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Research Article

Do Football Players Train Hard? Difference in Intensity Between Small-Big Sided Games and Matches Through GPS Data -

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ABSTRACT

The aim of the study is to compare external load parameters in football when measured during games and in different forms of training (e.g., small and big sided games). Data were collected from 35 football players from a U17 and U19 teams playing for a premier league football academy. All external load parameters were divided into two categories, those related to changes in velocity and those related to different speed zones. Parameters related to changes in velocity were significantly higher in small-sided games compared to matches. Parameters related to speed zones were mostly significantly higher in big sided games compared to matches, except for the parameters weighted total intensity, repeated sprints, ratio of repeated sprints and walking meters. The results show that these parameters are part of the match and are practiced in every training session, and by increasing their intensity in training, these parameters should increase in the matches. Findings can be used to enhance the periodization of training and ultimately player performance.

Keywords: External load; Intensity; Gps-data; Intensity in football; Intensity; Monitoring football; Football

INTRODUCTION

Since 1993 there has been a notion, created by football fans, that Manchester United receives extra time in injury time, known as 'Fergie time', to score a winning goal. If 'Fergie time' exists, is it Manchester United who actually scores the most winning goals during injury time? The history of the Premier League reveals that it is Liverpool who scores the most winning goals in injury time[1]. Does that mean that Liverpool has better physical performance than other teams in the Premier League that allows them to perform better in the final minutes? It could be. In any case, every trainer wants to have a team that performs as well at the end of the game as in the beginning. Previous studies have investigated the differences in physical demands between the first and the second half of a match. For example Bradley [1], found that the distance covered at high intensities (> 14.4 km/ h) was 18% lower in the last 15-minute period of the game than it was in the first. Similarly Rampinini [2] found that, for players with the highest amount of total distance covered, high intensities (> 14.4 km/ h) and very high intensities (> 19.8 km/ h) decreased in the second half, while players with less distance covered didn't decrease their performance. The same study also found that teams have the tendency to increase their distances covered in different speed zones at the end of the season compared to the start of the season.

It is important to know what the demands of the game are in order to know what the focus of the training should be. In the literature, parameters that have been most commonly examined include the total distance covered at different speed zones, such as total distances, high intensities, very high intensities, number of sprints, repeated sprints, accelerations and decelerations. All these studies recognize that elite football players cover in a game, in average, 11 km [1,3,4]. However, 11km does not say much about the intensity of the game. It is more important to know the manner in which the players cover this distance. Is it by walking? Is it by sprinting? Mohr [5], identified the distance covered at high intensities (> 14.4 km/ h) and very high intensities (> 19.8 km/ h) as a key performance indicator, and Bradley [1] found that, on average 2700m is covered at high intensities and 980m is covered at very high intensities. From the perspective of ball possession, research conducted in the Italian Serie A league found that the best teams cover greater distances in all speed zones while having ball possession compared to the rest of the teams in the league [6].

Parameters such as accelerations and decelerations, in the literature referred to as changes in velocities, give a better insight into game intensity because of their association with energy expenditure. This arises because it takes more energy to accelerate or decelerate than to keep a consistent velocity [7]. Furthermore, it has been found that the players have on average 650 accelerations and 610 decelerations in a football game. This information makes it imperative for the trainers to realize the importance of these parameters [8].

Given the importance of the accelerations, we conducted a literature search to determine whether any decrease has been detected between first and second half. The findings were contradictory, with Russel [8], finding that the number of accelerations decreases in the second half of a game, yet Bradley [1], has found that the number of accelerations didn't change. The reason for this contradiction might be caused by the different acceleration thresholds that were used between the two studies. If we take the findings of Russel [8] into consideration, we identify that accelerations have the same tendency to decrease as speed parameters do.

An additional parameter that is used in some studies is the metabolic power, which incorporates the energy cost and the velocity [9]. As a parameter, the metabolic power includes accelerations and decelerations, potentially constituting an even better measure of the true physical demands of football. Studies that compared the intensity of metabolic power with different speed zone intensities found that the metabolic power of $20^{\frac{W}{kg}}$ is equivalent to high intensity distance (> $14^{\frac{km}{h}}$) activity [7,10]. In a further analysis of the above, it is found that a run of $9^{\frac{km}{h}}$ with an acceleration of $1 m/s^2$ generates the same metabolic power as a constant speed at $14^{\frac{km}{h}}$ (7). It can be concluded that it takes more metabolic power to accelerate than to maintain a steady speed. If we combine this information with the amount of accelerations and decelerations from the study of Russell [8], it can be concluded that the parameters with the biggest influence in the decrease in physical performance are accelerations and decelerations.

