positional role undertaken by a player also has a great impact on their movement demands. It has been shown that central defenders have the lowest running demands, whilst midfielders (central and wide) are the positions that cover the most total distance, whilst wide-midfielders and full-backs cover greater amounts of distance at higher velocities [3,12,14].

Although it may be thought that running demands are influenced by the team's final league position, there is little scientific literature in regard to physical variables that differentiate successful and unsuccessful teams [3]. To date, only two studies have described the relationship between physical performance and a team's final position in the standings of European competitive national leagues [12,13]. Using data collected from 2003–2004 to 2005–2006 in the Premier League, Di Salvo [12] found that players from less successful teams covered a greater global distance above 19.8 $km \cdot h^{-1}$ and 25.2 $km \cdot h^{-1}$, as well as a greater distance above 19.8 $km \cdot h^{-1}$ without possession of the ball, than players from the highest-ranked teams. In contrast, the authors did not observe any relationship between league position, the standing distance, and the distance above 19.8 $km \cdot h^{-1}$ with possession of the ball. In the second study, conducted in the Italian Serie A League (1st division), Rampinini et al. [13] compared the physical performance of the first five and last five teams in the 2003–2004 season. Players in the lower-ranked teams accumulated a greater total distance and distance covered above 14 $km \cdot h^{-1}$ and 19 $km \cdot h^{-1}$, whilst the higher-ranked teams accumulated a greater distance covered in all variables related to possession of the ball: total distance covered, distance covered above 14 $km \cdot h^{-1}$ and 19 $km \cdot h^{-1}$. Although these studies were carried out in two of the most important European leagues, some limitations should be considered. Firstly, both studies only considered two or three performance strata. This could be considered very general in the current understanding of elite football competitions, where one position up or down the table could determine success. Secondly, the competitive level of the leagues during those seasons could be questioned, as the final points difference between the 1st and the 3rd teams in the league were 14.0 ± 5.0 and 14.5 respectively.

Additionally, in only one of the four seasons studied, did teams perform to a high standard (champion, finalist, or semi-finalist) in the competitions of the Union of European Football Associations (UEFA): Champions League and Europe League.

In recent years, Spanish football has dominated European and World soccer. The national team has won one FIFA World Cup and two UEFA Euro championships, and club sides from Spain have won more UEFA Champions Leagues, UEFA Europa Leagues, and FIFA Club World Cups [9] than teams from any other country. Despite this, we have no evidence of any study that analyzes the time-motion demands of the Spanish league, where the teams' high levels of international and domestic performance are precisely categorized. For these reasons, the aims of this study were to analyze the time-motion characteristics of teams in a highly competitive European national league and to compare them according to their competitive level as defined by final league position.

Methods

The current study was designed to examine the match play running performance of all the teams in the Spanish first division (La Liga) using a semi-automatic computerized player tracking system. Teams were placed into one of five categories based on their final league position of the 2013–2014 season (Figure 1). From the Champions league group, three out of the four teams were either champions, finalists, or quarterfinalists in the Champions League during the period studied. Similarly, in the Europa League, one of the team of this group was the champion, one of the Upper middle table teams was a quarterfinalist, and one of the relegated team reached the round of sixteen. This information indicates the strength of competition during the 2013–2014 season.

Sample

A total of 9641 individual data points from outfield players (excluding goalkeepers) were analyzed, with a median of 19.7 games per player (range = 1–38). The protocol for inclusion was previously described in literature [4]: (1) matches in which 90 min of play was completed; and (2) matches in which players played in their customary position throughout play, and the team's playing formation remained unchanged. The experiment protocol was approved by the local Institutional Ethics Committee of the University of Pablo de Olavide, and was conducted according to the principles expressed in the Declaration of Helsinki.

P	Teams	Pl	W	D	L	Pt	Abbreviations	
1.	Atlético de Madrid	38	28	6	4	90	UEFA Champions League	CL
2.	Barcelona	38	27	6	5	87		
3.	Real Madrid	38	27	6	5	87		
4.	Athletic Club	38	20	10	8	70		
5.	Sevilla	38	18	9	11	63	UEFA Europa League	EL
6.	Villarreal	38	17	8	13	59		
7.	Real Sociedad	38	16	11	11	59		
8.	Valencia	38	13	10	15	49	Upper Middle Table	UMT
9.	Celta de Vigo	38	14	7	17	49		
10.	Levante	38	12	12	14	48		
11.	Málaga	38	12	9	17	45		
12.	Rayo Vallecano	38	13	4	21	43		
13.	Getafe	38	11	9	18	42	Lower Middle Group	LMG
14.	Espanyol	38	11	9	18	42		
15.	Granada	38	12	5	21	41		
16.	Elche	38	9	13	16	40		
17.	Almería	38	11	7	20	40		
18.	Osasuna	38	10	9	19	39	Relegation	R
19.	Real Valladolid	38	7	15	16	36		
20.	Real Betis	38	6	7	25	25		

Figure 1. Organization of team groups according to the final classification in the season 2013–2014. P = position; Pl = played matches; W = matches won; D = matches Drawn; L = matches lost; Pt = points. Underlined letters represent the letters used to create the abbreviations of each group.

Procedures

A multi-camera, semi-automatic computerized player tracking system (MediaPro, Barcelona, Spain) was used to record the locomotors demands (velocities and distances) of match play (https://portal.mediacoach.es). Sixteen cameras placed high in the stadiums recorded the running performance of players, the system was in use by all teams of the 1st and 2nd division of the Spanish league [9]. Data collected were sent to a virtual server where coaches analyzed them. The use of this tracking system has appeared in previous research [9,16]. Utilizing trigonometry, the cameras captured the location of the players continuously, and the coaches downloaded the report post-hoc. The analyzed variables are displayed in Figure 2 and previously have been utilized in literature [10].

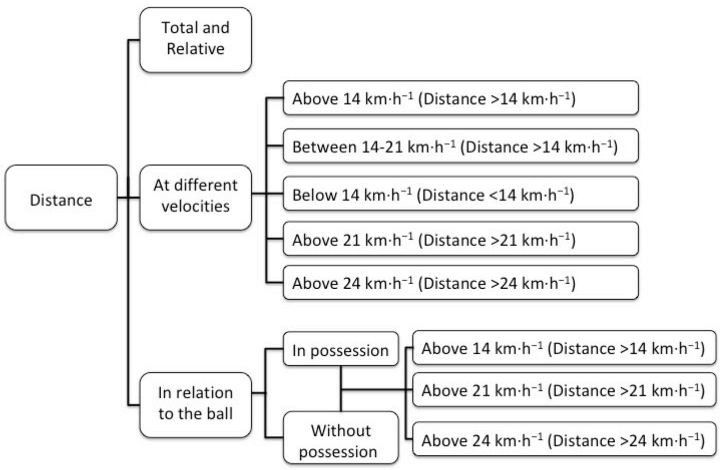

Figure 2. Variables analyzed to assess the locomotors demands of the matches.

Statistical Analysis

Data are presented as means ± standard deviation (SD). All variables presented a normal distribution (Shapiro–Wilk Test). A repeated-measures analysis of variance (ANOVA) was used to determine differences in each speed zone, in the distance covered, accelerations, decelerations, maximal velocity, and relative distance. Cohen's effect size (ES) was also calculated in order to compare the magnitude of the differences between groups for certain variables [11]. Quantitative differences were assessed qualitatively [17] as: <1%, almost certainly not; 1−5%, very unlikely; 5−25%, unlikely; 25−75%, possible; 75−95%, probably; 95−99%, very likely; and >99%, almost certain. A substantial effect was set at >75% [14]. If the chance of higher or lower differences was >75%, data greater than this percentage were considered as a substantial effect between groups. The SPSS statistical software package (V20.0 for Windows, SPSS Inc., Chicago, IL, USA) was used for data analysis.

Results

The physical demands of the different groups of teams studied are shown in Table 1 and Figure 3. Similarly, the effect size and p values are shown in the Table 2.

In terms of total distance covered and relative distance, UMT, EL, and R teams accumulated the greatest values and showed substantial differences to CL teams. For distances >14 $km \cdot h^{-1}$ and between 14–21 $km \cdot h^{-1}$, the teams finishing between 8th and 12th in the league table obtained the greatest values, whilst teams between 1st and 4th positions accumulated the lowest amount of distance below 14 $km \cdot h^{-1}$ compared to all other teams. In the two highest velocity zones (distance >21 and >24 $km \cdot h^{-1}$), there were no differences between any of the groups of teams studied. Likewise, there were no differences between any of the teams' values without the ball except for the distance covered without possession >14 $km \cdot h^{-1}$, where UMT teams showed a statistically greater amount of distance covered than the CL and LMT teams. Data for distance covered in possession of the ball showed that teams from the EL and UMT groups accumulated greater total distance and distance >14 $km \cdot h^{-1}$;

whereas in the highest speed zone in possession, the top four teams in the league had the highest values.

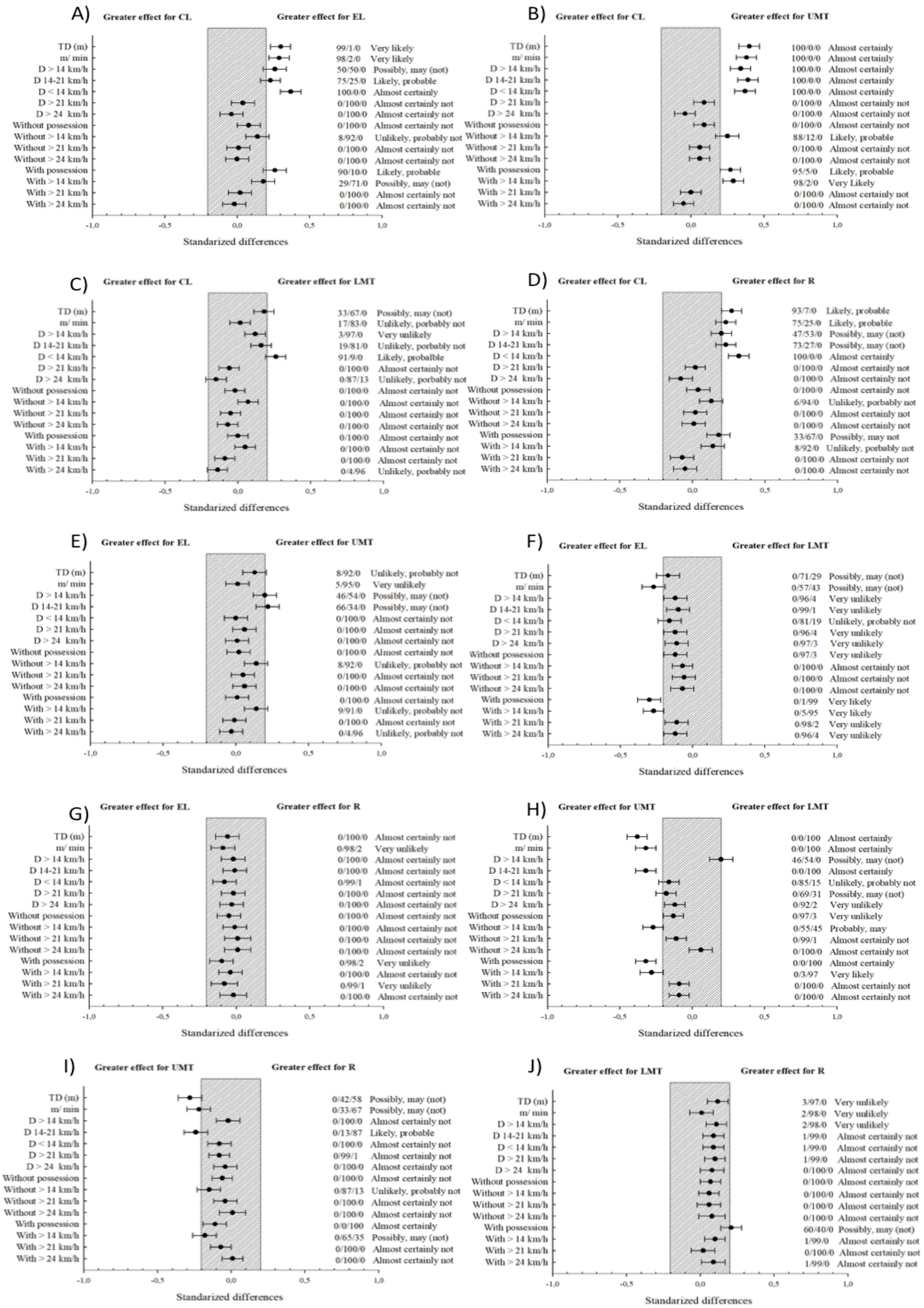

Figure 3. Comparison of the physical demands between groups. UEFA Champions League (CL), UEFA Europa League (EL), Upper Middle Table (UMT), Lower Middle Table (LMT) and Relegation (R). Bars indicate uncertainty in the true mean changes with 90% confidence intervals. The trivial area was calculated from the smallest worthwhile change (SWC).

Table 2 shows the effect size comparison between groups. Data from this figure show small differences between groups, with trivial changes in most of the studied variables in relation to the smallest worthwhile change.

Table 1. Time-motion of the Spanish League teams in the season 2013–2014.

	Classifications of the Teams				
Variable	**CL**	**EL**	**UMT**	**LMT**	**R**
Total distance	10,137 ± 1407 $^{U, MH, R}$	10,509 ± 983	10,643 ± 980	10,323 ± 100 ^{MH}	10,442 ± 971
Relative distance	108 ± 16 $^{U, MH, R}$	112 ± 11	113 ± 11	110 ± 11 ^{MH}	111 ± 11
Distance >14 km·h^{-1}	2411 ± 745 ^{MH}	2505 ± 637	2643 ± 669	2415 ± 622 ^{MH}	2478 ± 622
Distance 14–21 km·h^{-1}	1928 ± 624 $^{U, MH}$	2026 ± 540	2154 ± 577	1970 ± 529 ^{MH}	2013 ± 543 ^{MH}
Distance <14 km·h^{-1}	7726 ± 898 *	8005 ± 565	8000 ± 551	7908 ± 561	7958 ± 569
Distance >21 km·h^{-1}	483 ± 229	478 ± 205	489 ± 207	445 ± 187	464 ± 193
Distance >24 km·h^{-1}	238 ± 146	232 ± 137	232 ± 133	211 ± 123	223 ± 125
Distance in possession	3674 ± 890	3704 ± 792	3732 ± 837	3620 ± 813	3663 ± 776
Out Possession >14 km·h^{-1}	1080 ± 509 ^{MH}	1109 ± 493	1172 ± 475	1078 ± 491 ^{MH}	1101 ± 478
Out Possession >21 km·h^{-1}	225 ± 153	221 ± 150	231 ± 147	206 ± 137	220 ± 142
Out Possession >24 km·h^{-1}	111 ± 98	108 ± 91	111 ± 88	98 ± 81	107 ± 85
Distance without possession	3919 ± 963 $^{U, MH}$	4134 ± 861	4132 ± 839	3870 ± 843 $^{U, MH}$	4048 ± 856
In Possession >14 km·h^{-1}	1174 ± 537 $^{U, MH}$	1224 ± 498	1297 ± 508	1162 ± 513 $^{U, MH}$	1207 ± 503
In Possession >21 km·h^{-1}	250 ± 170	247 ± 159	249 ± 153	229 ± 148	235 ± 146
In Possession >24 km·h^{-1}	123 ± 105	121 ± 101	119 ± 93	110 ± 90 ^{C}	113 ± 89

Note: Data represent means and standard deviations. CL = UEFA Champions League; EL = UEFA Europa League; UMT = Upper Middle Table; LMT = Lower Middle Table; R = Relegation; * = Substantial differences with all other teams; C = Substantial differences with Champions League Teams; U = Substantial differences with UEFA Europa League Teams; MH = Substantial differences with Upper Middle Table; R = Substantial differences with relegation teams.

Table 2. Effect size and *p* valor.

	Comparison between Groups																			
	CL vs. EL		**CL vs. UMT**		**CL vs. LMT**		**CL vs. R**		**EL vs. UMT**		**EL vs. LMT**		**EL vs. R**		**UMT vs. LMT**		**UMT vs. R**		**LMT vs. R**	
Variable	**ES**	***p***	**ES**	***p***	**ES**	***p***	**ES**	***p***	**ES**	***p***	**ES**	***p***	**ES**	***p***	**ES**	***p***	**ES**	***p***	**ES**	***p***
Total Distance	0.3	0.00	0.4	0.00	0.0	0.00	0.3	0.00	0.1	0.00	−0.2	0.00	−0.1	0.25	−0.4	0.00	−0.3	0.00	0.1	0.01
Relative distance	0.3	0.00	0.4	0.00	0.2	0.00	0.2	0.00	0.1	0.00	−0.3	0.00	−0.1	0.07	−0.3	0.00	−0.2	0.00	0.1	0.02
In Possession	0.3	0.00	0.3	0.00	0.0	0.93	0.2	0.00	0.0	0.88	−0.3	0.00	−0.1	0.06	−0.3	0.00	−0.1	0.02	0.2	0.00
Without Possession	0.1	0.08	0.1	0.02	0.0	0.59	0.0	0.39	0.0	0.73	−0.1	0.01	−0.1	0.34	−0.1	0.00	−0.1	0.16	0.0	0.12
Distance >14 km·h^{-1}	0.2	0.00	0.3	0.00	0.1	0.00	0.2	0.00	0.2	0.00	−0.1	0.09	0.0	0.75	0.2	0.00	0.0	0.75	0.1	0.01
Distance 14–21 km·h^{-1}	0.2	0.00	0.4	0.00	0.2	0.00	0.2	0.00	0.2	0.00	−0.1	0.03	0.0	0.82	−0.3	0.00	−0.2	0.00	0.1	0.04
Distance <14 km km·h^{-1}	0.4	0.00	0.4	0.00	0.3	0.00	0.3	0.00	0.0	0.92	−0.2	0.00	−0.1	0.13	−0.2	0.00	−0.1	0.10	0.1	0.05
Distance >21 km·h^{-1}	0.0	0.40	0.1	0.03	0.1	0.15	0.0	0.63	0.1	0.21	−0.1	0.01	0.0	0.66	−0.2	0.00	−0.1	0.06	0.1	0.02
Distance >24 km·h^{-1}	0.0	0.37	0.0	0.37	−0.2	0.00	−0.1	0.10	0.0	0.90	−0.1	0.01	0.0	0.50	−0.1	0.00	0.0	0.38	0.1	0.09
Out Possession >14 km·h^{-1}	0.1	0.00	0.3	0.00	0.1	0.08	0.1	0.00	0.1	0.00	−0.1	0.11	0.0	0.84	−0.3	0.00	−0.2	0.01	0.1	0.17
Out Possession >21 km·h^{-1}	0.0	0.84	0.1	0.18	−0.1	0.25	0.0	0.74	0.1	0.31	−0.1	0.21	0.0	0.90	−0.1	0.00	0.0	0.37	0.1	0.16
Out Possession >24 km·h^{-1}	0.0	0.99	0.1	0.16	−0.1	0.10	0.0	0.83	0.1	0.22	−0.1	0.15	0.0	0.85	0.1	0.24	0.0	0.85	0.1	0.11
In Possession >14 km·h^{-1}	0.2	0.00	0.3	0.00	0.1	0.21	0.1	0.00	0.1	0.02	−0.3	0.00	0.0	0.38	−0.3	0.00	−0.2	0.00	0.1	0.03
In Possession >21 km·h^{-1}	0.0	0.74	0.0	0.91	−0.1	0.03	−0.1	0.16	−0.1	0.80	−0.1	0.02	−0.1	0.10	−0.1	0.01	−0.1	0.12	0.0	0.66
In Possession >24 km·h^{-1}	0.0	0.64	0.1	0.20	−0.1	0.00	−0.1	0.35	0.0	0.48	−0.1	0.01	0.0	0.66	−0.1	0.04	0.0	0.82	0.1	0.04

Note: ES = Effect size; p = p valor. CL = UEFA Champions League; EL = UEFA Europa League; UMT = Upper Middle Table; LMT = Lower Middle Table; R = Relegation.

