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The effect of balanced and unbalanced soccer small-sided games on the rating of perceived exertion in youth players

El efecto de los partidos reducidos de fútbol equilibrados y desequilibrados en la calificación del esfuerzo percebido em los jugadores juveniles

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Abstract. The integration of methods to quantify the physical demands [e.g., Rating Perceived Exertion (RPE)] in small-sided games (SSGs) in younger soccer players, has been scarcely studied. In addition, few studies have been addressing the impact of balanced vs. unbalanced SSGs, in particular in youth players' RPE. This study aimed to investigate differences between balanced and unbalanced format games in young soccer players' RPE, controlling for different playing field sizes. The sample comprised 10 field players and 2 goalkeepers (Gk) being 13,55±0,51 years-old. The players performed 6 randomized different situations, following an identical methodology across the training days: (1) 4Vs.4+Gk (2) 4Vs.5+Gk, and (3) 4Vs.6+Gk. All situations were performed in 30x25m and 40x30m. The game situations lasted 5 minutes of practice and another 5 minutes of rest. After the execution of all game situations, participants were asked individually about their self-perceived effort, using the OMNI effort scale. In unbalanced format games when the difference in the number of players increases, RPE is lower. This tendency seems to be more evident in smaller compared to bigger playing field areas. The difference in RPE scores considering different dimensions of playing space seems not to be linear. Balanced soccer SSGs promote higher RPE than unbalanced soccer SSG. More studies on the topic are required considering different playing field areas as well as different players' backgrounds.
Keywords: small-sided games; RPE; soccer; youth players.

Resumen. La integración de métodos para cuantificar las demandas físicas [por ejemplo, Calificación del Esfuerzo Percibido (CEP)] en juegos reducidos (JR) en jugadores de fútbol más jóvenes, ha sido poco estudiada. Además, pocos estudios han abordado el impacto de los JR equilibrados frente a los no equilibrados, en particular en el CEP de los jugadores juveniles. Este estudio tuvo como objetivo investigar las diferencias entre los juegos de formato equilibrado y desequilibrado en el CEP de los jugadores de fútbol jóvenes, controlando los diferentes tamaños del campo de juego. La muestra estuvo compuesta por 10 jugadores de campo y 2 porteros (P) con 13,55 ± 0,51 años. Los jugadores realizaron 6 situaciones diferentes aleatorias, siguiendo una metodología idéntica a lo largo de los días de entrenamiento: (1) 4Vs.4 + P (2) 4Vs.5 + P, y (3) 4Vs.6 + P. Todas las situaciones se realizaron en 30x25m y 40x30m. Las situaciones de juego duraron 5 minutos de práctica y otros 5 minutos de descanso. Después de la ejecución de todas las situaciones del juego, se preguntó a los participantes individualmente sobre su esfuerzo autopercibido, utilizando la escala de esfuerzo OMNI. En los juegos de formato desequilibrado, cuando aumenta la diferencia en el número de jugadores, el CEP es menor. Esta tendencia parece ser más evidente en las áreas de juego más pequeñas que en las más grandes. La diferencia en las puntuaciones de CEP considerando las diferentes dimensiones del espacio de juego parece no ser lineal. Los JR de fútbol equilibrado promueven un CEP más alto que el JR de fútbol desequilibrado. Se requieren más estudios sobre el tema considerando las diferentes áreas del campo de juego, así como los antecedentes de los diferentes jugadores.
Palabras clave: juegos reducidos; CEP; fútbol; Jugadores juveniles.

Introduction

Perceived exertion is a brief, non-invasive technique for monitoring internal training load and represents the feeling of how heavy and strenuous a physical task is (Borg, 1998). The rating of perceived exertion (RPE) method has been considered one of the best indicators of subjective perception of global internal load, also in younger soccer players, since it is a measure of both physical and psychological stress (Rodríguez-Marroyo and Antoñan, 2015; Romero-Caballero and Campos-Vázquez, 2019). It means that RPE is valid for monitoring, prescribing, and regulating exercise intensity and assessing training load.