Discussion

The aim of this study was to analyze teams in a highly competitive European national league according to their competition level. The main findings were that: (1) Teams in the Spanish first division did not have large differences in match running demands when analyzed according to competitive level. (2) The amount of distance covered in the analyzed variables did not seem to relate to success in the population and time frame studied, as the teams that qualified for the highest level of competition, the Champions League (positions 1st–4th), did not obtain the highest values. (3) Successful and unsuccessful teams had the same running requirements at higher velocities (>21 and 24 $km \cdot h^{-1}$).

Linking the success (or failure) of a team to physical performance has been of importance to coaches and strength and conditioning professionals. The analysis of the present data has demonstrated that the final position in the classification table of the Spanish La Liga did not depend on the running performance of the teams. These findings support the idea that overall, technical, and tactical effectiveness probably has a greater impact on results and a team's final league ranking in soccer [3].

Although our general results are in line with those described in the Premier League [12] and Serie A [13], which shows different physical performances in teams at different competitive levels, our data shows some notable differences. Previous literature describes less successful teams as those that cover greater total distance and distance above 14 and 19 $km \cdot h^{-1}$ in Serie A [13], and greater distance above 19.8 and 25.2 $km \cdot h^{-1}$ in the English premier League [12]. Our results show that in La Liga during a competitive season, the worst teams (R and LMT) did not cover a greater distance than those teams who finished higher in the standings (CL, EL and UMT) in practically any of the variables studied. These findings contrast with Rampinini et al. [13] who showed that in Serie A, less successful teams (15th–20th in the final ranking) covered 4% greater total distance than the more successful teams (1st–5th in the final ranking). Our data showed no differences between the last three teams and the seven best teams in the final league table. In light of this, it seems that covering greater distances than other teams and maintaining higher mean speed during the matches is not sufficient to achieve a position amongst the top four teams in the league.

The idea that a greater physical performance (running more meters) allows a team to win more matches should be discarded based on our data, as the most successful teams (CL) did not have the highest values for any of the previously mentioned variables or distances above and below 14 $km \cdot h^{-1}$, between 14–21 $km \cdot h^{-1}$, and above 21 and 24 $km \cdot h^{-1}$. This finding is backed up by the lack of difference between the second most successful group of teams (EL) and the teams at the bottom of the rankings who were relegated to the second Spanish division. With this in mind, we might suppose that the best teams in the league utilize technical and tactical means to win matches, and when a team is lower in the league it is probably not due to poor physical performance.

Despite the fact that previous research in soccer has shown that the distance covered at higher velocities (high intensity running and sprinting) is an important indicator of performance [9,10,15] and influences league position [12,13], the present research did not replicate these findings. These differences are possibly caused by the more precise classifications of performance groupings (CL, EL, UMT, LMT and R).

As previously described in the literature [10], variations in tactical instruction could have affected the physical demands placed on soccer players in and out of ball possession. Distance in possession >24 km·h^{-1} was the only variable where the most successful teams obtained the highest values. Considering that sprints are the most important action in decisive offensive situations in soccer [18], the higher values achieved by CL could provide them an advantage in creating a greater number of these situations; thus having more opportunities to win matches, and by consequence, finishing higher in the league table. Although it has not been studied in this work, the different percentages of ball possession in the Spanish league (successful >52.8% vs. unsuccessful <48.9%) also could explain this outcome. Successful teams spend more time with the ball, allowing more opportunities to accumulate more meters in this variable. The conclusions of previous literature vary depending on the league studied. In the Italian Serie A, the best teams cover the greatest total distance and total distance above 14 and 19 km·h^{-1} with ball possession [15]; whilst in the English premier league, the worst and middle ranked teams covered a greater distance above 19.8 km·h^{-1} without the ball [12].

Our data did not discriminate between the physical performance of successful and unsuccessful teams in La Liga, casting doubt on the idea that worse teams have greater physical outputs than the best teams. These values of match activity can be understood to be important for a better ranking at the end of the League season, without forgetting that overall technical and tactical effectiveness probably have a greater impact on results and teams' final league rankings [3].

This study presents some limitations. Firstly, it has only researched some physical data without including technical-tactical information or parameters gained by GPS microtechnology that allow us to assess performance in a more holistic manner. For this reason, we feel it would be interesting to replicate this study including technical-tactical data and accelerations, decelerations, player load, etc. Likewise, another limitation present in this work is that data with and without possession were studied without taking into account the number or the effective time of possession in each group. Future studies should perform this analysis to verify how these data are modified. Another important limitation is that the presented data show mean responses of a group of teams without explaining individual responses of the players in each team, so future literature should identify individual responses of each position in the chosen groups.

In summary, our results show that there were differences in physical performance in competitions between successful and unsuccessful teams in a highly competitive league season. These differences occur even among successful teams when they are classified in terms of final ranking (UEFA Champions League, UEFA Europa League and Upper Mid-Table). Equally important, is that our data indicates that unsuccessful teams do not always achieve a higher physical performance than successful teams, as has been established previously in the literature.

The present study shows that when teams are classified in terms of their final ranking, there are no differences in running demands between successful and unsuccessful teams. With this data in mind, it can be said that:

- Having a knowledge of the physical demands of the game allows coaches to prepare specific training that allows the players to cope with this demand. The present data helps them to obtain some guidelines on the performance of professional teams.

- Technical staff should ensure that their players can achieve the values necessary to achieve optimal performance in their league.
- Increasing the physical demands of the players, alongside their technical and tactical abilities, is a potentially suitable route to increasing team performance. Thus, training in a holistic manner where players improve their fitness with the ball through modified games, could be a recommended modality to achieve success in soccer.

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CHAPTER 3: STUDY 2

Influence of the tactical behaviour in the time-motion of the three best teams of a highly competitive and successfully soccer league.

Abstract

The aims of this study were to examine the influence of tactical behaviour (playing formation, playing style and tactics) on the physical performance top three teams of Spanish league and compare the differences in the physical demands of each individual positional role depending of the characteristics of these teams. A total of 54 soccer players of the top 3 teams in the Spanish first division were assessed during a complete season, using a video match-analysis system to obtain a total of 814 individual match observations. The players were categorised as full backs (FB), central defenders (CD), central midfielders (MF), wide midfielders (WM) and Strikers (S). Match performance parameters measured were: Total Distance covered (TD), Relative Distance (RD), Distance covered when the team was in possession of the ball (Dist. In Possession), Distance covered when the team was not in possession of the ball (Dist. Out Possession), High-intensity running (Distance >14 km·h^{-1}), Distance 14-21 km·h^{-1}, Distance below of 14 km·h^{-1}, Distance above of 21 km·h^{-1} (Distance >21 km·h^{-1}) and Sprint running (Distance >24 km·h^{-1}). There were very few significant differences in any variable measured between the teams except 3 of them in which there were differences between two teams. However, there were several differences in individual physical performance depending on the position. Although tactical behaviour did not influence in time-motion global performance of the teams, it did in the individual physical performance of their players depending on the position. These data demonstrate that the demands of each soccer player is influenced by playing formation, playing style and tactics of the teams where they are playing.

Key words: Soccer; football; match analysis; training; monitoring; demands.

Introduction

In the last 20 years there have been many studies that have described the physical demands of match play in professional soccer players (Abade, Gonçalves, Leite, Sampaio, 2014; Vigne et al., 2013). This increase in time-motion research has improved our understanding of the global match demands (Bradley & Nassis, 2015) and position-specific activity profile of soccer players (Dalen et al., 2016). Most studies have described differences in activity profile (i.e. distance covered at different speed ranges) according to the playing position and its relationship with match performance (Aquino et al., 2018; Gonçalves et al., 2014; Torreño et al., 2016). As a result of these studies, it is known that central defenders (CD) cover less total distance, less distance very high intensity distance and sprint distance during match play, while both central and wide midfielders (MF) travel greater distances (Mohr, Krustrup, & Bangsbo, 2003; Di Salvo et al., 2007; Di Salvo et al., 2009; Rampinini et al., 2007; Buchheit et al., 2010; Bradley et al., 2010; Torreño et al., 2026). However, wide midfielders (WM) travel greater distances than central MF during both high, and very high intensity running (Di Salvo et al., 2009; Bradley et al., 2010; Torreño et al., 2016; Buchheit et al., 2010). Indeed, both strikers (S) and WM cover more distance sprinting (Di Salvo et al., 2009; Di Salvo et al., 2007; Buchheit et al., 2010). Collectively, these studies show that that the different playing positions have unique physical and bioenergetics demands (Bradley et al., 2010).

Whilst the playing position has been the most common approach to analysing time-motion data, there are other contextual factors that may also influence activity demands of soccer. Indeed, team playing style, formation and tactics can also affect to the player's individual physical performance (Carling et al., 2008). Specifically, Bradley et al. (2011) showed that whilst playing formation (1-4-4-2, 1-4-3-3 and 1-4-5-1) playing formation did not influence the overall high intensity activity profiles of players (with the exception of except for attackers), it did influence the very high-intensity running activity both with and without ball possession.

In addition to playing formation, the competitive level of the team individuals are playing within can also affect match activity profile. Studies from both the English Premier League (Di Salvo et al, 2009) and the Italian Serie A League (Rampimini et al 2009) have shown differences in the physical behaviour between the best and worst teams (comparing first 5 teams vs last 5 teams and top 10 vs last 10, respectively), and that each position's performance is influenced by the type of team (including its habitual player formation). Recently, our research group reported differences in physical activity profile with the team's competitive level in the Spanish 1st division (La Liga), with results showing that when teams were classified in terms of their final raking, there were differences in the match running activity of the successful and unsuccessful teams (under review). So it can be affirmed that the physical activity varies between teams with different competitive levels but currently, it is not possible to determine if this behaviour also happens with teams of similar level but different technical-tactical characteristic.

At present no studies have determined if different playing formations, within the same homogenous competitive level (of the same league) might influence activity profile. Moreover, no studies have described the player's match physical activity profile for each individual positional role within different formations in teams with different playing formations, playing style and tactics, but similar competitive level. Therefore, the aims of this project were to 1) examine the influence of the playing formation, playing style and tactics in the physical performance of the best three teams of a highly competitive national soccer league; and, 2) determine the differences in the physical demands of each individual positional role depending of the characteristics of these teams.

Methods

Subjects and match data

Match physical performance data were collected from 54 soccer players, from the top three teams of the Spanish La Liga 1st division league during the 2013 – 2014season. Players were categorised into one of five individual playing positions including full backs (FB) (n = 12), central defenders (CD) (n = 12), central midfielders (MF) (n = 9) and wide midfielders (WM) (n = 14) and Strikers (S) (n = 7). A total of 814 individual match observations were undertaken on outfield players (goalkeepers were excluded) with a median of 15 games per player (range = 1 – 34). The inclusion criteria were (Carling et al., 2016): (1) participation in a minimum of 10 of these matches, (2) matches in which 90 min play were completed; and (3) matches in which players played in their customary position throughout play and the team playing system was unchanged.

The seasonal performance of the teams analyzed was very high, with the top three teams performing very well in the European leagues (i.e. the 1st, 2nd and 3rd ranked League teams were finalist, champion and quarter finalist in Champion's League, respectively). Moreover, these teas performed very well in the national league 1st, 2nd and 3rd teams making 90, 87 and 97 league ranking points, respectively. Additionally, the 1st, 2nd and 3rd teams were semifinalist, finalist and champion, in the national cup respectively. As a result of the high level of success and competitive level the total number of official matches played during the season (including Champions League, League and Cup) was also very similar (i.e. 59, 58 and 60 matches, respectively).

A group of UEFA qualified coaches verified each team's technical-tactical profile and playing formation throughout each game using video analysis. The tactical organisations referred to how teams were distributed in the pitch across time and, anecdotally, were held responsible either for increasing or decreasing the overall productivity of the players (Memmert, Lemmink, & Sampaio, 2017). The three evaluated teams had the following characteristics:

1st team - Atlético de Madrid (ATM): This team employed a compact structure distributed in a 1-4-4-2 formation. In defensive phases, they usually accumulated most of the players behind the ball. Direct attacks were the most frequent offensive style.

2nd team - FC Barcelona (BAR): The standard formation of this team was 1-4-3-3. Their style of play was mainly indirect they constantly used short passes and accumulated several players around the ball. A common defensive characteristics was creating rapid pressure in the same area of the possession loss.

3rd team - Real Madrid CF (RMA): This team used a 1-4-3-3 formation, with an offensive style of play using on elaborate attacks and a strong counter-attack. In defence they prioritized the high pressure in opponent pitch with the ball.

Data collection and analysis

A multiple camera semi-automatic computerised player tracking system (AMISCO Pro®, Sport-Universal Process, Nice, France) was used to characterise match-running performance. The validity of this tracking system has been previously verified (Zubillaga, 2006). Similar to other study (Bradley et al., 2011), the matches were analyzed by distinguishing a set of activity categories including: Total Distance covered (TD) (m), Relative Distance (RD) ($m \cdot min^{-1}$), Distance covered when the team was in possession of the ball (Dist. In Possession) (m), Distance covered when the team was not in possession of the ball (Dist. Out Possession) (m), High-intensity running (Distance >14 $km \cdot h^{-1}$) (m), Distance 14-21 $km \cdot h^{-1}$ (m), Distance below of 14 $km \cdot h^{-1}$ (m), Distance above of 21 $km \cdot h^{-1}$ (Distance >21 $km \cdot h^{-1}$) (m) and Sprint running (Distance >24 $km \cdot h^{-1}$) (m).

Statistical Analyses

The data are presented as mean ± standard deviation (SD). All variables presented normal distribution (Shapiro-Wilk Test). A repeated-measures analysis of variance was used to determine differences in the distance covered in each speed zone, accelerations and decelerations, maximal velocity and metres per minute covered. Quantitative differences were assessed qualitatively (Hopkins et al., 2009) as: <1%, almost certainly not; 1−5%, very unlikely; 5−25%, unlikely; 25−75%, possible; 75−95%, probably; 95−99%, very likely; and >99%, almost certain. A substantial effect was set at >75% (Suarez-Arrones et al., 2015; Torreño et al., 2016). If the chance of higher or lower differences was >75%, the true difference was assessed as clear.

Results

Analysis of data showed substantial differences between team in TD, distance covered above 14 $km \cdot h^{-1}$, distance covered above 21 $km \cdot h^{-1}$ and distance covered above 24 $km \cdot h^{-1}$ (see table 1). Specifically, ATM players covered a substantially greater TD than BAR, without differences between RMA and both teams. RMA mean distances (above 14, 21 and 24 $km \cdot h^{-1}$) were substantially greater than BAR, but not different to ATM. There were no differences, in RD, Dist. in possession, Dist. out possession, distance 14-

21 km·h^{-1} and distance below 14 km·h^{-1} between any of the teams.

Table 1: Comparison of the time-motion characteristics of three best team of Spanish League during the 2013-14season.

Variable	ATM	BAR	RMA
Total Distance	10364 ± 1108^{B}	10074 ± 1172	10168 ± 748
m·min^{-1}	110 ± 11	107 ± 12.6	108.1 ± 8.2
Distance In Possession	3995 ± 911	3864 ± 926	3960.6 ± 809
Distance Out Possession	3626 ± 876	3821 ± 898	3772.3 ± 683
Distance < 14 km·h^{-1}	7878 ± 512	7819 ± 799	7708.4 ± 517
Distance >14 km·h^{-1}	2485 ± 802	2254 ± 513	2459.2 ± 445^{B}
Distance 14-21 km·h^{-1}	2001 ± 706	1804 ± 444	1942.3 ± 389
Distance >21 km·h^{-1}	484 ± 199	449 ± 216	516.9 ± 207^{B}
Distance >24 km·h^{-1}	235 ± 131	220 ± 141	263.6 ± 147^{B}

The ATM and BAR FB covered substantially more TD than those of RMA. The RMA CD covered substantially more TD than their counterparts from other teams. For both midfield positions (i.e. MF, WM), ATM players covered substantially more total distance, although in the case of WM there were also substantial differences between BAR and RMA. Similarly, ATM S covered substantially more TD than those of BAR, but both covered substantially less TD than those form RMA. The variable RD, showed similar behaviour that variable TD to the three teams. The players of teams also showed a different physical activity profiles whilst in possession of the ball. Whilst in possession, FB of ATM and BAR covered substantially more distance than the RMA FB.

Table 2: Time-motion characteristics adjusted for position and team. Note: Data represent means and standard

	ATM					BAR					RMA				
Variable	FB	CD	MF	WM	S	FB	CD	MF	WM	S	FB	CD	MF	WM	S
Total Distance	10680±519^{R}	9230±586	11582±623*	11288±499*	9327±568^{B}	10745±545^{R}	9266±751	10859±700	10420±349^{R}	8381±1072	10079±625	9788±412*	10896±811	9986±626	10092±631*
$m \cdot min^{-1}$	113±5^{R}	98±6	123±6*	120±5*	99±6^{B}	114±5^{R}	98±8	115±7	110±4^{R}	88±11	107±6	104±4*	106±9	106±7	106±6*
Dist In Possession	4115±746^{R}	3477±661	4603±933^{B}	4418±999*	3495±685^{B}	4144±786^{R}	3552±526^{A}	4155±917	3889±1221	3251±1144	3886±574	3728±510*	4395±812	3653±940	3859±938^{B}
Dist Out Possession	3742±677	3159±737	4142±991	3979±934	3242±597	4144±786*	3552±526^{A}	4204±874	4158±1050^{R}	3066±1021	3750±513	3525±399^{A}	4179±651	3653±990	3871±717*
Distance $< 14\ km \cdot h^{-1}$	7856±256^{R}	7706±397^{B}	8360±324	8289±299*	7097±389^{B}	8051±400*	7349±518	8561±374*	7789±250^{R}	6624±681	7488±499	7766±314^{B}	8144±576	7398±362	7564±344*
Distance $>14\ km \cdot h^{-1}$	2824±474^{R}	1523±278	3221±754*	2999±345^{R}	2230±297^{B}	2693±293^{R}	1916±326^{A}	2298±459	2631±257	1756±456	2591±348	2022±254*	2752±364^{B}	2587±401	2527±368*
Distance $14\text{-}21\ km \cdot h^{-1}$	2209±399*	1220±237	2979±590*	2513±326*	1550±266^{B}	2051±268	1524±299^{A}	2039±443	1889±125	1290±290	1986±241	1640±201*	2371±373^{B}	1839±301	1930±302*
Distance $>21\ km \cdot h^{-1}$	614±141	302±93	442±215^{B}	485±116	1550±266^{B}	642±163	391±100^{A}	258±99	745±200^{A}	1290±290	605±180	311±96^{A}	381±140^{B}	748±163^{A}	1930±302*
Distance $>24\ km \cdot h^{-1}$	297±97	149±67	169±105^{B}	213±77	420±142*	335±120	193±66^{A}	93±56	396±133^{A}	242±139	303±134	190±75^{A}	155±86^{B}	439±126^{A}	290±67^{B}

However, RMA CD covered significantly more distance than ATM and BAR CD. The ATM MF and WM performed substantially more distance than BAR midfielders. Both, WM of RMA and S of ATM and RMA also showed substantial differences with BAR. Whilst not in possession of the ball, BAR FB covered substantially more distance than FB from both other teams. CD of both BAR and RMA covered more distance than ATM CD, without substantial differences. In the case of midfielders, while the MF of the three teams carried out the same physical work, BAR WM performed higher physical activity than those of RMA without possession of the ball. Finally, RMA S covered substantially more distance than those of ATM and BAR.

There were also differences in terms of distance covered in different speed zones. BAR FB travelled greatest distance < 14 $km \cdot h^{-1}$, followed ATM and RMA, with substantial differences between each. CD of ATM and RMA covered substantially more distance than those of BAR. Similarly, BAR MF covered substantially more distance than those of ATM and RMA. The ATM WM players covered the highest distance, followed BAR and RMA, with substantial differences all teams. Similarly, the S also showed substantial differences for the three teams, where RMA S accumulated greatest distance, followed of ATM and BAR.

FB of ATM and BAR ran substantially more distance at high intensity (>14 $km \cdot h^{-1}$) than their RMA counterparts, while RMA CD were covered more distance, with substantial differences than both ATM and BAR. ATM MF were covered substantially more distance at >14 $km \cdot h^{-1}$ than the BAR and RMA.

The RMA S and BAR S, travelled substantially greater and lower distances that the ATM forwards, respectively. The ATM and RMA travelled greatest distances 14-21 km·h^{-1}. Indeed, the FB, MF and WM of AMT covered substantially more distance than those of BAR and RMA. Similarly, there were substantial differences between the MF of BAR and RMA. Both the CD and S of RMA covered substantially more distance than those of ATM and BAR. There were also substantial differences between ATM and BAR for these positions.

With the exception of the S, there was similar physical activity profile in the two highest speed zones (>21 km·h^{-1} and >24 km·h^{-1}). There were no differences for the FB position between teams. However, the CD, WM of BAR and RMA covered greater distance in these zones compared to their counterparts at ATM. Moreover, the ATM and RMA covered substantially more distance than BAR MF in these zones. For the distance >21 km·h^{-1}, the RMA S covered substantially more distance than those of ATM and BAR, while the ATM S covered substantially more sprint distance (> 24 km·h^{-1})than those of RMA and BAR.

Discussion

The purposes of this study were analysing the influence of tactical behaviour (playing formation, playing style and tactics) on the physical performance of the best three teams of a highly competitive and successfully national soccer league; and, to describe the differences in the physical demands of each individual positional role depending of the characteristics of these teams. The present results showed that the time-motion of the three best teams of Spanish first division were not significantly affected by their tactical profile while, it did influence the individual physical performance of their players depending on the position.

Our outcomes indicated that the running activity of the more successful teams in La Liga did not condition their final classification because, ATM (champions team) showed no difference with the third classified (RMA) and uniquely had differences in 1 (TD) of 9 analyzed variables with BAR (second classified). These observations are in accordance with previous several previous studies on top national level leagues (Bradley et al., 2011; Carling, 2013; Di Salvo et al., 2009; Rampinini et al., 2009) and support the idea of the physical performance is not directly related to the final position of the teams. On the other hand, our observations also agree with Bradley et al., (2011), who demonstrated that total distance, high-intensity running and very high-intensity running did not differ between 1-4-4-2 and 1-4-3-3. Based these previous observations, it has been suggested that overall technical-tactical effectiveness has a greater impact on results and teams´ final ranking than activity profile (Carling, 2013; Di Salvo et al., 2009). In our study they were only differences, in 3 from 9 variables, between BAR and RMA and in one between BAR and ATM. Since BAR and RMA had similar playing formation (1-4-3-3), these differences could be mainly due to the tactical style. For example, RMA typically demonstrated the greater ability to counter-attack and with interchange of play, which allowed them to use the wide free spaces and therefore travelling greater distances at higher speeds (i.e. > 14 $km \cdot h^{-1}$, 21 $km \cdot h^{-1}$ and 24 $km \cdot h^{-1}$). In contrast, BAR practiced more elaborate attacks, which implied that their player progressed together around the ball with shorter movements of them and a greater number of passes between teammates. This offensive style of BAR could cause differences in TD with respect to ATM that presented a greater defensive style and expended more time defending and with more dynamic attacks.

While is well established that playing position impacts on the demands of the players during the matches (Di Salvo et al., 2009; Rampinini et al., 2007; Torreño el al., 2016), no studies have examined if the demands of each individual position could be influenced by the tactical characteristics of successful teams with the same competitive level. The present results showed that tactical profile of teams affected differently to individual positions to each of them. The FB of both ATM and BAR travelled greater total distances than their RMA counterpart. It appears that these differences could be due the tactical role of the ATM and BAR. For example, ATM FB were continually recovering the initial position in order to maintain defensive organisation, whilst the BAR FB made continuous movements to incorporation to the attack. In contrast, the quick interchange of play practiced by RMA could explain the distance covered by CD compared to the other teams. Notably, in contrast to Bradley et al. (2011) who described that the defenders in the 1-4-4-2 formation covered more total distance that those in a 1-4-4-3 formation, we did not have the same observations. One possible explanation for these differences is the influence of different tactical approaches on these characteristics.

The ATM style - which is used a compact structure in a 1-4-4-2 formation and played most of the players behind the ball in defence and commonly used direct attacks - is reflected in MF and WM activity profiles. Indeed, both the MF and WM tended to played defensively and this was shown in higher TD covered, while the MF of both BAR and RMA played with an offensive attitude, therefore they spent more time in offensive actions. The quicker interchange of play and the great ability to counter-attack allowed to RMA S to take advantage of wide defensive spaces and the defensive disorganization of opponents which resulted in greater overall and relative distances than their counterparts from ATM and BAR. These arguments could also explain that responses of all positions were similar to RD and TD with only exception of BAR S, who their greater amount of positional attacks together with the greater accumulated time close to the area goal could have lower their RD.

The FB of both BAR and ATM covered more distance in possession of the ball than the RMA FB. This could be explained by the tactical approach of the BAR FB who usually passed more often allowing the, to link into the attack and being involved in more creative attacking movements. In the case of ATM, the tactical approach of their WM was to occupy central field positions in attack which allowed them to be more involved in offensive phases of play. Indeed, the offensive style of BAR and RMA can be seen in others defensive positions. For example, both CD from BAR and RMA participated more with possession of the ball than ATM CD who tended to adopt a more defensive style. The greater ability of BAR and RMA to attack using an indirect approach (i.e. where the ball is moved from one side to the other, mainly through short passes and with continuous player´s movements) could explain the higher distance covered by MF and WM of ATM compared to those of RMA and BAR. The attacking style may also explain the differences observed in the forwards. For example, the BAR S used to be situated closer to the opponent´s goal during attack, which may have allowed them to travel lower distances than the S of RMA and ATM.

Due to their typical offensive style of BAR and RMA their defenders were required to travel greater distances regain pressure on the opposing teams and/or to obtain an appropriate defensive position. Indeed, the high activity of BAR WM could be in part, explained by their relatively wide positioning which required them to cover greater distances to regain pressure when defending. RMA S also showed, as in the most of variables, a greater physical performance than S of other teams. How it is know, when a counter-attack is performed in soccer, strikers are responsible of run fast to the opponent pitch to achieved long and intense runs, as pointed out above, the frequent ability to counter-attack of RMA could be the cause why their stickers had a greater demands.

In the next velocity zones evaluated (> 14 km·h^{-1} and between 14-21 km·h^{-1}), it was observed the same behaviour in the teams. In the case of FB, players of ATM covered more distance in both zones than others, these data are similar previous research which showed that defenders in a 1-4-4-2 formation, as ATM, cover more distance at high intensity and very high intensity than those of a 1-4-3-3 formation used by BAR and RMA (Bradley et al., 2011). In contrast, RMA CD covered more distance than the ATM and BAR. Differences in the present observations, with previous studies could be due other investigators analyzed FB and CD together. The higher possession of the ball of BAR and RMA (Collet, 2013) could explain that ATM MF had to expend more time defending and trying to recover the ball at these speeds. The offensive and defensive organization of ATM and BAR could also explain the greater distance covered by their S compared with the S of BAR. Mainly, philosophy of BAR is characterized because the ball has to be moved beyond to the players in attack, and them, have to execute the ¨lost-pressure¨ (when a player loses the possession, he and his nearest teammate go to press to the place where it was lost) in defence. Both aspects are related to have the possession and to run the less possible. So this could be the reason why S of BAR achieved a lower demands than their colleagues of ATM and RMA. This paradigm also would explain why The FB and MF of BAR covered significantly more distance at low intensity (< 14 km·h^{-1}). To maintain the ball possession, MF need to move continuously at low intensity providing support across the pitch, both in defensive and offensive phases of play and also providing a linking role (Di salvo et al., 2007), and FB have the same support role but in the wider zone of the pitch. Unlike its teammate, CD of BAR achieved the significantly lower values in this variable than CD of ATM and RMA. Normally than teams when teams played against BAR, they retracted their defensive lines, so these players had not opposition in attack (offering a positional support) and in defence, how the lost of the ball where in more advanced positions (where the opponent team was placed), the ¨lost-pressure¨ of their teammates allowed them less movements scoring lower values. Considering that the defensive balance of ATM requires to accumulate players in the central zone, especially WM, could have led that many times they adopted a MF role, covering more distance at low-intensity than the WM of the other teams. The greater amount of work carried out by the S of RMA also was reflected in this variable, slower movements to star the defensive pressure or to prepare the counter-attack would be the cause of this.

When were analyzed the highest velocities (> 21 $km \cdot h^{-1}$ and > 24 $km \cdot h^{-1}$), all the positions kept the same behaviour to both, except in the case of striker position. the FB covered the same distance, irrespective of their team. These observations suggest that FB of the top Spanish teams have the similar demands at highest speeds. This is likely explained by their continued involvement in both phases of the game (attack and defence), and the regular opportunities of space on the flanks that are provided by the opponent team as part of their defensive system (Bradley et al., 2009). The offensive style of the BAR and RMA might explain the higher distances covered at highest speeds in the CD, particularly as they are required to defend further away from the goal and are less protected than ATM CD. The lower activity demands of BAR MF might be explained by the attempt to cluster players within the same zone, which doesn’t allow players to run into space and achieve higher speeds. This also likely occurred with the ATM WM, who frequently used the central zone of the pitch to attack, rather than using the flanks to attack (where high speeds are usually achieved) (Di Salvo et al., 2007). Considering that both ATM and RMA frequently made greater amount of attacks further away from the opponent goal, it could explain the greater distance obtained at these speeds for their S in comparison with the players of BAR.

Collectively, the present observations support the concept that soccer match performance results from the players' individual and multidimensional skills, expressed within a collective organisation (Memmert, Lemmink, & Sampaio, 2017). Despite that can teams presents the same competitive level in the classification, their tactical profile (formation and philosophy) could affect group and individual physical performance of soccer players. For this reason, it can be affirmed that the physical aspect is not the sole determinant of success in soccer and that to achieve a suitable understanding of soccer it is necessary a holistic vision that integrate the tactical, technical, psychological, and physical issues (Castellano et al., 2014).

Despite the important knowledge reported in this paper about the time-motion analysis of most successful Spanish teams, it is important to note that some limitations should be considered. We only compare 3 successful teams of the Spanish first division. These data could not be replicate to others group-teams. With this in mind, it would be necessary to reproduce this analysis in others important leagues or with groups of other standard performance, i.e. unsuccessful teams. Although an analysis of running performance of teams has been showed, more physical information it is necessary because the absence of locomotors variables (acceleration, deceleration or player load, etc.) and variables of internal load (rating of perceived exertion and hearth rate) could b necessary to avoid underestimate the real effort and load of soccer players (Dalen et al., 2016). Despite that the most of results are explained according to a holistic perspective, in this work technical-tactical data have not been contrasted objectively so it would be interesting to know if this knowledge is corroborated in an objective analysis of the technical-tactical behaviour of the teams.

Practical Applications and Conclusions

To provide relevant data on time-motion of successful teams, the current study examined the match running performance of three best Spanish teams. The present study showed that the physical performance of them in a very competitive league practically did not changed. With this in mind, coaches should be ensured that their teams will have the same running behaviour than their main opponents to avoid that they will be overcome in the physical aspect. By achieving this, their activity should be focused to the technical-tactical perspective and how win to their contenders through that. On the contrary, tactical profile of teams has been configured than a key element in the individual physical performance of players. The philosophy and formation of teams condition movements and intensities of them. With this knowledge, strength and conditioning coaches must design specific, individual and preventive training to players may be able to resist efforts of matches and maintain their selves without injury.

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CHAPTER 4: STUDY 3

The examination of external load in competitive, non-competitive matches and small-sided games amongst elite soccer players

Abstract

The primary aim of this study was to compare the external load of competitive and non-competitive matches in addition with a modified-sided game in order to analyse differences between them. Time-motion of ten elite soccer players (age= 20.1 ± 2.1 years) a professional team of Spanish first division were recorded during official (n=12), friendly (n=7), training (n=6) matches and a 5 vs. 5 + goalkeepers modified-sided game (n=3) with a similar relative pitch area competitive match-play (300 m^2). GPS devices were used to monitor distance in speed thresholds (<13.9 $km \cdot h^{-1}$, >14 $km \cdot h^{-1}$, 18 $km \cdot h^{-1}$, 21 $km \cdot h^{-1}$ and 25 $km \cdot h^{-1}$), number of accelerations and decelerations (between 1.5 – 2.5 $m \cdot s^{-2}$, 2.5 – 4 $m \cdot s^{-2}$ and 4 – 8 $m \cdot s^{-2}$), maximum speed and relative distance. The results of this study show that, in comparison to official matches, training matches showed more distance covered at high speed (>25 $km \cdot h^{-1}$), accelerations and decelerations than official matches (except high accelerations), SSG's showed higher values in all accelerations and decelerations, SSG and friendly matches elicit higher relative distances ($m \cdot min^{-1}$) and peak velocity was lower in all tasks analyzed. Coaches should fully understand the different physical outputs of these specific tasks depending on the targeted objective based on the fact that each of them have a significant different physical outcome.

Key words: demands, football, training, monitoring.

Introduction

Despite the worldwide popularity of soccer, many uncertainties concerning the game's multidimensional requirements and consequently uncertainties when planning for teams' optimal training and conditioning processes still exist (Abrantes et al., 2012). Throughout the last decade, a substantial growth in research related to specific training methods in soccer with a strong emphasis on the effects of small-sided games (SSG) has been produced (Owen et al., 2012; Aguiar et al., 2012; Hill-Haas et al., 2011). SSGs represent modified games played on reduced pitch areas, often using adapted rules and involving a smaller number of players than full-size soccer matches (Hill-Haas et al., 2011). Amongst the technical and conditioning staff within football, SSGs are fundamental to the development of technical and tactical skills simultaneously under greater than normal specific physical loads (Hill-Haas et al., 2011). Recent literature has also highlighted that SSGs maintain higher levels of player motivation in unpredictable training environments (Torres-Ronda et al., 2015).

Player comparison between competitive match demands with different SSGs types seem fundamental for coaches and practitioners in professional soccer. As a result, these comparisons are suggested to allow specific drills that elicit similar, greater or lower loads compared to actual match-play, with the aim of providing an optimum training intensity stimulus (Owen et al., 2014; Torreño et al., 2016). However, very few studies have compared the demands of the competition and the SSG with the intention of achieving more specific adaptations and better performance of the soccer players (Gómez-Carmona et al., 2018). In this sense, Dellal et al., (2012) compared the effect of three different 4vs. 4 conditioned SSGs (where the numbers of touches allowed was modified) with two friendly matches and they observed that the amount of high intensity activities and the metres per minute of play were higher in the SSGs than in friendly matches. In a similar study, Casamichana et al., (2012) showed that players covered greater quantity of sprints and with more duration and distance in friendly matches than in the SSGs. However, in the SSGs players spent more time running in the zone of 7-12.9 $km \cdot h^{-1}$ and accumulated greater overall workloads. There are few studies that have compared the demands of SSGs and official matches (Gabbet & Mulvey, 2008; Gómez-Carmona et al., 2018). A recent study in this area conducted with female soccer players, showed more repeated sprint performance in international matches than in domestic-league, national league and SSGs. The second, study in a similar area performed with youth semi-professional soccer players showed how SSGs overload and underload specific metrics when compared with official matches, highlighting the need to have clear coaching objectives pre-planning stage of training (Gómez-Carmona et al., 2018).

However, to the best of the authors knowledge, no studies compare the demands of official, friendly and training matches and SSG in professional soccer players. As a result, this study will target and evaluate the usefulness of different tasks as a training medium, analysing their demands (i.e. relative distance, accelerations, etc.) and compare them with those obtained in official matches. The aim of this study was to analyse external load of competitive matches, non-competitive matches and a modified-sided game to analyse differences between them.

Methods

Experimental approach to the problem

Player's movements pattern and demands of SSG games were recorded and compared with those of official, friendly, and training matches in elite soccer players. We hypothesized that each of these drills of soccer would offer a specific training stimulus for different variables with regard of competition. Activity profiles of matches and SSG were obtained using global positioning system (GPS) technology, which enables movement patterns in sports to be monitored in a valid and reliable manner (Castellano et al., 2011; Jennings, et al., 2010; Petersen et al., 2009).

Subjects

Ten elite soccer players [(mean ± SD) age, 20.1 ± 2.1 years; maximal oxygen consumption, 55.96 ± 3.3 $mL^{-1} \cdot kg^{-1} \cdot min^{-1}$] participated in this study. Athletes were members of the second team of a professional soccer team of Spanish first division. In addition to the five skills-based sessions (i.e., small-sided training games), players performed two strength trainings sessions and two field conditioning sessions each week. All participants received a clear explanation of the study, including the risks and benefits of participation, and written consent was obtained. The institutional review board for human investigation approved all experimental procedures.

Procedures

Data were collected using portable GPS devices (SPI Pro X; GPSports Systems, Canberra, Australia) operating at a sampling frequency of 5 Hz and accelerometer at 100 Hz. ~~The~~ Players wore a special harness that enabled these devices to be fitted to the upper part of their backs. The GPS device was activated 15 minutes before kick-off, in accordance with the manufacturer's instructions. After recording, the data were downloaded to a PC and analyzed using the software package (SPI Pro X; GPSports Systems, Canberra, Australia). Players were familiarized to the use of these devices and to the SSG format used, during previous weeks. The validity and reliability of the GPS system have been previously reported (Coutts and Duffield, 2010; Varley, Fairweather & Aughey, 2012) and widely used in soccer players (Suárez-Arrones et al., 2015; Torreño et al., 2016; Casamichana, Castellano & Castagna, 2012)

Time-motion analysis was completed during training and official matches. All training sessions (n = 9) consisted one modified-sided game (n=3) played: six versus six in half pitch, dimensions of 50x60 (relative area per player of 300 m^2) and training matches (n=6) played: eleven versus eleven in a pitch of 100x60 (relative area per player of 300 m^2). SSGs were designed to develop similar skills and demands of the rest of task, so goalkeepers and official goals were included and the same relative area (m^2) per player and were played during 6 bouts of 5 minutes separate by 2 minute of passive recovery. During rest periods, the players could drink fluids ‘‘at libitum.’’ All the participants were advised to maintain their normal diet, with special emphasis being placed on a high intake of water and carbohydrates (Casamichana, Castellano & Castagna, 2012). To ensure the continuity of the match play several balls were collocated around the zone of play (Casamichana & Castellano, 2010). Likewise, to ensure the maximal intensity and motivation during the play the encouragement of coach was always presented (Rampinini et al., 2007).