In sports like soccer, where systematically brief bouts

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of high-intensity running and longer periods of low-intensity exercise occur, it is very important to monitor the acute physiological and perceptual responses to better adequate the external workload training (Bujalance-Moreno et al., 2019). On the other hand, as RPE is a recognized marker of homeostatic disturbance during exercise and has showed to be remarkably accurate and reliable to avoid exhaustion states (Eston, 2012).

The small-sided games (SSGs) are soccer specific training situations played on smaller fields with fewer players than the 11 versus 11 on the field in competition. The SSG have been considered as a high-intensity intermittent training exercise and are one of the most common drills used by coaches for soccer training (Torreblanca-Martínez et. al., 2018; Bujalance-Moreno et al. 2019; Selmi et al., 2020). Despite of growing evidence about the impact of different constraints in SSGs on younger soccer physiological demands (Bujalance-Moreno et al., 2019), such as the pitch size (Casamichana and Castellano, 2010), the number of players taking part (Praça et al., 2015; Sanchez-Sanchez et al., 2017; Dellal et al., 2011), coach encouragement (Brandes and Elvers 2017), bout duration and recovery periods (Arslan et al. 2017; Köklü et al., 2017), different game rules (Halouani et al., 2014), the presence of goalkeepers (Hulka et al., 2016; Köklu, et al., 2015), the use of floaters, (Rábano-Muñoz, et al., 2019), result variation (Menegassi et al., 2020), among other factors, the integration of brief methods to quantify the physical demands (i.e., RPE) during the SSGs practice, should be more explored in the practical context by the coaches. RPE is a non-expensive instrument that can quantify accurately internal physiological responses and provide insight into the physical workloads imposed upon players during SSGs (Stojanoviæ et al., 2021).

Among the SSG formats studied in previous literature, the effect of unbalanced games in young soccer players' physiological workload is scarce. The few studies that have analysed the impact of this game situation predominantly focused their attention on the improvement of the technical skills (Sgrò et al., 2018). Nonetheless, Praça et al. (2015) concluded that a reduction in physical demands was verified in unbalanced situations (4vs.3), including a shorter total distance covered, distance covered at higher intensities, and acceleration demands. Despite these findings, no study has explored the differences between balanced SSG formats and unbalanced formats (considering low- and high-inferiority situations) on young soccer' RPE, controlling for different pitches areas.

Using a brief and valid instrument to quantify the exercise intensity and training load in youth soccer players (i.e., OMNI scale; Rodríguez-Marroyo and Antoñan, 2015), this study provides valuable information on the subjective perception of the player's effort for understanding the different physiological responses imposed upon players by varying the level of opposition of different SSGs formats. This is of particular importance since quantifying the physical and physiological demands imposed by SSGs affect the training process and optimization of athletes' performance (Mujika, 2013).

Therefore, this study aimed to investigate differences between balanced and unbalanced format games (4vs.4; 4vs.5; 4vs.6) in young soccer players' RPE, controlling for different playing field sizes (35 m x 25 and 40x30m).

Methods

Participants

The sample consisted of 10 field players plus 2 goalkeepers (13,55±0,51 years). All members belonged to the same team, with a regular practice based on 3 training sessions of 75 minutes each, plus the competitive moment at the end of the week. All players were federated for at least 3 years.

All the players were informed about the objectives of the research and its requirements, as well as the potential benefits and risks. Participation was voluntary. The parents or legal guardians signed an informed consent and the players gave his/her verbal assent. All procedures followed the guidelines stated in the Declaration of Helsinki.

Design and Procedures

This study ran for 3 consecutive training days with an interval of 48 hours apart between each day. The main purpose of these 3 assessment days was to have more accurate conclusions from the data collected. It was selected 6 different SSG formats, that lasted 5 minutes of practice and another 5 minutes of rest (passive and hydrated) between each performance. The order of the exercises was randomized on the first day of the study (from 1 to 6), following the same order on the remaining days. The full description of each game format and the random order are presented in Table 1.