Training matches, of 30 minutes of duration with official rules, were played during the training sessions. These types of matches are very common in professional soccer and the coaches use it often during the training weeks. Official matches (n=12) were registered during the first half of the league and the friendly matches (n=7) were played during the preseason. Both were played in pitches that maintain the same relative area per player of 300 m^2. All matches were 90 minutes in duration (the extra time were excluded) and only players that completed it were registered. Match activities were assessed at least 72 hours elapsed between each match, the opposing teams were always of a similar level, and the match format was kept constant to reduce any variability in the players' physical performance (Rampinini et al., 2007). The team used a 1–4–3–3 formation, comprising 2 central defenders, 2 full backs, 3 central midfielders and 3 strikers during all the matches.

The variables used to compare the physical demands of matches and SSG were as follows: The distance covered below 13.9 $km \cdot h^{-1}$ per minute, the distance covered above 14 $km \cdot h^{-1}$, 18 $km \cdot h^{-1}$, 21 $km \cdot h^{-1}$ and 25 $km \cdot h^{-1}$, the number of minor accelerations (Acc 1; Accelerations between 1.5 – 2.5 $m \cdot s^{-2}$), moderate accelerations (Acc 2; Accelerations between 2.5 – 4 $m \cdot s^{-2}$) and high accelerations (Acc 3; acceleration 4 – 8 $m \cdot s^{-2}$), the number of minor decelerations (Dec 1; decelerations between 1.5 – 2.5 $m \cdot s^{-2}$), moderate (Dec 2; decelerations between 2.5 – 4 $m \cdot s^{-2}$) and high decelerations (Dec 3; decelerations 4 – 8 $m \cdot s^{-2}$), the maximum speed (S_{max}) achieved and the relative distance (RD) covered per minute ($m \cdot min^{-1}$). These speed and movement zones are similar to those used in the study of Torreño et al. (2016). To compare results, all data were normalized per minute.

Statistical Analyses

The data are presented as mean ± standard deviation (SD). All variables presented normal distribution (Shapiro-Wilk Test). A repeated-measures analysis of variance was used to determine differences in the distance covered in each speed zone, accelerations and decelerations, maximal velocity and metres per minute covered. Significant differences were determined by a Bonferroni's post-hoc test. Cohen's effect size (ES) was also calculated to compare the magnitude of the differences between groups on certain variables (Cohen, 1988) and quantitative differences were assessed qualitatively (Hopkins et al., 2009) as: <1%, almost certainly not; 1−5%, very unlikely; 5−25%, unlikely; 25−75%, possible; 75−95%, probably; 95−99%, very likely; and >99%, almost certain. A substantial effect was set at >75% (Torreño et al., 2016). If the chance of higher or lower differences was >75%, the true difference was assessed as clear. The SPSS statistical software package (V20.0 for Windows, SPSS Inc., Chicago, IL) was used for data analysis.

Results

Table 1 shows the results of the comparison of external load between official matches, friendly matches, training matches and SSG. In SSGs soccer players covered with clear differences more distance at low-medium intensity (<13.9 $km \cdot h^{-1}$) than in official, friendly and training matches (90.9 ± 7.3 $m \cdot min^{-1}$ vs. 81.3 ± 3.2 $m \cdot min^{-1}$ vs. 85.2 ± 4.6 $m \cdot min^{-1}$ vs. 76.3 ± 11.8 $m \cdot min^{-1}$, respectively). When the matches are compared, it can be seen how in training matches less distance were covered, with clear differences with official a friendly matches. Likewise, between official and friendly matches there were clear differences too. When distance covered at high intensity (>14$km \cdot h^{-1}$) is compared the results show the same behaviour that in the distance covered at low-medium intensity, being the SSG in which the soccer players covered more distance with clear differences to the official, friendly and training match (24.9 ± 3.3 $m \cdot min^{-1}$ vs. 20.8 ± 3.6 $m \cdot min^{-1}$ vs. 22.1 ± 3.3 $m \cdot min^{-1}$ vs. 18.4 ± 4.1 $m \cdot min^{-1}$) also were found clear differences in the official and friendly matches with respect to the training matches and between both. When the distance covered at the next two speed ranges were assessed there were not differences in any of task, covering the same distance in official matches, friendly matches, training matches and SSG for the distance covered above 18 $km \cdot h^{-1}$ (8.8 ± 2.0 $m \cdot min^{-1}$ vs. 8.8 ± 2.1 $m \cdot min^{-1}$ vs. 7.8 ± 3.4 $m \cdot min^{-1}$ vs. 9.1 ± 2.3 $m \cdot min^{-1}$, respectively) and the distance covered above 21 km·h^{-1} (4.4 ± 1.1 m·min^{-1} vs. 4.0 ± 1.3 m·min^{-1} vs. 4.2 ± 2.7 m·min^{-1} vs. 3.6 ± 1.2 m·min^{-1}, respectively). It was in highest speeds (>25 km·h^{-1}) in which differences were found. Training matches were those in which the soccer player covered more distance above of this speed, with clear differences with official matches, friendly matches and SSG (1.3 ± 0.3 m·min^{-1} vs. 1.1 ± 0.5 m·min^{-1} vs. 1.5 ± 1.5 m·min^{-1} vs. 0.5 ± 0.3 m·min^{-1}, respectively). Theses data also shown substantial differences between official and friendly matches and revealed that lower distance was covered in SSG, with clear differences with regard to the official and friendly matches.

Table 1: Physical demands of official, friendly, training matches and modified-sided game.

	Competitive context	Non-competitive context		
Variable	Official Matches	Friendly Matches	Training Matches	Modified-sided game
TD < 13.9 km·h^{-1}	81.3 ± 3.2 ^{t}	85.2 ± 4.6 ^{o,t}	76.3 ± 11.8	90.9 ± 7.3 *
TD > 14 km·h^{-1}	20.8 ± 3.6 ^{t}	22.1 ± 3.3 ^{o,t}	18.4 ± 4.1	24.9 ± 3.3 *
TD > 18 km·h^{-1}	8.8 ± 2.0	8.8 ± 2.1	7.8 ± 3.4	9.1 ± 2.3
TD > 21 km·h^{-1}	4.4 ± 1.1	4.0 ± 1.3	4.2 ± 2.7	3.6 ± 1.2
TD > 25 km·h^{-1}	1.3 ± 0.3 ^{f,s}	1.1 ± 0.5 ^{s}	1.5 ± 1.5 *	0.5 ± 0.3
Acc1/min	1.7 ± 0.1 ^{f}	0.6 ± 0.1	1.7 ± 0.4 ^{f}	8.5 ± 0.5 *
Acc2/min	0.7 ± 0.1 ^{f}	0.2 ± 0.0	0.7. ± 0.2 ^{f}	2.0 ± 0.4 *
Acc3/min	0.03 ± 0.01	0.03 ± 0.01	0.06 ± 0.04 ^{o,f}	1.07 ± 0.27 *
Dec1/min	0.5 ± 0.1	0.6 ± 0.1 ^{o}	0.5 ± 0.2	2.3 ± 0.4 *
Dec2/min	0.2 ± 0.0	0.2 ± 0.0	0.2 ± 0.1	0.6 ± 0.2 *
Dec3/min	0.04 ± 0.02 ^{f}	0.03 ± 0.01	0.05 ± 0.05 ^{f}	0.16 ± 0.05 *
S_{max}	32.5 ± 0.9 *	29.4 ± 1.0 ^{t}	27.9 ± 2.2	27.1 ± 1.9
RD (m·min^{-1})	102.2 ± 5.5 ^{t}	107.4 ± 6.2 ^{o,t}	94.9 ± 12.2	116.1 ± 7.6 *

TD = Total distance; Acc = accelerations (Acc1: 1,5-2,5 m·s^{-2}, Acc2: 2,5-4 m·s^{-2}, Acc3: 4-8 m·s^{-2}); Dec = Deceleration (Dec1: 1,5-2,5 m·s^{-2}, Dec2: 2,5-4 m·s^{-2}, Dec3: 4-8 m·s^{-2}); S_{max} = maximal speed; RD = relative distance. Significantly different compared to the other tasks *; Official matches ^{O}; Friendly matches ^{f}; Training matches ^{t}; Modified-sided game ^{s}.

Accelerations analysis is shown in the table 1. In SSG more accelerations were performed, with clear differences than official matches, friendly matches and training matches (8.5 ± 0.5 $m \cdot s^{-2} \cdot min^{-1}$ vs. 1.7 ± 0.1 $m \cdot s^{-2} \cdot min^{-1}$ vs. 0.6 ± 0.1 $m \cdot s^{-2} \cdot min^{-1}$ vs. 1.7 ± 0.4 $m \cdot s^{-2} \cdot min^{-1}$, respectively) and moderate accelerations (2.0 ± 0.4 $m \cdot s^{-2} \cdot min^{-1}$ vs. 0.7 ± 0.1 $m \cdot s^{-2} / \cdot min^{-1}$ vs. 0.2 ± 0.0 $m \cdot s^{-2} \cdot min^{-1}$ vs. 0.7. ± 0.2 $m \cdot s^{-2} \cdot min^{-1}$, respectively). The results also indicate that more minor and moderate accelerations were obtained in official and training matches, than in friendly matches. In the case of higher accelerations although in the SSG (1.07 ± 0.27 $m \cdot s^{-2} \cdot min^{-1}$) continued performed clearly more accelerations than in the other task, were in the training matches (0.06 ± 0.04 $m \cdot s^{-2} \cdot min^{-1}$) in where only clear differences were found with the friendly matches, without differences between friendly (0.03 ± 0.01 $m \cdot s^{-2} \cdot min^{-1}$) and official matches (0.03 ± 0.01 $m \cdot s^{-2} \cdot min^{-1}$) as occurred in the both kind of accelerations examined before. On the other hand, decelerations showed a different than accelerations (table 1). Clear differences in SSG were found, showing more meters decelerating *vs* official matches, friendly matches and training matches for all kind of decelerations: minor (2.3 ± 0.4 $m \cdot s^{-2} \cdot min^{-1}$ vs. 0.5 ± 0.1 $m \cdot s^{-2} \cdot min^{-1}$ vs. 0.6 ± 0.1 $m \cdot s^{-2} \cdot min^{-1}$ vs. 0.5 ± 0.2 $m \cdot s^{-2} \cdot min^{-1}$, respectively), moderate (0.6 ± 0.2 $m \cdot s^{-2} \cdot min^{-1}$ vs. 0.2 ± 0.0 $m \cdot s^{-2} \cdot min^{-1}$ vs. 0.2 ± 0.0 $m \cdot s^{-2} \cdot min^{-1}$ vs. 0.2 ± 0.1 $m \cdot s^{-2} \cdot min^{-1}$, respectively) and highest (0.16 ± 0.05 $m \cdot s^{-2} \cdot min^{-1}$ vs. 0.04 ± 0.02 $m \cdot s^{-2} \cdot min^{-1}$ vs. 0.03 ± 0.01 $m \cdot s^{-2} \cdot min^{-1}$ vs. 0.05 ± 0.05 $m \cdot s^{-2} \cdot min^{-1}$, respectively). Moreover, differences were found only between friendly matches and official and training matches for the minor decelerations and between official matches and training matches regarding the training matches in the case of highest decelerations, being clear differences in all the cases. There were no more differences in moderate decelerations, except the explained those explained previously.

Maximal speeds (S_{max}) are also presented in the table 1. Peak of velocity during official matches (32.5 ± 0.9 $km \cdot h^{-1} \cdot min^{-1}$) was clearly higher than those obtained in friendly matches (29.4 ± 1.0 $km \cdot h^{-1} \cdot min^{-1}$), training matches (27.9 ± 2.2 $km \cdot h^{-1} \cdot min^{-1}$) and SSG (27.1 ± 1.9 $km \cdot h^{-1} \cdot min^{-1}$). There were also substantial differences in maximal velocities between friendly and training matches and clear differences between friendly matches and SSG. RD ($m \cdot min^{-1}$), also it is shown in the table 1. Players covered clearly more distance per minute in SSG than in either case: 116.1 ± 7.6, 102.2 ± 5.5, 107.4 ± 6.2 and 94.9 ± 12.2 $m \cdot min^{-1}$ in SSG, official matches, friendly matches and training matches, respectively. RD was higher in friendly matches than the obtained in the other two matches modalities, while the official and training matches also had a different performance, being significantly lower in these last.

Discussion

The aim of this study was to compare the external load of competitive matches, non-competitive matches and a modified-sided game to analyse differences between them. In comparison with the official matches, results suggested that: 1) Training matches showed more distance covered at high speed (>25 $km \cdot h^{-1}$), accelerations and decelerations (except high accelerations), 2) SSG's showed higher values in all accelerations and decelerations, 3) SSG and friendly matches elicit higher relative distances ($m \cdot min^{-1}$) and 4) peak velocity was lower in all tasks analysed.

There is no consensus on distance covered at different intensities, comparing SSGs and the competition. Our data revealed distance at low-medium intensity was higher in SSGs than official, friendly and training matches, being in last case the modality of matches where was observed less distance at low-medium intensity covered for the soccer players.

These findings are in line with the obtained by Casamichana et al., (2012) who found during the SSGs a greater total distance at lower intensity when these were compared with friendly matches. However, it is important to empathize that in this study the differences between friendly matches and SSG were shown within the 7.0 and 12.9 $km \cdot h^{-1}$ speed zone while in the lowest intensity zone (0-6.9 $km \cdot h^{-1}$) no differences were highlighted. A lower number of players together with similar relative area per player (300 m^2) could provoke that in SSGs the soccer players decide to wait for the opponent in more defensive positions nearest to the goal. This is a common behaviour in professional to defend the nearest zone to the goal, when is not possible to defend adequately all the space. This idea is strengthened by the fact that our study's soccer players replicate the same behaviour, being found the same differences, in the in the next zone of intensity (>14 $km \cdot h^{-1}$). However, the literature has showed contradictory results. On one side, Dellal et al., (2012) found similar results to ours, but Owen et al. (2014) found that in smaller and medium formats of SSGs (4vs4, 5vs5 or 6vs6) were covered less distance at these intensities than in the 11 vs 11. The differences in the results may file to the employed formats and player surface area in each study. Thus, although found similar values to ours, Gómez-Carmona et al. (2018) obtained different results between each SSGs and official matches, analysing the effects of modification of the SSGs´ rules (maintain, goal line, mini-goals and one goalkeeper),

There were no differences in distance covered at >18 and >21 $km \cdot h^{-1}$, suggesting that all of the tasks (SSG, training and non-competitive matches) were adequate to stimulate the same demands of competition in this aspect. Therefore, it can be assumed that these tasks were specific for the conditioning of soccer players. Previous studies had described different results in these variables. Owen et al. (2014) did not found differences, Casamichana et al., (2012) uniquely found differences in >21 km·h^{-1} speed zone, Dellal et al. (2012) found higher distance covered at theses intensities in SSGs *vs* friendly matches and Gómez-Carmona et al. (2018) described lower high intensity and sprint demands in SSGs vs official matches (except SSG's with goalkeeper included). These differences *vs* our results could be due to the differences in the relative pitch area of the studies (83 m^2 *vs* 300 m^2), in which a lower space could affect to the ability of obtaining highest velocities in SSGs. Different results found by Casamichana et al., (2012) can due to the different speed zones (>21 km·h^{-1} chosen by these authors vs >21 km·h^{-1} and > 25 km·h^{-1} selected by us). Furthermore, different in SSGs rules used by Dellal et al. (2012), in which they constrained the numbers of touches. It is known that the manipulation of the rules can modify the demands in these kind of tasks (Hill-Haas et al., 2011), so this could have affected to their physical demands and explain, at least in part, the differences between their and our results.

Soccer players covered more distance above 25 km·h^{-1} in training matches than in all other tasks. These results differ from those obtained by Dellal et al. (2012) in which sprint distance was higher SSGs than in friendly matches, and Gabbet & Mulvey (2008) in which a more frequent sprint were is described in international matches than in domestic matches, national matches and SSGs. The possibility of the reduction of high intensity during the course of match (Mohr, Krustrup & Bangsbo, 2003; Mohr, Krustrup & Bangsbo, 2005) could be the consequences of the lower distance covered per minute at sprint in official matches than in training matches because in our data. On one side, training matches are played during shorter time so pacing effect could be reduced. On the other hand, the competition between teammates to be a starter, that can be seen in these exercises, can be a good option to stimulate competition's high speed demands during training. The SSG proposed in the present study could be a good to reproduce match's high velocity demands. To keep the same area relative ($300m^2$) in order the players to have enough space to achieve high velocities but decreasing the number of players to set the soccer player is in the centre of play (increasing the possibility of interact with the ball) could be a good option in the design of tasks which these objectives. In fact, it has been described in previous studies (Casamichana & Castellano, 2010; Castellano et al., 2013; Dellal et al., 2011; Hill-Haas et al., 2011; Kelly & Drust, 2009).

Although the distance covered at different threshold of velocity have been very popular in soccer, it should not be ignored the metabolic demand of the soccer players (Akenhead, et al., 2013). Previous studies have described more low and moderate accelerations and decelerations with reductions of the pitch dimension, while maximal accelerations and decelerations increase when SSG dimensions being bigger (Gaudino, Alberti & Iaia, 2014). However, there is no study that compares the accelerations and decelerations jointly in official, friendly, training matches and SSGs. Our results are in line with those previously described (Gómez-Carmona et al., 2018), showing a greater amount of minor, medium and high accelerations and decelerations in the SSG than in official, friendly and training matches. Taking account that football matches reduce significantly concentric and eccentric peak torque of the knee extensors (Rahnama et al., 2003) and that failure of working muscles to produce the required force at appropriate times may increased risk of injury (Smith, Sizer & James, 2009), coaches could use this formats of SSG to stimulate predominant muscles in acceleration and deceleration because they are requested with greater intensity during this task.

S_{max} achieved in different matches and the proposed task were greater than the described by Owen et al. (2014) and Casamichana, Castellano & Castagna (2012). Despite this, S_{max} analysis revealed that none of the tasks allowed to achieve same values than the obtained in official match. This could be due to that, despite maintain the same rules than occurs in the friendly and training matches, the soccer players uniquely perform their maximum level when are integrated in the context of the official competition where the attention, motivation and pressure are highest. With respect to the large-side game played, it can be affirmed that even though it was played with the same area relative per player than the official game and the space of play was fairly large (60x50m), it does not seems enough to achieve maximum S_{max}. So, perhaps bigger dimensions should be used in the modified-sided games to obtain to obtain similar S_{max} stimulus than in official matches.

RD ($m \cdot min^{-1}$) was higher in SSG than in matches, as previously described (Casamichana, Castellano & Castagna, 2012; Owen et al., 2014; Gómez-Carmona et al., 2018). These values are similar to those shown by Casamichana, Castellano & Castagna (2012) and Owen et al., (2014) in their largest SSG formats (116.1, 118.3 and 120.4 $m \cdot min^{-1}$) and to SSGs proposed by Gómez-Carmona et al. (2018) when they used main the possession, goal line and one goalkeeper (127.4, 109.3 and 117.5 $m \cdot min^{-1}$, respectively). However, Owen et al., (2014) found greater RD values (198.5 $m \cdot min^{-1}$) in smaller formats of SSG. This could be due to the proximity of the opponents, when the area is decreased the team in possession has limited time in possession from the pressure exerted by the opponents (Owen et al., 2014). When matches data were compared neither friendly matches nor training matches obtain the same RD than official matches, being greater in the first case and smaller in the second.

In accordance with some authors, coaches, practitioners and sports scientists should be aware of the physical and physiological demands associated with the competition and used them to design drills that can elicit similar loads than the obtained in match-play, to provide an optimum training stimulus (Torreño et al., 2016).

The present study can help to know better the differences between official matches and three kind of task widely used in soccer, like friendly matches, training matches and modified-sided game. All professionals that want to optimize the training of their squad, to return to play to a injured players or to prepare to a substitute player for the game, it may use each of this tasks depending on the pursued objective due to each of them have particular physical requirements. Considering that nowadays, some match demands are adequately simulated in training and others are not (Dawson et al., 2004), supplemented SSG with game-specific training that simulates the sprint demands of most intense scenarios (Gabbet & Mulvey, 2008) or combined adequately the task of this paper, could be some solutions for programming the training. Futures studies should compare others common types of SSG in football training (different sizes, special constrains, with floaters players, etc.) to reinforce knowledge that exist about the SSG´s requirements with respect to competitive and no competitive matches.

In summary, the results of this study show that, in comparison to official matches, training matches showed more distance covered at high speed (>25 $km \cdot h^{-1}$), accelerations and decelerations than official matches (except high accelerations), SSG's showed higher values in all accelerations and decelerations, SSG and friendly matches elicit higher relative distances ($m \cdot min^{-1}$) and peak velocity was lower in all tasks analyzed.

Practical Applications

The technical staff can use nom-competitive matches and modified-side games to prepare to he soccer players to the official matches, according to ours data, some recommendations to planning the soccer training can be:

1) Modified-sided game should be use to stimulate the neuromuscular strength of lower limbs because they show higher values of accelerations and decelerations than the matches.

2) Aerobic ability of the soccer players through specific context could be training with modified-sided game inasmuch as this task obtained more RD and meters covered at lower velocities.

3) Friendly and training matches may be utilised to accumulate meters above of 25 km · h^{-1} but particular attention should be given to the S_{max} training because neither proposed tasks score the same peak of velocity than official competition, so others modified-sided game or an unspecific stimulus could be used.

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CHAPTER 5: STUDY 4

Differences between distinct spatial orientations based on individual player profile.

Abstract

The aim of this study was to verify the influence of the modification of the game spatial orientation (greater width or depth) on the internal and external load of soccer players, based on their individualized physical profile. For this purpose, internal and external load of 10 youth soccer players were analyzed during training sessions characterized by 2 small sided games (SSG) based on a 5 vs. 5 with the goalkeeper, performed in three 4-minute sets with 2 minutes of passive recovery, keeping the same pitch area per player (120 m^2), but different spatial orientations (30x40 m versus 40x30 m). The results showed that regardless of the orientation of the playing space used, players' performance decreased over the sets, obtaining higher TD, TD> VT_2 and accelerations between 2 and 4 $m/m \cdot s^{-2}$ in the 1st set compared to the 3rd, with substantially higher values of subjective perception effort (RPE) in the latter. When both SSG were compared, greater running demands and accelerations were obtained when the depth was prioritized over the width. This study demonstrates the importance of programming adequate recovery times between series of SSG to maintain the physical demands, as well as emphasizes the role of game spatial orientation as one of the elements that coaches can use to modify SSG physical demands.

Key words. Soccer, small-sided games, training, endurance, individual player profile.

Introduction

Football is a specific system constituted by the interaction of many players (Clemente et al., 2014). To improve this interaction, Small-sided games (SSG) have become one of the most popular training methods, regardless of the age and level of the players (Hill-Haas et al., 2011). The continuous search for specificity carried out by coaches along with the similarity that these tasks present with the competition (Little, 2009; Toscano et al., 2018), make them very used to reproduce physical, technical and tactical match's demands (Flanagan & Merrick, 2002, Hoff et al., 2002, Reilly & White, 2004, Sassi et al., 2004, Gabbett & Mulvey, 2008). Previous studies characterize SSG as versatile training tools, which thanks to the multiple modifications that their design can support allow to manipulate physical, technical and tactical demands generated by these tasks (Aguiar et al., 2012; Fradua et al., 2013;). These modifications can affect aspects such as the number of players, the size of the pitch, the duration of the task and rest periods, the rules of the game, the coach's stimulus, the availability of balls or the form of scoring (Bangsbo, 1994; Balsom, 2000; Hill-Haas et al., 2009a). The constant study of the effect generated by the modification of these variables in the SSG will allow coaches to have a greater control of the training process.

Considering the physical demands, one of the variables that has received most attention is the game space, generally being approached from a double perspective: the size of the game area and the orientation of the space through the inclusion of goals. The most of the studies agree that an increase in the size of the playing area provoke to an increase in internal load, manifested through an increase in heart rate (HR), blood lactate concentration or rating of perceived exertion (RPE) of the players (Hill-Haas et al., 2011; Köklü, et al., 2012; Rampinini et al., 2007); Although in the literature there are also studies that found no differences in player's HR despite assessing the impact of different areas of play (Kelly & Drust, 2008). In relation to the external load, previous studies show that in spaces more larges SSG provided higher demands on variables such as TD, maximum speed, distance covered at different speeds, number of accelerations or decelerations, frequency of sprints or rest-work ratios (Casamichana & Castellano, 2010, Paolo, Giampietro & Marcello, 2014).

In terms of the orientation of the game space, although there are works that define it than an key variable in the design of the reduced games (Casamichana, et al., 2011), the influence that the orientation of the game space may have on the patterns of movement and intensity of the task is not clearly defined (Casamichana, Castellano & Hernández-Mendo, 2014). Based on this, the objective of the present study was to verify, the influence of the orientation of the space (greater width or depth) on the internal and external load of soccer players during small sided games.

Methods

Subjects

10 amateur soccer players from the same team (age: 16.3 ± 0.5 years, height: 175.3 ± 6 cm, 65.8 ± 3.2 kg) participated in the study. All the players performed three training sessions (90 min. approximate duration) plus a match every week. They were in good health conditions, evaluated through medical exam in the Autonomic Football Federation. All the procedures were approved by the local ethics committee in institutional research (Pablo de Olavide University) in accordance with the current national and international laws and regulations that govern the use of human beings (Declaration of Helsinki II).

Experimental procedure

An observational design was used to examine the external and internal load of the players during the SSG, using portable global positioning systems (GPS) and measuring-heart rate response. For this, two tasks were carried out where the independent variable was the orientation of the game space. Although in both SSG one 5 vs 5 with goalkeepers was played and the individual interaction space remained constant (120m^2), in one of the games they prioritized the width of the game space over the depth (30x40m), while in the other in the opposite way the depth was above the width (40x30m). SSG were carried out during two training sessions held in consecutive weeks, the same day of the week (Tuesday), and at the same time to avoid the circadian effect performance (Drust et al., 2005). The first week began with the SSG in 30x40 and then continued with the SSG in 40x30, while in the second week it was reversed by modifying the order to avoid the possible fatigue effect. For each SSG, 3 series of 4 min were performed with 2 min of passive recovery between series of the same SSG, and a recovery of 6 min when the SSG was changed with different orientation of the space. At each break, players could hydrate freely. Members of each team were always the same, no regulatory limitation was established during the game and balls were distributed around the space to guarantee the longest effective time (Casamichana & Castellano, 2010). As a result of the importance of individualizing player's locomotor profile, the load (Núñez-Sánchez et al., 2017), to establish the locomotor profile of each player and exhaustively analyze the external load during the SSG, the test carried out were linear sprint test a maximal effort in a treadmill.

Treadmill test

Prior to SSGs and to individualize external load, an incremental ramp test was carried out until the exhaustion to know its functional capacity. This test was carried out to establish the different speed zones individualized based on the velocities of their thresholds and their $VO2_{max}$. The test was started with a warm-up at 7 $km \cdot h^{-1}$ for 4 minutes and then the speed was increased by 0.5 $km \cdot h^{-1}$ every 30 seconds until the exhaustion. The variables obtained in this test were: aerobic threshold velocity (VT_1), anaerobic threshold velocity (VT_2) and maximal aerobic velocity (MAS) (López-Chicharro & Fernández-Vaquero, 2006).

Analysis of external load

The external load of the players during the SSG was analyzed by GPS systems with a recording frequency of 15 Hz (SPI Pro, GPSports systems, Canberra, Australia). The external load was analyzed based on the locomotor profile of each player using the following speed zones: distance covered between 0-6 $km \cdot h^{-1}$, between 6 $km \cdot h^{-1}$ - VT_1, between VT_1 - VT_2, between VT_2 - MAS, and covered distance > MAS. In addition to the total distance covered (TD) and the distance covered (D) at different speeds, the number of large (2.5-4 $m \cdot s^{-2}$) and very large accelerations (> 4 $m \cdot s^{-2}$) was analyzed, together with the maximal speed (Vmax) obtained by each player.

Analysis of internal load

The internal load was analyzed individually using the telemetric devices associated with the GPS (Polar Team Sport System, Polar Electro Oy, Finland). In addition to recording the heart rate mean (HR_{mean}) of the exercise, to identify this variable, 5 zones were established based on the maximum heart rate (HR_{max}) that each player obtained in the stress test. The zones were: Zone 1 (50-60% HRmax), Zone 2 (60-70% HRmax), Zone 3 (70-80% HRmax), Zone 4 (80-90% HRmax) and Zone 5 (90-100 % FCmax). To analyze the internal load of the SSG, the Edward's method was used to calculate Training impulses (TRIMPS) (Edwards, 1993), and the subjective perception of effort (RPE-TL) was also used (Foster et al., 2001; Campos-Vazquez et al., 2015).

Statistical analysis

Data were presented as mean ± standard deviation. All the variables presented a normal distribution (Shapiro-Wilk test). The effect size (ES) was calculated to compare the magnitude of the differences between the different series of the same SSG, and between the different SSG in all the variables under study (Cohen, 1988). The Hopkins scale to determine the magnitude of effect sizes has been used, where 0 - 0.2 = trivial, 0.2 - 0.6 = small, 0.6 - 1.2 = moderate, 1.2 - 2.0 = large,> 2.0 = very large (Hopkins et al. al., 2009). The quantitative differences were evaluated qualitatively according to the proposal of Hopkins et al., (2009) as: <75%, it is not clear; 75-95%, probable; 95-99%, very likely; > 99%, almost certainly. A substantial effect was determined at differences with a probability> 75% as in previous studies (Suarez-Arrones et al., 2014).

Results

Movement patterns during the three series of SSG in the 30x40 m space are shown in table 1. There was a substantial reduction in the TD covered and the number of large accelerations during the third serie compared to the first two, while the $D>VT_2$ during the third serie was substantially smaller compared to the first. The internal load during the three series of SSG in the space 30x40 m is shown in table 2. There was a greater subjective perception of the effort (RPE-TL) in the third serie compared to the first two, while in the rest of internal load variables no differences were found.

Table 1: Comparison of movement patterns between series of SSG 30x40

Movement patterns of the SSG 30x40 m			
	Series		
Variables	1	2	3
Total D (m)	432.2 ± 68.1	416.6 ± 61.8	377.3 ± 69.3[a+,b]
D > VT_2 (m)	62.5 ± 32.0	54.9 ± 30.4	48.2 ± 27.7 [a]
D > MAS (m)	22.5 ± 20.8	12.5 ± 13.3[a]	13.6 ± 16.7
#Acc 2.5-4 (m/s^2)	5.2 ± 1.9[b]	5.9 ± 2.7	3.7 ± 2.7 [a b]
# Acc >4 (m/s^2)	0.8 ± 1.0	0.9 ± 1.0	0.9 ± 0.6
Vmax (km/h)	20.9 ± 2.7	19.9 ± 2.2	20.2 ± 1.9

D: Distance covered; #Acc: Number of accelerations; Vmax: Maximum speed reached.

a: Differences vs 1st serie; b: Differences vs 2nd serie. 1 letter (a): probable; 2 letters (aa): very likely; Letter + (a +): almost sure.

Table 2: Internal load of the SSG 30x40 m during the three series

Internal load of the SSG 30x40 m			
	Series		
Variables	1	2	3
HR_{mean}	158.7 ± 18.9	164.4 ± 10.1	165.2 ± 9.6
HR_{max}	178.3 ± 11.2	181.6 ± 9.8	181.4 ± 9.8
Time > 90% HRmax	31.4 ± 34.4	35.5 ± 27.2	39.9 ± 28
Edwards-TL (UA)	14.9 ± 3.7	16 ± 2.3	16.2 ± 2.3
RPE-TL (UA)	14 ± 6.2	15.4 ± 6.4	18 ± 5[aa,b]

HR: Heart rate; Edwards-TL: Internal charge through the Edwards TRIMPs; RPE-TL: Internal charge through the subjective perception of effort. UA: Arbitrary units.

a: Differences vs 1st serie; b: Differences 2nd serie. 1 letter (a): probable; 2 letters (aa): very likely; Letter + (a +): almost sure.

Movement patterns during the three series of SSG in the space of 40x30 are shown in table 3. There was a substantial reduction in the TD covered, D> VT_2 and the number of large accelerations in the second and third series compared to the first. The internal load during the three series of SSG in the space 30x40 m is shown in table 4. There was a greater subjective perception of the effort (RPE-TL) in the second and third series compared to the first, while the HR_{mean} was substantially lower in the second and third series compared to the first.

Table 3: Comparison of movement patterns between series of SSG 40x30

Movement patterns of the SSG 40x30 m			
	Series		
Variables	1	2	3
Total D (m)	470.2 ± 63.7	423.5±54.2^{aa}	400.5±86.5^{a+}
D > VT_2 (m)	88.5 ± 44.4	68.2 ± 27.6^{a}	62.6 ± 46.3^{a}
D > MAS (m)	32.5 ± 24.6	28.2 ± 24	26.1 ± 26.1
#Acc 2.5-4 (m/s^2)	7.5 ± 3	5.8 ± 2.7^{a}	5.6 ± 2.8 ^{a}
# Acc >4 (m/s^2)	1.2 ± 1.1	0.62 ± 1^{a}	0.8 ± 1.2
Vmax (km/h)	21.8 ± 3.2	23.1 ± 5.8	21 ± 4.0 ^{b}

D: Distance covered; #Acc: Number of accelerations; Vmax: Maximum speed reached.

a: Differences vs 1st serie; b: Differences vs 2nd serie. 1 letter (a): probable; 2 letters (aa): very likely; Letter + (a +): almost sure.

Figure 1 shows the comparison of the movement patterns recorded during the two types of SSG (30x40 m vs 40x30 m). In all the locomotor variables studied, substantially higher values were recorded in the SSG of 40x30m compared to that of 30x40m, with the unique exception of the V_{max}. Figure 2 shows the comparison between SSG for the different variables of internal load. There were no differences between SSG.

Table 4: Internal load of the SSG 40x30 m during the three series.

Internal load of the SSG 40x30 m			
	Series		
Variables	1	2	3
HR_{mean}	161.6 ± 12.8	157.6 ± 13.1 [a]	158.2 ± 13.9 [a]
HR_{max}	180.2 ± 10.8	180.9 ± 11.5	178.2 ± 12.7
Time > 90% HRmax	35 ± 33.8	23.6 ± 29	24.4 ± 28.9
Edwards-TL (UA)	15.6 ± 2.9	14.5 ± 2.8	14.8 ± 2.8
RPE-TL (UA)	14.3 ± 2.6	16.3 ± 3.7[aa]	16.3 ± 5.1[a]

HR: Heart rate; Edwards-TL: Internal charge through the Edwards TRIMPs; RPE-TL: Internal charge through the subjective perception of effort. UA: Arbitrary units. a: Differences vs 1st serie; b: Differences 2nd serie. 1 letter (a): probable; 2 letters (aa): very likely; Letter + (a +): almost sure.

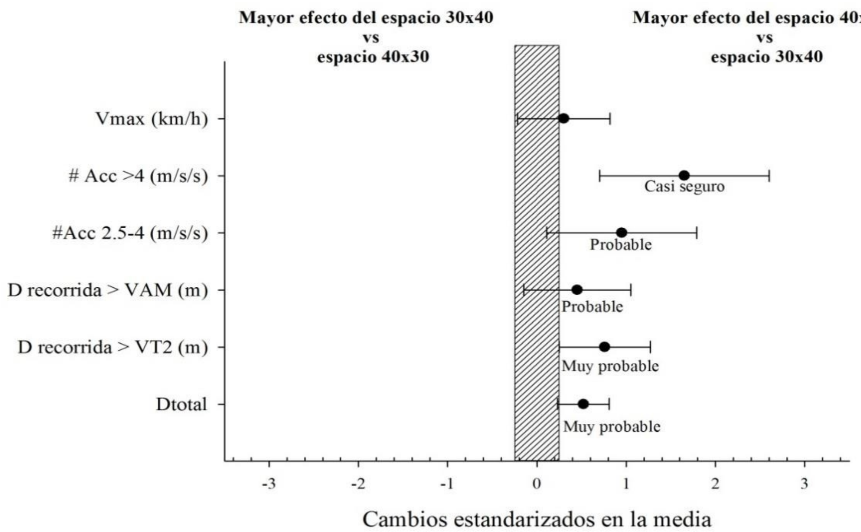

Figure 1: Differences in movement patterns during the series of SSG in a space of 40x30 m vs 30x40 m (Effect Size ± 90% LC).

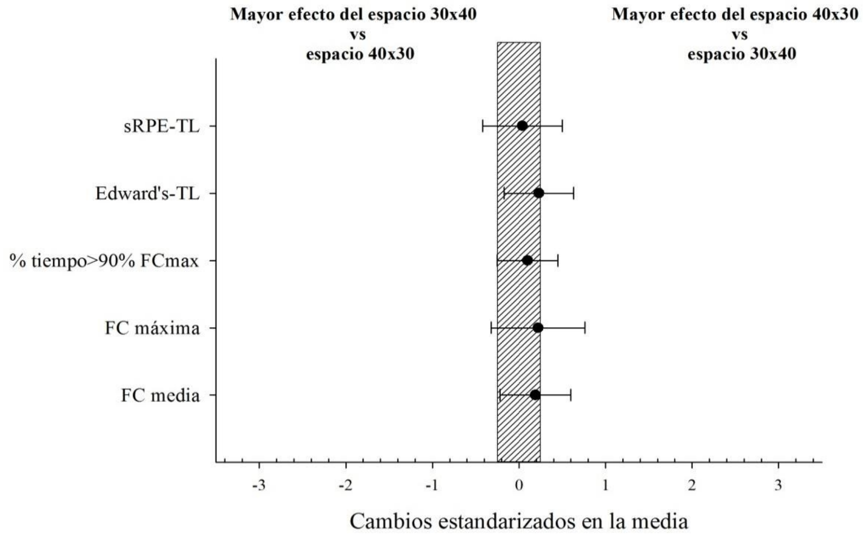

Figure 2: Differences in the internal load during the three series SSG in a space of 40x30 m vs 30x40 m (Effect Size ± 90% LC).

Discussion

The objective of the present study was to verify the influence of the space orientation (greater width or depth) on the internal and external load in SSG. The main findings of this study reflect a higher locomotor demands (external load) when the SSG was developed in a space with greater depth than width, while the different orientations of the space did not alter the internal load of the players.