The activities started at 10:30 am and ended at 12 pm every day, including warm-up, game situations,

recovering time, cooldown, and stretching. The warm-up lasted 15 minutes, with the first phase of general mobilization and musculoskeletal activation, ending with a ball possession situation and active stretching.

The field was located an altitude of 292 meters above sea level and was a space of totally uncovered synthetic grass, with the dimensions of 100 meters long and 64 meters wide.

Table 1
Description of the small-sided games

Order	Format	Game Space (ratio play area per player)	Observations
1st	4 Vs. 6 + Gk	35 x 25 m (87,5 m²)	-
2nd	4 Vs. 5 + Gk	40 x 30 m (133 m²)	Remove only one element from the team with 6.
3rd	4 Vs. 6 + Gk	40 x 30 m (120 m²)	Add removed element to the same team
4th	4 Vs. 4 + Gk	40 x 30 m (150 m²)	Remove the added element and 1 more from the team of 6.
5th	4 Vs. 5 + Gk	35 x 25 m (79,5 m²)	Re-add the element that played the first situation of 4 Vs. 5 + Gk.
6th	4 Vs. 4 + Gk	35 x 25 m (109 m²)	Remove again the element added to the team of 5.

The goals used were those of the variant of soccer 7, with 6 meters in length and 2 meters in height. Replacements of the ball in the game were made by hand-throwing when the ball came out of the sidelines. In the case of goal occurred, the goalkeeper was the freedom to follow with the controlled ball by hand or feet unopposed. In the case of a corner, the ball was set by the goalkeeper of the team that would have the possession of the ball, trying to reduce breaks or stops in the pace of the game.

Teams were assembled using the knowledge of the team coach, striving to strike a balance between commonly played game functions and individual quality, also taking into account the permanent numerical inferiority of a team over 4 of 6 formats. No request was made for the players to occupy functions normally performed, only advised to try to maintain an organized structure, taking into account the need to defend one goal and attack another. No instructive feedback was provided, just the constant call to keep up the pace and seek to perform the actions with the commitment. The study took place in the middle of the season, during the winter break in a period without official competition. Before the main study, a pilot study was performed at the same facilities to validate the assessment protocols and the experimental game situations.

After the execution of each game format, participants were asked individually about their self-perceived effort, using the Children's OMNI-walk/run Scale of Perceived Exertion, a scale that was built directly for children and adolescents (category range, 0-10; Utter et al., 2002; Robertson, 2004). Previously, before the participation in the game formats, all participants were individually instructed on the specifics of the OMNI Scale, as well as when they were asked (individually so as not to be influenced by the responses of their opponents or teammates). The researcher interviewed each participant right after each exercise using the OMNI picture system that clearly elucidated the different levels of effort and the different possible response options (with '0 indicating a minimum response and '10 indicating a maximum response)

Statistical Analysis

The descriptive statistics of RPE scores were reported as means, standard deviation and 95% confidence interval for means of the rating perceived exertion per each game format thought 3 assessment days. Preliminary analyses were performed to analyze the distribution of the data and the assumptions of normality using the Shapiro Wilk test. Across the 3 days, the Man-Whitney U test was individually performed at first to test differences in RPE between balanced and unbalanced game formats (4vs.4; 4vs.5; 4vs.6), and second to test differences in RPE between the two dimensions of playing field sizes. Afterwards, the effect size of the Man-Whitney U test was calculated from the z value (standardized test statistics) using the following formula: r= z / squared root of N, where N= total numbers of cases. All analyses, except for effect size calculation, were performed using the IBM SPSS Statistics software (version 25; SPSS, Inc., Chicago, IL, USA). A level of significance of 5% was adopted in all analyses.

Results

Table 2 present the descriptive statistics of the RPE (means, standard deviation, and 95% confidence intervals for means) per each game format in the smaller and the bigger game space, across the 3 assessment days are displayed.