One of the aspects analyzed in this study was the impact that the effort of the first serie of SSG could have on the rest of the programmed series. Our data revealed that, regardless of the orientation of the playing space used, player’s movements at different intensities, and their number of large accelerations, were substantially reduced as the number of series progressed. These results are in line with those previously reported in the literature. For example, Casamichana, Castellano & Dellal (2013) affirmed that regardless of the length of the series of the SSG (4', 8' or 16') in the first 4 '(0-4') a greater TD was covered, while Dellal et al. (2013) postulated that especially high intensity activities are those that were affected with the increase in the number of series. This aspect shows that the recovery time between series can be a determining factor in the planning of SSG.

Our results showed that, from all the internal load variables analyzed, only RPE-TL showed higher values in the subsequent SSG serie compared to the initial serie. Although these results are similar to those proposed by Dellal et al. (2013), who found no differences in the internal load when comparing the first and third serie in a SSG without restriction on the number of touches, but they found differences between the first and the fourth. By contrast, Kelly & Drust (2009) found a lower HR in the first serie compared to the second, third and fourth. These discrepancies may be due to the fact that they used an active recovery instead of the passive one proposed in this study, which could cause a lower decrease in HR after the first repetition. The RPE-TL is a reliable method to measure the internal load in collective sports (Coutts et al., 2009). Besides being a good indicator of energy intake and psychological stress, it is sensitive to accumulated fatigue and neuromuscular fatigue of athletes (Impellizzeri, et al., 2004). Recent studies even suggest that RPE-TL could be a better method than heart rate to quantify aerobic-anaerobic internal load SSG (Campos-Vazquez et al., 2015). Although the internal load analyzed through the HR remains more or less stable during the different SSG series, player's RPE, together with reduction in movement patterns during subsequent SSG, would support the idea a possible accumulated fatigue on players when as we accumulated several series with little recovery time. Depending on the objective of the training, these periods of recovery should be increased or decreased.

Another target of this study was to determine whether prioritizing the width or depth in SSG can affect the internal or external load of the players. To date, no study has investigated the possible effects of changing the space orientation on the player's locomotor performance when a certain SSG is applied. Our results showed that, when the depth is prioritized (SSG 40x30) running demands are higher than when the width is prioritized (SSG 30x40). The reason for greater TD, TD> VT_2, DT> MAS and more accelerations are performed in the 40x30 SSG, could be due to the greater distance between goals, allowing players to have more space to accelerate and maintain high speeds. The availability of space in the field, can also cause teams way to attack, with greater number of transition actions of transitions and direct attacks, and therefore, greater number of actions at higher speed in the longest SSG; and greater number of positional attacks and consequently lateral movements of the players, in the widest SSG. When comparing the internal load in both SSG, it should be noted that no differences were found in any of the variables studied. This suggests that the orientation of the space, prioritizing the width or depth, does not affect the internal load and external load. Therefore, our results showed that although there are two different external load stimuli, the internal physiological load remains stable. This is very important when prescribing SSG since, in this case, we can work with the same physiological stress, but increasing or substantially reducing their locomotor load.

Conclusions

This study is the first to provide information on the demands of physiological intensity and movements relativizing the training load to the soccer player's profile in one of the most used tasks in football training such as SSG. The results of this work show that a recovery time of only 2 minutes can fatigue players, decreasing their movement patterns and increasing their sRPD-TL as the series progresses, although the internal load analyzed through the HR remain stable.

Likewise, this study provides a new dimension in the SSG designing and planning, demonstrating that in addition to the number of players, the size of the playing field, the duration of the exercise, the rules of the game, the coach's encouragement, the availability of balls or the way to get points (Bangsbo, 1994, Balsom, 2000, Hill-Haas et al., 2009a), the orientation of the space prioritizing the width or depth of it, is another of the elements available to coaches to manipulate SSG demands. Considering that a deeper space of play will cause a greater external load on the players than a wider one, without modification in the internal load.

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CHAPTER 6: STUDY 5

Age-Related Differences in the Physical and Physiological Demands during Small-Sided Games with Floaters. Sports 2019, 7(4), 79.

Abstract

The purpose of this study was to compare the physical and physiological demands of a small-sided game (SSG) in three different age groups (senior, under-19 [U-19] and under-17 [U-17]) belonging to the same academy. A further aim was to contrast the physical and physiological profiles of normal and floater players during this task. Thirty male football players performed a 4 vs. 4 + 2 floaters on a playing field of 40 by 30m for four bouts of 4 min with 2 min of passive recovery. In addition to heart rate (mean and maximal), a GPS (Global Positioning System) system was used to record the distances covered at different speeds, the number of accelerations and decelerations, and the work/rest ratio (W:R Ratio). Analysis of the data showed that the demands of the SSGs are determined by the age of the players and that the regular players have greater demands than floater players in the SSGs utilized. These results suggest that the coaches should pay attention to the promotion of players to superior teams because there are physical differences between them (especially the U-17 to U-19 teams). Likewise, coaches should understand that floaters are a useful tool for regulating the training load of players and programming the return-to-play process, as floater players experience lower demands than normal players.

Keywords: football; soccer; training; movement patterns; GPS; time-motion; youth players

Introduction

Small-sided games (SSGs) represent modified football games played on reduced pitch areas, often using adapted rules and involving a smaller number of players than full-size soccer matches [1]. SSGs are one of the most common drills used by coaches in their daily training to develop technical and tactical skills, as well as the endurance capacity of their players [2]. In the last few years, many research studies have focused on analyzing how the diverse constraints applied in these games affects the responses of the players [3]. The most common responses analyzed are physiological (heart rate, blood lactate), physical (distances, speeds, time), perceptual, and technical [1,3,4]. Although the most investigated variables are the pitch size, player number and the multiple combinations of them [5,6], there are other aspects that have received attention such as inclusion of goalkeepers [7,8], duration of bouts [9,10], coach encouragement [11], number of touches allowed per player and the method of defending [12,13]. In general, results suggest that the fewer the number of players that are involved, the greater the physiological and perceptual responses and the number of technical actions [1,3,14].

Nowadays, SSGs have become a useful resource to train players of all ages and competitive levels [15]. In soccer academies, it is common for players of different ages to perform similar SSGs. Surprisingly, to our knowledge, no study has documented responses to an identical SSG task in players of a similar competitive level but different age. There are studies that examine the age-related differences in the physical and physiological demands of youth players during matches [16], and age-related differences in physical capacities and their correlation with soccer-related physical performance [17]. Such studies have also demonstrated that tactical behavior of players varies during the same SSG with the age groups of under-9, under-11 and under-13 [18], and under-16, under-17 and under-19 [19]. Despite this, there is no information about the effect of age on the physical responses in the same training exercise.

A common practice in elite-soccer academies is the movement of players between teams. In some cases, individuals are recruited by higher teams to train and compete with them due to the player's skill in soccer and their high performance in matches. In other cases, the reduction of players in a squad as a result of injury or infraction events (e.g., players sent off) may also lead to player recruitment. Additionally, as a consequence of technical decisions or occasional occurrences, the movement of players has become standard practice during the soccer season. In particular, this practice occurs between the under-23 (senior), under-19 and under-17 age groups. Each of these teams have their specific player age ranges: Under-17 (players > 16 and < 17 years old), under-19 (players > 17 and < 19 years old) and senior (players > 19 years old). However, one player may train for three days with players of his age group, and then with another team for the two days before a competitive match. Understanding the weekly workload variations of the teams according to the competition and the developmental ages of the players (with more technical skills in the younger players and more intense weeks with an increase in age) [15] and that an inadequate, excessive or rapid increase in training loads could result in increased soft-tissue injuries, reduced fitness and poor performance [20,21], coaches should manage the physical demands of SSG tasks in different age groups to optimize player performance and prevent overuse injuries.

A common rule used in SSGs design is the use of floater players. The floater is a special player who participates with the two teams in the offensive phase, always remaining with the team in possession of the ball [22]. With the use of floater players, practitioners aim to create an imbalance, with the intention of making the SSG drill more representative of a real game. Soccer is frequently played with a numerical imbalance, either momentarily or permanently [13]. However, most of the related literature has been focused on SSGs with the same numbers of players [23]. Only two studies, with differing results, have compared the responses of normal and floater players in SSGs. Hill-Haas et al. [24] found that the floaters travelled greater total distances and completed more sprints than normal players. Recently, Lacome et al. [22] demonstrated that locomotor activity and external mechanical load were lower in floaters compared with regular players, independent of the size (large and small) and type (possession game and game simulations) of SSGs. These authors suggested that the floater position could be administered to players for whom a lower physical demand would be beneficial (i.e., the youngest player or a recently injured player in a team). Taking this into account, it is necessary to examine if the floater players always have lower demands than normal players for different age ranges in these drills.

Therefore, the aims of the present study were to 1) compare the movement and physiological demands of the same SSG in three consecutive teams (senior, under-19 and under-17) of the same academy, and 2) contrast the physical and physiological profile of normal and floater players in this task.

Method

Participants

Thirty male football players divided in 3 different age groups; under 17 years (U-17), under 19 years (U-19) and senior semi-professional players (SP), participated in this study. Athletes were members of a semi-professional Spanish team and prior to the study, all of them had an experience greater than 8.5 years playing soccer. Their standard week always were involved by four sessions where the coaches used SSGs during the most part of the training to improve the fitness of the players and prepare the competition. Goalkeepers and players who had been injured during the season were excluded. This work was conducted according to the ethical standards in sport and exercise science research [21]. All the players who participated were notified about the aims of the study and gave their informed consent before starting.

Table 1. Participant characteristics.

Group	Age (years)	Height (cm)	Weight (kg)	Experience (years)
SP	24.09 ± 3.51	177.18 ± 5.91	70.27 ± 8.19	13.18 ± 2.96
U-19	17.73 ± 0.85	175.1 ± 6.42	65.67 ± 7.39	8.64 ± 1.86
U-17	15.97 ± 0.58	171.2 ± 5.57	60.49 ± 5.95	6.45 ± 1.61

Note: The data represents means and standard deviations, with SP = Senior players; U-19 = Under 19 players and U-17 = Under 17 players.

Procedures

Three weeks' worth of data were collected during the 2017-2018 competitive season. Players participated in four training sessions per week (between 80-120 minutes of duration) and one competitive match (Sunday). Measurements took place on the day after the day off, when stronger training sessions were performed (Wednesday). All these sessions started with the same 20-min warm up based on mobility and active stretching, and were completed on the same artificial turf and at the same time of day (20:00 – 22:00 pm).

The SSG carried out in this study 4 vs. 4 + 2 (Figure 1) was frequently used as a part of the training, so the participants were highly familiarized with this task. Each team in the SSGs was balanced according to technical and tactical level, competitive experience, player positions and the subjective evaluation of the coaches [10, 18]. The two teams of 4 players participated in the SSG with the aim of keeping possession while they were supported by two floaters who always assumed an offensive role to create an offensive numerical superiority [8]. The drill was development in a pitch size of 40 x 30 m (relative area per player = 150 m2) and it was played during 4 bouts of 4 minutes with 2 minutes of passive recovery. Both pitch size and duration have previously been used previously in the literature [26, 33].

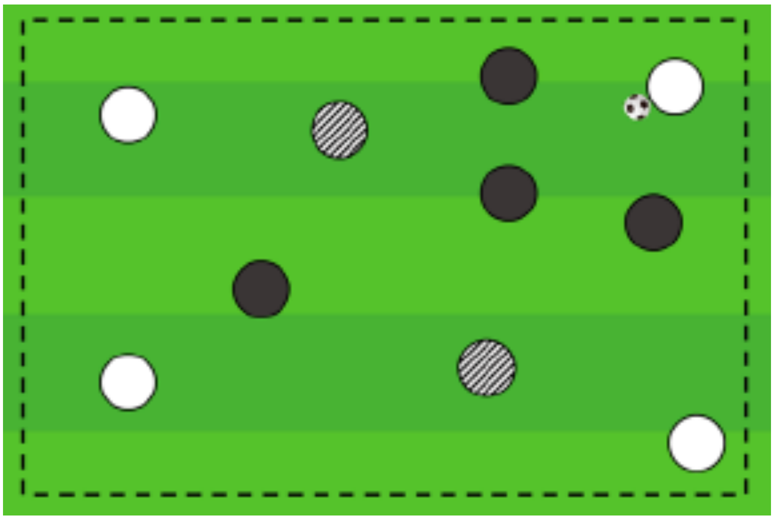

Figure 1. Format of the small-sided games (SSG), 4 vs. 4 small-sided games with two internal floaters.

The SSGs were performed without a limit on the number of ball touches and with player-to-player marking. To avoid any disruption of play, footballs were deposited around the edge of the pitch. Coaches verbally encouraged the players to maintain a high work rate during the SSG bouts.

Measures

Movement performance parameters were monitored using GPS system (GPSports SPI Elite System, Canberra, Australia) with a sampling rate of 5 Hz. These devices have previously been validated for measuring time-motion characteristics in team sports [4, 15]. The distances covered at varying speeds were recorded using different thresholds as described in previous research [11]. The same approach was used for the number of accelerations and decelerations (6, 36) and the work/rest ratio (W:R Ratio) [8, 11]. Each player wore a heart rate monitor (Polar Team 2®, Polar Electro Oy, Finland) to obtain the values of maximal and mean heart rate (HR_{max} and HR_{mean}, respectively).

Statistical analysis

The data are presented as mean ± standard deviation (SD). All variables presented normal distribution (Shapiro-Wilk Test). A repeated-measures analysis of variance was used to determine differences in the distance covered in each speed zone, accelerations and decelerations, maximal velocity and metres per minute covered. Cohen's effect size (ES) was also calculated to compare the magnitude of the differences between groups on certain variables and quantitative differences were assessed qualitatively [24] as: <1%, almost certainly not; 1−5%, very unlikely; 5−25%, unlikely; 25−75%, possible; 75−95%, probably; 95−99%, very likely; and >99%, almost certain. A substantial effect was set at >75% [5, 35]. If the chance of higher or lower differences was >75%, the true difference was assessed as clear. The SPSS statistical software package (V20.0 for Windows, SPSS Inc., Chicago, IL) was used for data analysis.

Results

The comparison of external and internal load during the SSG are arranged by age group in table 2.

Comparison between age groups

Significant differences were found in the movement demands between the three age groups. The U-17 group presented substantially lower values with respect to U-19 and SP in total distance covered (1733.2 ± 167.6 vs. 1963.6 ± 119.7 and 1957 ± 145.5), distance covered at 7-13.9 km·h-1 (818.4 ± 190.3 vs. 936.5 ± 134.9 and 960.2 ± 131.8), distance covered at 14-17.9 km·h^{-1} (159.6 ± 31 vs. 293.1 ± 93.1 and 288.6 ± 81.7), distance covered at >18 km·h^{-1} (5.4 ± 3.6 vs. 20.7 ± 16.5 and 37.1 ± 23.9), W:R Ratio (6.52 ± 1.7 vs. 9.21 ± 2.57 and 9.89 ± 2.02), and number of accelerations (13.5 ± 3.6 vs. 19.8 ± 13.5 and 20.7 ± 5.1). This group only reached higher values than the rest in distance covered at 0-6.9 km·h^{-1} (749.4 ± 58.6 vs. 705.5 ±72.9 and 671.1 ± 62.5). Similarly, the U-17 group presented substantially lower values with respect to U-19 in the number of decelerations (24.5 ± 7.7 vs. 38.4 ± 9.3). The U-19 group covered substantially less distance than the SP group between 7-13.9 km·h^{-1} (936.5 ± 134.9 vs. 960.2 ± 131.8) and distance covered at >18 km·h^{-1} (20.7 ± 16.5 vs. 37.1 ± 23.9). Nevertheless, the U-19 group present a higher number of decelerations (38.4 ± 9.3 vs. 26.7 ± 8.6) and a higher HR_{mean} (170.6 ± 13.5 vs. 160.4 ± 9.7) in comparison to the SP group. Heart rate demands of U-17 group also presented lower values than U-19 and SP in HR_{mean} (155.5 ± 17.7 vs. 170.6 ± 13.5 and 160.4 ± 9.7).

Table 2. Physical and physiological demands of the normal and floater players during 4 vs. 4 + 2 floaters SSG.

Variable	SP		U-19		U-17	
	Regular	Floater	Regular	Floater	Regular	Floater
Total Distance	1957.0 ± 145.5	1508.8 ± 160.0 *	1963.6 ± 119.7	1725.8 ± 223.3 *	1733.2 ± 167.6 ^{s,j}	1531.7 ± 116.7 *
Maximal Speed	20.7 ± 1.2	20.3 ± 1.4 *	20.6 ± 1.2	21.15 ± 4.7	19.4 ± 1.2	18.5 ± 3.1
Distance 0–6.9 km·h^{-1}	671.1 ± 62.5 ^{c}	740.3 ± 106.0	705.5 ± 72.9 ^{c}	758.4 ± 72.9	749.4 ± 58.6	846.7 ± 34.8
Distance 7–13.9 km·h^{-1}	960.2 ± 131.8	616.6 ± 74.1*	936.5 ± 134.9 ^{s}	751.3 ± 294.2 *	818.4 ± 190.3 ^{s,j}	643.6 ± 100.1*
Distance 14–17.9 km·h^{-1}	288.6 ± 81.7	144.9 ± 36.4 *	293.1 ± 93.1	201.2 ± 16.7 *	159.6 ± 31.0 ^{s,j}	38.7 ± 13.5 *
Distance >18 km·h^{-1}	37.1 ± 23.9	7.0 ± 3.5 *	20.7 ± 16.5 ^{s}	14.6 ± 1.2 *	5.4 ± 3.6 ^{s,j}	3.2 ± 2.8
W:R Ratio	9.89 ± 2.02	4.74 ± 0.96 *	9.21 ± 2.57	6.75 ± 2.49 *	6.52 ± 1.7 ^{s,j}	4.56 ± 0.6 *
Acc > 2.5 m·s^{-2}	20.7 ± 5.1	12.0 ± 2.65 *	19.8 ± 7.9	13.5 ± 2.1 *	13.5 ± 3.6 ^{s,j}	9.7 ± 2.4 *
Dec > 2.5 m·s^{-2}	26.7 ± 8.6 ^{j}	13.0 ± 2.7 *	38.4 ± 9.3	23.0 ± 2.8 *	24.5 ± 7.7 ^{j}	15.6 ± 0.6 *
HR_{mean}	160.4 ± 9.7 ^{j}	152.5 ± 21.7 *	170.6 ± 13.5	155.8 ± 17.0 *	155.5 ± 17.7 ^{s,j}	132.6 ± 25.6 *
HR_{max}	183.6 ± 6.8	179.7 ± 15.1	188.9 ± 12.8	186.5 ± 2.1	185.6 ± 8.9	184.5 ± 9.2

Note: The data represents means and standard deviations, with s indicating substantial differences with respect to SP, j indicating substantial differences with respect to U-19, and c indicating substantial differences with respect to U-17. The * designates that substantial differences between floater and normal players were present.

Comparison between regular and floater players

Floater players presented lower values in most of the variables analyzed for all age groups (table 2). In the SP group, floater players reached lower values in total distance (1508.8 ± 160 vs. 1957.0 ± 145.5), distance covered at 7-13.9 km·h^{-1} (616.6 ± 74.1 vs. 960.2 ± 131.8), distance covered at 14-17.9 km·h^{-1} (144.9 ± 36.4 vs. 288.6 ± 81.7), distance covered at >18 km·h^{-1} (7.0 ± 3.5 vs. 37.1 ± 23,9), W:R Ratio (4.74 ± 0.96 vs. 9.89 ± 2.02), number of accelerations (12.0 ± 2.65 vs. 20.7 ± 5.1), number of decelerations (13.0 ± 2.7 vs. 26.7 ± 8.6) and HR_{mean} (152.5 ± 21.7 vs. 160.4 ± 9.7). For the U-19 group, results were similar and floater players presented inferior values in total distance (1725.8 ± 223.3 vs. 1963.6 ± 119.7), distance covered at 7-13.9 km·h^{-1} (751.3 ± 294.2 vs. 936.5 ± 134.9), distance covered at 14-17.9 km·h^{-1} (201.2 ± 16.7 vs. 293.1 ± 93.1), distance covered at >18 km·h^{-1} (14.6 ± 1.2 vs. 20.7 ± 16.5), W:R Ratio (6.75 ± 2.49 vs. 9.21 ± 2.57), number of accelerations (13.5 ± 2.1 vs. 19.8 ± 7.9), number of decelerations (23.0 ± 2.8 vs. 38.4 ± 9.3) and HR_{mean} (155.8 ± 17.0 vs. 170.6 ± 13.5). Similarly again, floater players in the U-17 group obtained less total distance (1531.7 ± 116.7 vs. 1733.2 ± 167.6), distance covered at 7-13.9 km·h^{-1} (643.6 ± 100.1 vs. 818.4 ± 190.3), distance covered at 14-17.9 km·h^{-1} (38.7 ± 13.5 vs. 159.6 ± 31.0), W:R Ratio (3.2 ± 2.8 vs. 6.52 ± 1.7), number of accelerations (9.7 ± 2.4 vs. 13.5 ± 3.6), number of decelerations (15.6 ± 0.6 vs. 24.5 ± 7.7) and HR_{mean} (132.6 ± 25.6 vs. 155.5 ± 17.7).

Discussion

The main aim of this study was to analyse the physical and physiological demands during a frequently used SSG with floaters (4 vs. 4 + 2) in three different age groups of elite players belonging to the same academy. Further, an analysis of the performance of regular and floater players was performed. The main findings showed that 1) the demands of the drills are determined by the age of the players and 2) regular players have greater demands than floaters players in SSGs utilized.

There is no previous research that compares age related differences between the same SSGs, but analysis of match demands in elite youth football indicates that total distance covered increases with the age [7]. The results of the present research are in line with this study, showing that all groups have different movement demands. The groups SP and U-19 covered a higher total distance and relative distance than U-17. This study also is the first to compare SP and U-19 players and the results indicate that there is the existence of a possible ceiling effect from 19 years of age in terms of total distance covered. With regard to high-speed efforts, our data are in line with previous literature [7], showing that the activities >18 $km \cdot h^{-1}$ are influenced by age and that an increase of the age is accompanied by a greater amount of high velocity in the soccer activities. in the same way that our results a previous study found differences in the acceleration, maximum running speed and repeated sprint performance in a group of highly trained young male soccer players Under 14, Under 16 and Under [29]. The changes in the performance could be attributed to differences in the biological maturation which allow to older players are better prepare to achieve efforts of high intensity. Likewise than under the physical perspective, our data could be explained under the technical-tactical approach. As it has been published in the literature that the soccer players of higher level cover a more high-speed running and sprint distance than players of lower level in the task [17], the greater experience and ability of the older players of this study could be responsible that they accumulated a greater volume of efforts at these velocities than their colleagues.

Focusing on maximal speed performance, there were no significant differences between groups. This is probably due to the limitation of SSGs in producing high-speed activities [11] because they are played smaller pitch areas [13], where the players do not have enough space to reach their maximal sprinting speed. For this reason, and until future research is able to implement SSGs with a special focus on the development of the high speed, acceleration and deceleration profiles could provide useful information about high intensity actions [40]. Concerning the number of accelerations and decelerations, the SP and U-19 groups reached a greater number of accelerations and decelerations than U-17 group. This finding is relevant considering accelerations and decelerations are an important part of the neuromuscular load in football specific-training [40].

Physiological responses showed a different behavior depending of the analyzed variable. While data of HR_{max} was similar in the three age groups, HR_{mean} reveled distinct values to SP, U-19 and U-17 group. Taking into account that U-19 had greater HR_{mean} than SP but they had similar physical demands it could be affirmed that SP had a better fitness level how it has been explained previously in the literature [18]. Despite the differences of the HR values obtained showed, the SSGs studied could be an adequate stimulus for aerobic training of these age-groups because the reported values were close to the 80-85% of HR_{max} of the players in the most of the cases as it has been explained in the literature (Dellal et al., 2008; Hammami et al., 2018).

The use of floater players is a normal practise for coaches to replicate specific game situations [19], although to our knowledge, only two studies have compared responses of regular and floater players during SSGs [22, 27] and they found contradictory results. In our study, the floaters players had a lower physical and physiological demands than normal players in all analyzed variables except to the highest speed reached and HR_{max}

where there were not differences between groups. So it could be affirmed the established knowledge by Lacome et al., [27] where the floaters players present a lower load than normal players. These data support the idea that floaters can be used by coaches to minimize the training load in some special events (players overtraining, after injury or when they are recruited to train with older team) because although they can train with the teammates while they receive a specific and particular load.

This study has the limitation that uniquely it has studied the comparison between the three age superiors teams of a academy, and it has evaluated one task, so in the future it should be interesting carry on works where it could be compared all the age categories and it could be researched common drills used in soccer.

Conclusions

Data of this study has demonstrated that during a frequent SSG of football 4 vs. 4 + 2 floaters the load received by the soccer players is different to each age group and role in the task (normal or floater player) being able to affirm that:

• The demands of the drills are determined by the age of the players, showing greater performance with the increasing age. Particular attention should be given to the promotion of U-17 players to U-19 teams because is in this stage where appears a greater difference in the physical behaviors. The coaches should to take into account these data and to be aware these differences to prioritize the technical-tactical talent of the players (especially with youngest players) and thus to avoid a possible ageism. In a soccer academy, uniquely it should not to promote the players with a greater physical performance but also should be promoted players with worse physical performance but a greater ability to play soccer.

• Regular players have greater demands than floaters players in the SSG utilized, so this figure can be used by technical staff to minimize the load of soccer players. Although is accepted by soccer community that after injuries or with overtraining players floaters are used to minimize training stress, our data offer an new and interesting approach in which floaters could be used to reduce the physical impact of players that are promoted of lower age teams.

To know physical and physiological demands of the soccer task likewise that all the possibility that they have to increase or decrease the load (for example: the use of floater), it should be one of the main concerns of the coaches and assistants to create adequate sessions and training weeks that they optimize the performance and fitness of the soccer players to improve the preparation of the matches and also for the most demanding phases of them (Cunningham et al., 2018).

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CHAPTER 7: STUDY 6

Is the role of the floaters players determinant in the performance of the soccer tasks?

Summary

The aim of this study was to examine acute physiological responses and time-motion characteristics associated with five soccer-specific small-sided game (SSG) format (4 vs. 4, 4 vs. 4 + 2 internal floaters, 4 vs. 4 + 2 external floaters, 4 vs. 4 + 2 square floaters, 4 vs. 4 + 2 zone floaters, and 4 vs. 4 + 2 square floaters). Ten male semi-professional soccer players (mean ± SD: age = 24.09 ± 3.51 years, height = 177.18 ± 5.91 cm, weight = 70.27 ± 8.19 kg, % body fat = 11.54 ± 1.89) from the same team participated in the study in which heart rate (HR), rating of perceived exertion (RPE) and time motion characteristics were recorded. The analysis of data showed that the physical demands of the floater and normal players were conditioned for the role that floaters play in the SSGs, being in both cases generally greater when the floaters are used than internal and external support and lower when they are collocated in a square or zone. However, independently of the position adopted by the floaters, the normal players have greater demands than them in the most of variable studied. Coaches should consider the inclusion of floaters to manipulate the activity of normal players and use them to reduce the training load of the overtraining players or programming progressive return-to-play with injured players.

Key words: Soccer; Small-sided games; floaters; training; GPS;

Introduction

The football is a sport that can be considered as complex, self-organised, unstable, unpredictable and highly dynamic systems in which players interact with each other trying to obtain their offensive and defensive approaches (Davids, Araujo, Correia, & Vilar, 2013; Vilar, Araujo, Davids, & Button, 2012). Sometimes, that interaction can be understood as random and stochastic (McKenzie and Cushion, 2013; Yue et al., 2008), so one of the most important issues to enhance performance in soccer is the incorporation of training exercise that totally or partially mimic the requirements of formal competition (Katis & Kellis, 2009) to obtain a stimulus that provide the maximum benefits to the football player in connection with the game (Mallo & Navarro, 2008; Turner & Stewart, 2014). In this sense, the small sided games (SSGs) are among the most frequently used exercises by soccer coaches (Rampinini et al., 2007) because likewise that the matches, provide a continuous exploration, discovery and learning of specific situations (Ric, Hristovski & Torrents, 2015) and allow to train simultaneously the technical, tactical, and physical components (Hill-Haas et al., 2009; Dellal et al., 2008). SSGs are modified games played on reduced-sized field, often involving a smaller number of players and introducing adapted rules which are different from normal eleven-a-side game (Hill-Haas et al., 2011). Although in the last years the available research exposing the consequences of constraints manipulation during that drills has increased significantly (Aguiar et al., 2012; Hill-Haas et al., 2011), the most of these have been carried out in teams with the same numbers the players (Torres-Ronda et al., 2015) even though given that football is frequently played in numerical unbalance either momentary or permanently (Sampaio et al., 2014) and that in their training, the coaches constantly use the floaters when they want to regulating the load of some players (Lacome et al., 2017). Only two studies that have researched the time-motion in the SSGs comparing the responses of the normal regular and floaters players with different results. Hill-Haas et al. (2010) found that the floaters travelled greater total distance and more sprints than normal players, recently, Lacome et al. (2017) have demonstrate that locomotor activity and external mechanical load were lower in floaters compared with regular players. Considering that the literature is scarce and contradictory and that there is not paper comparing the demands of floaters in different SSGs, the purpose of this study was (1) to compare the locomotors, mechanical, heart rate (HR) and rate perceived exertion (RPE) responses of the floaters players depending on their role in a SSG (2) to identify how influence in the behaviour of the normal players and (3) to compare if there are differences between normal and floaters players.

Methods

Participants

Ten male semi-professional soccer players (age: 24.09 ± 3.51 years; height: 177.18 ± 5.91 cm; weight: 70.27 ± 8.19 kg; % body fat (Faulkner): 11.54 ± 1.89) from the same team participated in the study. All of them were notified about the aims of the study and gave their informed consent before starting.

Procedures

Data were collected for five weeks (October-November) during the competitive season 2017-2018. Players participated in 4 training sessions per week (80-120 minutes) plus 1 competitive match. Measurements took place during the day after the resting day, when they used to perform the stronger training session. All these sessions started with a similar 20-min standardized warm-up, and were completed in natural turf, at the same time of day (20:00 – 22:00 pm).

Small-sided games.

Five different SSGs were implemented over the duration of the study (Figure 1). These SSGs frequently took part of the training schedule, so the participants were familiarized with that exercises. The different teams of the SSGs were balanced according technical and tactical level, competitive experience, player positions (Dellal et al., 2012) and subjective evaluation of the coaches (Casamichana y Castellano, 2010).

The same two teams of 4 players faced with the aim to keep ball possession, with the incorporation of 2 floater players, who always assume an offensive role to stimulate the attacking numerical superiority (Campos-Vázquez et al., 2017). The pitch size (40 x 30 m) and the duration (4 bouts of 4-min, separated by 2-min of passive recovery) were permanent in all the SSGs (Kelly & Drust, 2009; Sánchez-Sánchez et al., 2017). The floaters players have delimited their space of action with and area of 200 m^2 but with different shape depending of the format of the SGG (see figure 1).

The SSGs were performed without limit of ball touches and no player-to-player marking induced. To avoid any disruption of play, soccer balls were disposed around the pitch. Coaches verbally encouraged the players to maintain a high-work rate during the different SSGs.

Physical profile

Physical performance parameters were monitored using GPS system (GPSports SPI Elite System, Canberra, Australia) with a sampling rate of 5 Hz. These devices have previously been validated for measuring time-motion characteristics in team sports (Coutts & Duffield, 2010; Barbero-Álvarez et al., 2010). The distances covered at varying speed were recorded using different thresholds according previous research (Casamichana et al., 2012). The number of accelerations and decelerations also were observed and divided in zones following preceding studies (Buchheit et al., 2014, Suárez-Arrones et al., 2016).

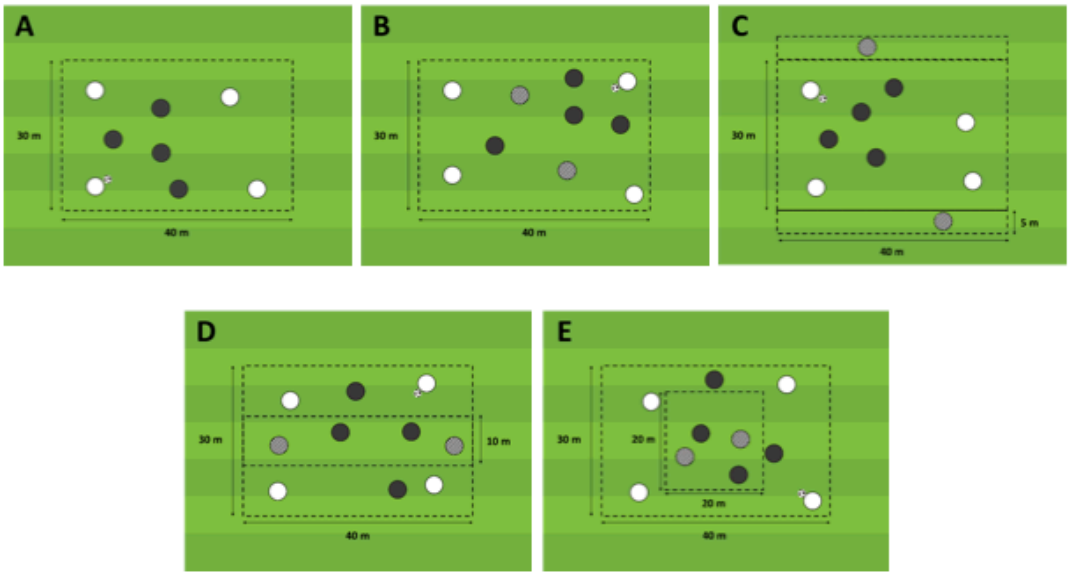

Figure 1. SSGs format: a) 4 vs. 4; b) 4 vs. 4 + 2 internal floaters; c) 4 vs. 4 + 2 external floaters; d) 4 vs. 4 + 2 zone floaters; e) 4 vs. 4 + 2 square floaters. Black and white circles: players with normal role from both teams. Grey circles: floaters players. Dashed lines are the area of play, both normal and floaters players.

Heart Rate and Rating and Rate Perceived Exertion

The HR was measured with a heart rate monitor (Polar Team 2®, Polar Electro Oy, Finland). HR_{max} (188.9 ± 9.12 ppm) was obtained previously to the study applying the Yo-Yo IRT1 (Bangsbo et al., 2008). Data collected during SSGs were the HR_{mean} and HRmax.

To assess the global internal load of each SSG, the rate of perceived exertion (RPE) scale (Foster et al., 2001) were recorded using the 1-10 Borg Scale (Borg et al., 1987). Players were already familiarized with that scale and were evaluated immediately on completion of each SSG using a standardized question, with no information of the other players (Coutts et al., 2009).

Statistical Analyses

The data are presented as mean ± standard deviation (SD). All variables presented normal distribution (Shapiro-Wilk Test). A repeated-measures analysis of variance was used to determine differences in the distance covered in each speed zone, accelerations and decelerations, maximal velocity and metres per minute covered. Cohen's effect size (ES) was also calculated to compare the magnitude of the differences between groups on certain variables (Cohen, 1988) and quantitative differences were assessed qualitatively (Hopkins et al., 2009) as: <1%, almost certainly not; 1−5%, very unlikely; 5−25%, unlikely; 25−75%, possible; 75−95%, probably; 95−99%, very likely; and >99%, almost certain. A substantial effect was set at >75% (Torreño et al., 2016). If the chance of higher or lower differences was >75%, the true difference was assessed as clear. The SPSS statistical software package (V20.0 for Windows, SPSS Inc., Chicago, IL) was used for data analysis.

RESULTS

Comparisons between floaters players

Table 1 presents the locomotors, HR and RPE responses of floaters depending of their role in the 4vs4+2floater SSG. The total distance (1847.4 ± 120.3), $M{\cdot}Min^{-1}$(115.5 ± 0.9), distance 0-6.9 $km{\cdot}h^{-1}$(1334.5 ± 435.7), distance 7–13.9 $km{\cdot}h^{-1}$(431.5 ± 284.8), distance

14–17.9 km·h^{-1} (65.1 ± 12.5) and distance >18 km·h^{-1} (8.8 ± 6.4) in the internal floaters were significantly higher than in external floater (1012.8 ± 14.9, 63.3 ± 0.9, 709.3 ± 56.2, 275.0 ± 25.1, 25.2 ± 15.0, and 3.4 ± 3.9, respectively), zone floaters (960.7 ± 207.6, 60.0 ± 13.0, 797.7 ± 54.6, 157.4 ± 108.4, 5.9 ± 6.8, and 0.0 ± 0.0, respectively) and square floaters (763.4 ± 93.5, 47.7 ± 5.9, 688.5 ± 33.8, 74.4 ± 42.2, 1.4 ± 0.35, and 0.0 ± 0.0, respectively). External floater also showed significantly differences with respect to the zone and square floaters in all the previous variables except for the distance 0-6.9 km·h^{-1} where the outcomes of zone floaters were higher. Between zone and square floaters there were significantly differences too, with square floaters obtaining significantly more total distance and M·Min^{-1} and zone more distance 0-6.9 km·h^{-1}, distance 7–13.9 km·h^{-1} and distance 14–17.9 km·h^{-1}.

In the profile of acceleration and deceleration were found significantly differences in the acceleration and deceleration between 2.5 and 4 m·s^{-2}, covered internal floater, external floater and zone floater greater acceleration (13.0 ± 3.7, 8.0 ± 1.2, 8.5 ± 1.7, respectively) and deceleration (11.3 ± 4.9, 5.1 ± 1.4, 8.0 ± 7.1, respectively) that square floater (2.0 ± 1.15 and 2.2 ± 1.4). Also were found significantly differences between Internal floater and external and zone floater. None of the studied cases showed differences when were analysed the highest acceleration and deceleration.

Although there were not differences in the HR demands among the four SSGs in any of the analysed variables (table 1), whether there were in the RPE, with the internal and external (6.8 ± 0.3 and 5.8 ± 0.4, respectively) floaters obtaining significantly differences with the zone and square floaters (4.8 ± 0.4 and 4.75 ± 0.4, respectively). Between internal and external floaters there were significantly differences too.