Table 2
Mean, Standard Deviation and 95% Confidence Interval for Mean of the rating perceived exertion per each game format thought 3 assessment days.

	n	RPE (Day 1)		RPE (Day 2)		RPE (Day 3)	
Game format		M±SD	95% CI	M±SD	95% CI	M±SD	95% CI
35x25 m							
4 Vs. 4 + Gk	8	7,0±2,3	5,7-8,3	7,0±1,1	6,1-7,9	6,6±0,9	5,9-7,4
4 Vs. 5+ Gk	9	6,0±1,7	4,7-7,3	6,6±0,9	5,9 – 7,2	5,3±1,3	4,3 – 6,4
4 Vs. 6+ Gk	10	4,3±1,0	3,6-5,0	4,0±0,7	3,5-4,5	3,7±1.0	3,0-4,4
40x30 m							
4 Vs. 4+ Gk	8	7,3±1,2	6,3-8,2	5,8±1,0	4,9-6,6	5,3±1,2	4,3-6,2
4 Vs. 5+ Gk	9	5,6±1,3	4,5-6,6	4,8±1,2	3,9-5,7	4,2±0,4	3,9-4,6
4 Vs. 6+ Gk	10	6,2±1,5	5,1-7,3	5,1±1,1	4,3-5,9	4,9±0,7	4,4-5,4

M, Mean; SD, Standard Deviation; 95% CI, 95% Confidence Interval for Mean; RPE, rating perceived exertion.

Differences in RPE related to unbalanced small-sided games

Smaller game space (35m x 25m)

4x4 versus 4x5 format

A Man-Whitney U Test revealed significant differences in the RPE in day 3 between 4x4 (Md=7, n=8) and 4x5 (Md=5, n=9), U=15.50, *z*= -2.04, p =.041, r=.49. No other differences were seen in the 1st and the 2nd days.

4x5 versus 4x6 format

There were significant differences in the RPE in day 1 between 4x5 (Md=6, n=9) and 4x6 (Md=4, n=10), U=18, *z*= -2.27, p =.024, r=.52; in day 2 between 4x5 (Md=7, n=9) and 4x6 (Md=4, n=10), U=1.00, *z*= -3.68, p <.001, r=.84; and in day 3 between 4x5 (Md=5, n=9) and 4x6 (Md=3.5, n=10), U=14.5, *z*= -2.56, p <.010, r=.59.

4x4 Versus 4x6 format

There were significant differences in the RPE in day 1 between 4x4 (Md=7, n=8) and 4x6 (Md=4, n=10), U=3.50, *z*= -3.29, p =.001, r=.78; in day 2 between 4x4 (Md=7, n=8) and 4x6 (Md=4, n=10), U=1.00, *z*= -3.55, p <.001, r=.84; and in day 3 between 4x4 (Md=7, n=8) and 4x6 (Md=3.5, n=10), U=2.00, *z*= -3.46, p <.001, r=.82.

Figure 1 presents the range of RPE in the small game space, across the 3 days for each game format.

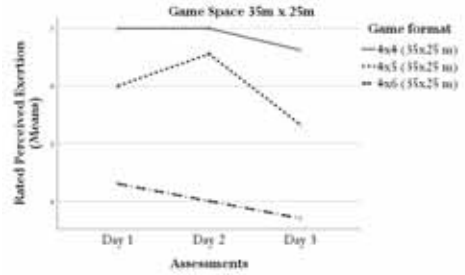

Figure 1 . Variation of the rated perceived Exertion across the 3 days for each game format (4x4; 4x5; 4x6) in a smaller game space (35 m x 25m).

Bigger game space (40m x 30m)

4x4 Versus 4x5 format

A Man-Whitney U Test revealed significant differences in the RPE in day 1 between 4x4 (Md=7.5, n=8) and 4x5 (Md=6, n=9), U=13.00, *z*= -2.31, p =.021, r=.56; as well as in day 3 between 4x4 (Md=6, n=8) and 4x5 (Md=4, n=9), U=15.50, *z*= -2.12, p =.034, r=.51. No significant differences were seen in the 2nd day.

4x5 Versus 4x6 format

There were significant differences in the RPE only in the 3rd day between 4x5 (Md=4, n=9) and 4x6 (Md=5, n=10), U=21.50, *z*= -2.14, p =.032, r=.49. No other differences were seen in the 1st and the 2nd days.

4x4 Versus 4x6 format

There were no significant differences in the RPE in any of the days between 4x4 and 4x6 game format.

Figure 2 presents the range of RPE in the bigger game space, across the 3 days for each game format.

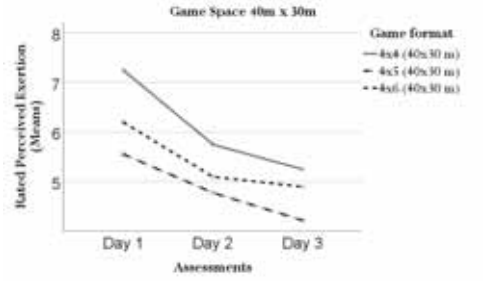

Figure 2. Variation of the rated perceived Exertion across the 3 days for each game format (4x4; 4x5; 4x6) in a bigger game space (40 m x 30m).

Differences in RPE related to dimension of playing field

4x4 (35m x 25m) versus 4x4 (40m x 30m)

A Man-Whitney U Test revealed significant differences in the RPE in day 2 between 4x4 (35m x 25m) (Md=7, n=8) and 4x4 (40m x 30m) (Md=6, n=8), U=12.50, z= -2.11, p =.035, r=.53; and in day 3 between 4x4 (35m x 25m) (Md=7, n=8) and 4x4 (40m x 30m) (Md=6, n=8), U=10.50, z= -2,38, p =.017, r=.60. No differences were seen in the first day.

4x5 (35m x 25m) versus 4x5 (40m x 30m)

There were significant differences in the RPE in day 2 between 4x5 (35m x 25m) (Md=7, n=9) and 4x5 (40m x 30m) (Md=5, n=9), U=10.00, z= -2.76, p =.006, r=.65; and in day 3 between 4x5 (35m x 25m) (Md=5, n=9) and 4x5 (40m x 30m) (Md=4, n=9), U=17.50, z= -2,15, p =.031, r=.51. No differences were seen in the first day.

4x6 (35m x 25m) versus 4x6(40m x 30m)

There were significant differences in the RPE in day 1 between 4x6 (35m x 25m) (Md=4, n=10) and 4x6 (40m x 30m) (Md=6.5, n=10), U=15.50, z= -2.66, p =.008, r=.59; in day 2 between 4x6 (35m x 25m) (Md=4, n=9) and 4x6 (40m x 30m) (Md=5, n=10), U=19.00, z= -2,45, p =.014, r=.55; and in day 3 between 4x6 (35m x 25m) (Md=3.5, n=10) and 4x6 (40m x 30m) (Md=5, n=10), U=15.00, z= -2,75, p =.006, r=.61;

Discussion

This study aimed to investigate differences between balanced and unbalanced format games in young soccer players' RPE, controlling for different playing field sizes. First, our results show that in unbalanced format games when the difference in the number of players increases (i.e., plus 1 and 2 players), RPE is lower. This tendency seems to be more evident in smaller (35 m x 25m) compared to bigger (40 m x 30m) playing field areas. The effect of unbalanced games on young soccer players' physiological workload is still an open issue.

Our study helps to better understand the effect of these game formats on RPE when different pitches areas are controlled. Our results are in line with other studies showing that specific SSGs constraints in the younger soccer training, such differences in the number of players taking part (Praça et al., 2015; Sanchez-Sanchez et al., 2017; Dellal et al., 2011; Stojanoviæ et al., 2021) and playing field size (Casamichana and Castellano, 2010; Hulka et al., 2016) can modify the intensity of SSGs and as consequence affect the physical demands.

Exploring this issue in detail, especially in younger soccer players, is of particular importance since it could represent a worthy and useful background for coaches to better manage these playing constraints in SSGs. Our results support the conceptual view that if coaches intend to increase the internal load in order to develop physiological adaptations by SSGs, they may use balanced instead of unbalanced game formats. Although, using different approaches to assess physical demands (i.e., global positioning systems), similar results were also seen by Praça et al. (2015), who concluded that the inclusion of additional players reduces physical demands in SSGs. They have reinforced the idea that unbalanced teams covered smaller distances as well as less accelerations. In addition, using only balance game formats, Stojanoviæ et al. (2021) concluded that the number of players has a direct impact on the player's physiological responses and activity demands.