Comparisons between normal players

The comparison of the normal players depending in each of the SSGs proposed can be observed in the table 1. The analyzed data indicated that when was used internal and external floaters was covered significantly more total distance and M·Min^{-1} (1975.2 ± 169.3, 123.5 ± 10.6 and 1982.0 ± 135.4, 123.9 ± 8.5, respectively) than when was incorporated zone and square floaters (1862.7 ± 191.8, 116.4 ± 12.0 and 1859.6 ± 155.0, 116.2 ± 9.7, respectively) and even when the SSG were played without floaters (1826.4 ± 107.2 and 114.2 ± 6.7). The profiles of performance to different speeds were dissimilar in all the categories studied. In lowest velocities (0–6.9 km·h^{-1}), N_z (850.4 ± 216.2) covered significantly more distance than N_{Wh} (739.8 ± 31.5), N_i (691.1 ± 113.5), N_e (683.9 ± 52.0) and N_s (710.9 ± 64.4). N_{Wh} showed significantly differences with N_i, N_e and N_s too. In reference to the distance 7–13.9 km·h^{-1} all the formats of SSGs achieved significantly more distance that N_z (915.6 ± 155.3). In this category, N_i (943.6 ± 160.3), N_e (1005.6 ± 163.0) and N_s (765.7 ± 306.0) also submitted significantly differences with N_{Wh} (857.3 ± 90.4). For the rest of velocities, N_i and N_e in the distance 14–17.9 km·h^{-1} and N_i in distance >18 km·h^{-1} performed significantly greater distance than the others players, being the data of N_{Wh}, N_i, N_e, N_z and N_s: 213.2 ± 73.6, 293.7 ± 90.5, 271.7 ± 54.8, 219.6 ± 91.0 and 216.8 ± 70.6 in the first case and 16.2 ± 10.7, 46.6 ± 19.6, 20.7 ± 16.5, 18.1 ± 14.7 and 16.4 ± 12.2 for the second one. In reference to the data of Acc 2.5 – 4 m·s^{-2} N_{Wh} (21.6 ± 4.4) and N_e (21.3 ± 7.2) scoring the highest values, with significantly differences with N_i (18.0 ± 3.4), N_z (16.4 ± 2.6) and N_s (19.1 ± 5.9). Between N_i and N_s also there were differences with N_z. In relation to the Acc > 4 m·s^{-2} N_{Wh} (2.4 ± 1.3) achieved greater values than N_i (1.9 ± 1.5), N_e (0.6 ± 0.7), N_z (1.9 ± 1.4) and N_s (0.3 ± 0.5). N_e and N_s performed significantly less acceleration of high intensity than N_{Wh}, N_i

and N_z. As can be seen in the table 1, there were no differences for the HR_{mean} and HR_{max} between for any of the formats employed while the values of RPE showed that N_i (7.6 ± 0.7) and N_e (7.6 ± 0.6) scored significantly greater register that N_{wh} (7.2 ± 0.6), N_z (6.9 ± 0.3) and Ns (6.9 ± 0.6).

Comparisons Normal vs floater players

Overall, normal players had greater physical demands than floaters players in the 4vs4+2 floaters. Internal floater obtained significantly less values than normal players in the variables $M \cdot Min^{-1}$ (115.5 ± 0.9 vs 123.5 ± 10.6), distance 7–13.9 $km \cdot h^{-1}$ (431.5 ± 284.8 vs 943.6 ± 160.3), distance 14–17.9 $km \cdot h^{-1}$ (65.1 ± 12.5 vs 293.7 ± 90.5), distance >18 $km \cdot h^{-1}$ (8.8 ± 6.4 vs 46.6 ± 19.6), Acc 2.5 – 4 $m \cdot s^{-2}$ (13.0 ± 3.7 vs 18.0 ± 3.4), Acc > 4 $m \cdot s^{-2}$ (0.5 ± 1.0 vs 1.9 ± 1.5) Dec > 4 $m \cdot s^{-2}$ (0.2 ± 0.5 vs 2.9 ± 2.1) and RPE (6.8 ± 0.3 vs 7.6 ± 0.7), in the variables total distance (1847.4 ± 120.3 vs 1975.2 ± 169.3), Dec 2.5 – 4 $m \cdot s^{-2}$ (11.3 ± 4.9 vs 13.3 ± 4.4), HR_{mean} (147.9 ± 18.6 vs 151.2 ± 16.4) and HR_{max} (180.0 ± 12.4 vs 181.7 ± 7.3) scored similar values and covered significantly more distance at 0–6.9 $km \cdot h^{-1}$ (1334.5 ± 435.7 vs 691.1 ± 113.5). External floater showed significantly differences in the variables total distance, $M \cdot Min^{-1}$, distance 7–13.9 $km \cdot h^{-1}$, distance 14–17.9 $km \cdot h^{-1}$, distance >18 $km \cdot h^{-1}$, Acc 2.5 – 4 $m \cdot s^{-2}$, Dec 2.5 – 4 $m \cdot s^{-2}$, Dec > 4 $m \cdot s^{-2}$ and RPE with the normal players (1012.8 ± 14.9, 63.3 ± 0.9, 275.0 ± 25.1, 25.2 ± 15.0, 3.4 ± 3.9, 8.0 ± 1.2, 5.1 ± 1.4, 0.0 ± 0.0, 5.8 ± 0.4 and 1982.0 ± 135.4, 123.9 ± 8.5, 1005.6 ± 163.0, 271.7 ± 54.8, 20.7 ± 16.5, 21.3 ± 7.2, 19.8 ± 8.4, 2.3 ± 1.8 and 7.6 ± 0.6, respectively) likewise that internal player, obtained significantly greater amount of meters at lowest intensity (709.3 ± 56.2 vs 683.9 ± 52.0) and performed the same register of Acc > 4 $m \cdot s^{-2}$ (0.5 ± 0.7 vs 0.6 ± 0.7), HR_{mean} (147.3 ± 17.0 vs 159.7 ± 15.6) and HR_{max} (172.5 ± 17.7 vs 183.9 ± 7.8). In the case of zone floaters (960.7 ± 207.6, 60.0 ± 13.0, 797.7 ± 54.6, 157.4 ± 108.4, 5.9 ± 6.8, 0.0 ± 0.0, 8.5 ± 1.7, 0.5 ± 1.0, 8.0 ± 2.1, 0.3 ± 1.2, 138.6 ± 6.9, 170.0 ± 8.3 and 4.8 ± 0.4) and square floaters (763.4 ± 93.5, 47.7 ± 5.9, 688.5 ± 33.8, 74.4 ± 42.2, 1.4 ± 0.35, 0.0 ± 0.0, 2.0 ± 1.15, 0.0 ± 0.0, 2.2 ± 1.4, 0.0 ± 0.0, 136.4 ± 18.6, 170.5 ± 12.0 and 4.75 ± 0.4) both showed significantly differences with respect to the normal players (1862.7 ± 191.8, 116.4 ± 12.0, 850.4 ± 216.2, 765.7 ± 306.0, 219.6 ± 91.0, 18.1 ± 14.7, 16.4 ± 2.6, 1.9 ± 1.4, 14.9 ± 3.8, 2.4 ± 1.7, 156.3 ± 17.2, 183.0 ± 8.2 and 6.9 ± 0.3, when played with two zone floaters and 1859.6 ± 155.0, 116.2 ± 9.7, 710.9 ± 64.4, 915.6 ± 155.3, 216.8 ± 70.6, 16.4 ± 12.2, 19.1 ± 5.9, 0.3 ± 0.5, 24.0 ± 5.9, 2.3 ± 2.1, 150.8 ± 18.8, 181.9 ± 5.2 and 6.9 ± 0.6, with square floaters) in their respective SSGs in all the variables studied.

Discussion

To our knowledge this study is the first to compare the locomotors, mechanical, HR and RPE responses of the floaters and the normal players depending of role of the floaters in a SSG.

The main findings of this study were (1) The physical demands of the floater and normal players are conditioned for the role that floaters play in the SSGs, being in both cases generally greater when the floaters are used than internal and external support and lower when they are collocated inside of a delimited area of play area and (2) To employ internal and external floaters also provoke that the normal players increased their physical demands and (3) independently of the position adopted by the floaters, the normal players have greater demands than them in the most of variable studied.

This study has shown that the floaters have different requirements depending on their position in the SSGs. The use of Internal floaters have been shown to have grater performance than the rest of floaters when it was analysed the distance covered at different speeds, this may have been because these players have the possibility of deciding where and when they want to participate in the possession using all the space of play. The dissimilar outcomes found between external floaters and the zone and square floaters may be due to the external players had to move throughout the length of the space of the ball to receive the ball, while in the other both cases, how they were occupying a central position in the game, they only should be focused in to adopt a suitable placement and body position that let them receive and pass the ball. When comparing our data with the exposed in the literature, we found that the data are different to the Lacome et al. (2017), because except the internal floaters, that they obtained greater relative distance and high-speed distance, in the others types of floaters these variables were lower. These differences should be interpreted with caution because they used SSGs with only one floater.

The data showed that these SSGs are not recommended to train high accelerations and decelerations in the floaters, cause the combination of the proposed area of play and the superiority of the offensive players involved that the floaters had not to perform these kinds of movements to participate in the play, this could be the consequences that there had not existed differences between floaters either. Internal floater and square floater registered the greater and lower amount of meters in relation with the accelerations and decelerations of lower intensity, this aspect reaffirms the idea that the inclusion of floaters in the middle of the SGG could covert it in a more positional play, while with the floaters moving freely for the space, convert it in more physical game.

Respect to the variables of internal load analysed, on the one hand it is interesting to stand out that the values of HR were similar to found in the only study that registered that variable in the floaters (Lacome et al., 2017) becoming this SSG in a good drill to improve the aerobic fitness of the floaters (Impellizzeri et al. 2006). On the other hand, the greater external load expressed by the internal floaters can reflect in their superior values of RPE showed, affirming that different types of floaters may induce different training effects (Sánchez-Sánchez et al., 2017).

With these data in mind it can be affirmed that the floaters have greater load when they play as internal floater, subsequently like external floater and finally playing in a zone in the middle of the space of play. This information could be interesting for the coaches to train to post-injured or over-trained players without leaving a specific context because they can reduce the load of the floaters only modifying the constrains of the task, although how propose Hill-Haas et al. (2011) these data should be interpreted with caution, given the low sample size of the floaters.

It has been demonstrated that inclusion of the floaters alters the activity of the normal players (Hill-Haas et al. 2010), but to the date, it is uncertain how it affect. Our data reveals that the use of internal and external floaters provokes a greater demand in the rest of the players. On one side, this can occur because the behaviour of these floaters, that force to the defenders to cover more distance at different speeds. Although in this paper have not been differentiate between offensive and defensive phase our results could be in line with Hill-Haas et al. (2010) and Sampaio et al. (2014) affirming that in the team under inferior conditions the demands are substantially higher than in their opponents.

Another important aspect that could justify these behaviours is the idea that the players change their spatial dispersion, shape and the distances maintained to their direct opponents when floaters are manipulated in SSGs (Sampaio et al., 2014). The formats with zone, square and without floaters could provoke that the players prioritised the occupation of the space close to the central zone, where the floaters are collocated or from which they can organize better the defence. These behaviours are common in football where the teams in attack tend to play wider in central areas of the pitch while forming less disperse shapes when they are close to the targets (Castellano et al., 2013), so it could be interesting to use SGGs with internal and external floaters whether you want practice the build-up play and use zone, square or without floaters formats to train the finishing phase.

Our data also reveal that in the SSGs where there were numerical equality (without and with external floaters) were achieved grater amount of accelerations as a consequence of the need of the players to stand out to receive the ball. In the case of deceleration, it was the inclusion of the square floaters what provoked greater decelerations of lower intensity while there were not found differences in the high intensity decelerations.

In relation with the cardiac response, our results are in line with the literature where it is affirmed that this is not affect by the introduction of different floaters (Sánchez-Sánchez et al. 2017). Instead, what were affected was RPE, with higher scores for the formats with

Table 1: Analysis of the locomotor, mechanical and internal responses of the SSGs.

Variable	4vs4	4 vs. 4 + 2 internal floaters		4 vs. 4 + 2 external floaters		4 vs. 4 + 2 zone floaters		4 vs. 4 + 2 square floaters	
	N_{Wh}	N_i	Floaters	N_e	Floaters	N_z	Floaters	N_s	Floaters
Total Distance	$1826.4 \pm 107.2^{i,e}$	1975.2 ± 169.3	1847.4 ± 120.3	1982.0 ± 135.4	$1012.8 \pm 14.9^{*,i}$	$1862.7 \pm 191.8^{i,e}$	$960.7 \pm 207.6^{*,i}$	$1859.6 \pm 155.0^{i,e}$	$763.4 \pm 93.5^{*,i,e,z}$
$M \cdot Min^{-1}$	$114.2 \pm 6.7^{i,e}$	123.5 ± 10.6	$115.5 \pm 0.9^{*}$	123.9 ± 8.5	$63.3 \pm 0.9^{*,i}$	$116.4 \pm 12.0^{i,e}$	$60.0 \pm 13.0^{*,i}$	$116.2 \pm 9.7^{i,e}$	$47.7 \pm 5.9^{*,i,e,z}$
Distance 0–6.9 $km \cdot h^{-1}$	739.8 ± 31.5^{z}	$691.1 \pm 113.5^{n,z}$	$1334.5 \pm 435.7^{*}$	$683.9 \pm 52.0^{n,z}$	$709.3 \pm 56.2^{i,z}$	850.4 ± 216.2	$797.7 \pm 54.6^{*,i}$	$710.9 \pm 64.4^{n,z}$	$688.5 \pm 33.8^{i,e,z}$
Distance 7–13.9 $km \cdot h^{-1}$	$857.3 \pm 90.4^{i,e,s}$	943.6 ± 160.3	$431.5 \pm 284.8^{*}$	1005.6 ± 163.0	$275.0 \pm 25.1^{*,i}$	$765.7 \pm 306.0^{n,i,e,s}$	$157.4 \pm 108.4^{*,i,e}$	915.6 ± 155.3	$74.4 \pm 42.2^{*,i,e,z}$
Distance 14–17.9 $km \cdot h^{-1}$	$213.2 \pm 73.6^{i,e}$	293.7 ± 90.5	$65.1 \pm 12.5^{*}$	271.7 ± 54.8	$25.2 \pm 15.0^{*,i}$	$219.6 \pm 91.0^{i,e}$	$5.9 \pm 6.8^{*,i,e}$	$216.8 \pm 70.6^{i,e}$	$1.4 \pm 0.35^{*,i,e,z}$
Distance > 18 $km \cdot h^{-1}$	16.2 ± 10.7^{i}	46.6 ± 19.6	$8.8 \pm 6.4^{*}$	20.7 ± 16.5^{i}	$3.4 \pm 3.9^{*,i}$	18.1 ± 14.7^{i}	$0.0 \pm 0.0^{*,i,e}$	16.4 ± 12.2^{i}	$0.0 \pm 0.0^{*,i,e}$
Acc 2.5 – 4 $m \cdot s^{-2}$	21.6 ± 4.4	$18.0 \pm 3.4^{n,e}$	$13.0 \pm 3.7^{*}$	21.3 ± 7.2	$8.0 \pm 1.2^{*}$	$16.4 \pm 2.6^{n,e,z}$	$8.5 \pm 1.7^{*}$	$19.1 \pm 5.9^{n,e}$	$2.0 \pm 1.15^{*,i,e,z}$
Acc > 4 $m \cdot s^{-2}$	2.4 ± 1.3	1.9 ± 1.5	$0.5 \pm 1.0^{*}$	$0.6 \pm 0.7^{n,i,z}$	0.5 ± 0.7	1.9 ± 1.4	$0.5 \pm 1.0^{*}$	$0.3 \pm 0.5^{n,i,z}$	$0.0 \pm 0.0^{*}$
Dec 2.5 – 4 $m \cdot s^{-2}$	15.7 ± 3.6^{s}	$13.3 \pm 4.4^{e,s}$	11.3 ± 4.9	19.8 ± 8.4^{s}	$5.1 \pm 1.4^{*,i}$	14.9 ± 3.8^{s}	$8.0 \pm 2.1^{*,i}$	24.0 ± 5.9	$2.2 \pm 1.4^{*,i,e,z}$
Dec > 4 $m \cdot s^{-2}$	2.5 ± 1.6	2.9 ± 2.1	$0.2 \pm 0.5^{*}$	2.3 ± 1.8	$0.0 \pm 0.0^{*}$	2.4 ± 1.7	$0.3 \pm 1.2^{*}$	2.3 ± 2.1	$0.0 \pm 0.0^{*}$
HR_{mean}	150.5 ± 44.3	151.2 ± 16.4	147.9 ± 18.6	159.7 ± 15.6	147.3 ± 17.0	156.3 ± 17.2	138.6 ± 6.9	150.8 ± 18.8	136.4 ± 18.6
HR_{max}	177.4 ± 21.3	181.7 ± 7.3	180.0 ± 12.4	183.9 ± 7.8	172.5 ± 17.7	183.0 ± 8.2	170.0 ± 8.3	181.9 ± 5.2	170.5 ± 12.0
RPE	$7.2 \pm 0.6^{i,e}$	7.6 ± 0.7	$6.8 \pm 0.3^{*}$	7.6 ± 0.6	$5.8 \pm 0.4^{*,i}$	$6.9 \pm 0.3^{i,e}$	$4.8 \pm 0.4^{*,i,e}$	$6.9 \pm 0.6^{i,e}$	$4.75 \pm 0.4^{*,i,e}$

Note: Data represent means and standard deviations. * Substantial differences between floater and normal player; n Substantial differences with respect to 4v4; e substantial differences with respect to 4v4 with internal floaters; i substantial differences with respect to 4v4 with external floaters; z substantial differences with respect to 4v4 with floaters in the middle zone; s substantial differences with respect to 4v4 with internal floaters in the square zone Nwh Without floaters Ni normal players with internal floaters Ne normal players with external floaters [illegible] the internal and external floaters, as consequences of their greater locomotors activity. These results are dissimilar to the found by Sánchez-Sánchez et al. (2017) because they did not observe greater RPE for the format with two internal floaters but it should be pointed out that they did not analyse the time-motion and consequently these data must not be compared.

The coaches should consider the inclusion of floaters to manipulate the activity of normal players too, employing internal and external floaters when they want to increase the load and train the build-up play and using formats without numeric superiority or with zone and square floaters when they want lower load or to work the finishing phase.

Although floaters players are a common practice during training sessions, few investigations have been performed on this issue (Ric, Hristovski & Torrents, 2015). To the date only two studies have compared the activity between normal and floaters players. Our analysis revealed that in all the SSGs proposed, the normal players had greater demands than floaters players in all the physical variables studied. These outcomes are in line with Lacome et al. (2017), who found that locomotor activity and mechanical load were likely lower in floaters players compared with regular players, independently of the size (large and small) and the type (possession game and game simulations) of SSGs, but it contrast with the results of Hill-Haas et al. (2010) who reported an increased total distance and high speed in floaters. We think that the fact that the normal players have to participate in the two phase of the game (offensive and defensive) provoke that they have greater demands than the floaters who only focus their activity in the offensive game.

Just as Lacome et al. (2017) there were no differences in the values of HR between floaters and normal players consequently if the coaches want to improve the aerobic system they could use both indistinctly. When is considered the RPE, our data also were different those encountered by Hill-Haas et al. (2010). This discrepancy could be due that in both papers were registered a higher RPE in the football players that had greater demands.

With the information provided in this work, it can be affirmed that the use of floaters players could be an important means of to reduce the training load of the overtraining players or an interesting tool to programming progressive return-to-play with injured players.

Practical applications

The major findings of this study are that the incorporation of the different floaters in the SGGs can influence the time-motion responses and possibly the technical/tactical behaviour of all players. With this in mind, the coaches should take account that:

- Floaters have greater load when they play as internal floater, subsequently like external floater and finally playing in a zone in the middle of the space of play.

- The inclusion of floaters affects the activity of normal players, increasing the physical demands when it is employ internal and external floaters and lowering the load when it is use formats without numeric superiority or with zone and square floaters.

- The normal players have greater locomotor and mechanical demands than floaters players, so the use of floaters players could be an important means of to reduce the training load of the overtraining players or a interesting tool to programming progressive return-to-play with injured players.

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