From another perspective, in terms of tactical behavioural dynamics, unbalanced format games seem to stimulate more the individual and team auto-organization and thus stimulate the collaborative process of teams (Goncalves et al., 2016). For example, the principle of concentration in the defense phase of the game, could induce a lower block and a joining of the defensive lines. As a consequence, it could reduce the total distance covered by the team. On the other side, teams in numerical superiority can have the area per player reduce, especially when the size of the field is smaller. It means that, generally, unbalanced format games can influence on average lower RPE in comparison with balanced format games. In a practical way, this information is useful to coaches in order to improve the training organization in terms of reducing or increasing the physical demands as well as to induce specific tactical behaviors.

Second, as a further crucial novelty, in our study, the difference in RPE scores considering different dimensions of playing space seem not to be linear. For example, in game formats where the two teams have numeric equality or one of the teams have advantage at one player, the RPE scores were lower in bigger than smaller size dimensions of the pitch. However, contrary results were seen when we compared unbalanced games formats with plus 2 players. In this kind of game format when the dimension of playing space is bigger, RPE is consistently higher in comparison to smaller size game pitches.

In the first case, in smaller playing field area with numeric equality or unbalanced game formats until one player, provides higher physical demand in comparison to bigger playing field areas. These results are in line with others showing that SSGs induced significantly higher heart rate responses as compared to large-sided games (Owen et al., 2011). Although in smaller playing field areas there is a decrease in the ratio of player to play area, Owen et al. (2011) founded that in small-SSGs (3x3) players spent a greater amount of time in intense heart rate zones as compared to large- SSGs (9x9). Based on these findings, it is likely that in our study the smaller playing field area provided a bigger amount of time in intense zone, increasing RPE.

Finally, we found that the unbalanced game format 4x6 played in a bigger playing field size (1200 m2) induces a higher intensity of the physical demands compared with the smaller playing field size (875 m2). In concordance to Sarmento et al. (2018) in a systematic review about SSGs soccer, the majority of studies reveal that larger areas lead to an increase in acute physiological load. In this specific case, those teams that have numerical superiority they need to guarantee greater mobility in its game, with constant attacks to space (i.e., to look for empty spaces to penetrate, with and without the ball), looking for actions in speed in order to create greater unpredictability and to break with the opposing defensive organization. Thus, as a consequence, it increases the players' appreciation of their perceived exertion. Other studies on the topic, such as Vilar et al.

(2014) and Frencken et al. (2013), reinforce the theory that the higher the dimensions of the field, the larger the area that was covered by the teams. Also, there was a bigger distance between players of the same team, as well as a rise in the distance, between the players of the team with the ball and their opponents. Altogether these results possibly explain the higher values of RPE obtained in our study by the game formats with larger dimensions.

Some limitations should be considered in this study. First, it was included only 12 players from the same team. In this sense, the present results should be analyzed with the necessary caution. Second, we acknowledged that it would be important to quantify other measures related to the internal load (i.e., HR) and external load using more reliable instruments. On the other hand, some important practical implications for the youth soccer coach should be taken into account. First of all, when coaches plan balance format games, such as 4Vs. 4 + Gk, it must be carefully considered the exercise time as well as the physiological capacity of the players, since it is one of the most demanding game formats analyzed. Second, our results support that 4Vs. 4 + Gk format, may be more effective to work increase players' aerobic capacity. Third, on the other side, unbalanced format games may be useful to improve the players' tactical strategy of the game.

The findings of the present study support that numerical superiority changes the physical demands of younger soccer players during SSGs. We conclude that in unbalanced format games when the difference in the number of players increases, RPE is lower. Additionally, smaller playing field areas tend to induce a bigger amount of time in intense zone, increasing RPE. Finally, the difference in RPE scores considering different dimensions of playing field areas seem not to be linear. More studies on the topic are required considering different playing field areas as well as different players backgrounds.

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