All the above information can provide us with knowledge about the needs of the game of football which will help make the periodization of training more precise. Periodization is crucial in sports since it determines the exact training load of the players. When periodization is not determined in a proper way, undertraining can occur as players do not train optimally. This leads to variations in their physical performance, potentially making the difference between being the best team or just one of the rest [2]. When overtraining occurs, the risk of injury increases dramatically. The relationship between training load and injury follows a 'U-shape', meaning that small changes in the training load will increase the likelihood of injury. In conclusion, the rapid increase in training load can cause

[1]Premier League clubs that have scored the most last-minute winners (2017, July 17). Retrieved from. https://talksport.com/football/257621/premier-league-clubs-have-scored-most-last-minute-winners-surprise-number-one-170717246967/.

injuries, whereas hard training protects against them [11]. In support, Hulin et al. [12] found that when the intensity increases more than 15% in one week, the risk of injury increases from 21% to 49%.

Interesting differences in internal and external load have been found when comparing different training forms, such as regular and small-sided games. Rampinini [2], investigated the internal load through Rate of Perceived Exertion (RPE) on a Borg scale, blood lactate and heart rate in small sided games and found that in a 3 *vs* 3 game the internal load is higher than in a 6 *vs* 6. In the past, small sided games were used to develop technical and tactical skills, but recently they are used more often for aerobic training. In a study that examined external load data [10], increases in moderate accelerations (2-3 m/s^2) and decelerations (2-3 m/s^2) were found when the pitch size decreased (5:5 > 7:7 > 10:10), whereas parameters such as distance covered in high intensities, maximum velocity and maximum accelerations and decelerations decreased when the pitch size decreased (10:10 > 7:7 > 5:5). Interestingly though, the mechanical power, which includes changes in velocity and maximum velocity, decreased when the pitch size decreased. From another perspective, small-sided games in a 5:5 situation were compared when using different sized playing fields (manipulating individual playing areas), and when considering the effective playing time, which is the playing time excluding the stops during fouls, goals, throw-in, and injuries, it was found that the effective playing time was higher when the dimensions of the pitch increased. Furthermore, the external and internal workloads and the ratings of perceived exertion were also higher. On the other hand, the number of motor behaviors, such as the number of passes, shots, tackles, headers and dribbles, were found to decrease when the pitch size increased [13].

Thus, it is important to know which parameters from GPS data can define intensity of a football match. Furthermore, it is also important to know the differences between these parameters in small-big sided games and matches. Although there are a lot of studies that have examined match intensity using external load parameters, so far as we know, no studies have compared these parameters between small-big sided games and matches. Therefore, the aim of this study is to compare external load parameters measured during matches with those found in different game forms used during training. By knowing the differences and similarities in external load parameters between training forms and matches, we would know which parameters are trained appropriately during training sessions and which parameters over or underestimate the demands of the match. First, this information will make coaches and sport scientists conscious of the physical conditions required by the match. Second, this information can be used effectively to train the requirements of the match. These new insights can be used as guidelines for better periodization at an appropriate intensity, eventually leading to the enhancement of the physical performance of the team.

METHODS

Participants

Two teams from the Feyenoord Football Academy in the Netherlands participated in this study. These were the Under 17 (U17) and the Under 19 (U19) teams with a total of 35 participants (age M = 17.8 SD = 0.63). The goalkeepers of the teams were excluded from this study because of their limited movement on the field. Each player had at least 8 years of experience in football and 7 players of the U17 squad were members of the Dutch national team that became the European champions in that year. Both teams typically trained six times per week and played one game. However, during some weeks, the teams played more than one game, resulting into less weekly training sessions.

Instruments

For the data collection Johan Sports V4 Global Position System (GPS) devices (Noordwijk, Netherlands) were used with a sampling rate of 10Hz. Johan V4 devices use the Galileo (European) satellite and incorporate a three-dimensional accelerometer, a three-dimensional gyroscope and a three-dimensional magnetometer with a sampling rate of 100Hz. These devices measure the activities of the football players and categorize them into speed thresholds. The speed thresholds are walking (< 7 km/ h), jogging (7.1 - 14.0 km/ h), running (14.1 - 20.0 km/ h), sprinting (20.1 - 25.0 km/ h) and high-intensity sprinting (>25.0 km/h). The devices also measure the total distance, maximum speed, accelerations, high-intensity accelerations (> 3 m/s^2) ,decelerations, high intensity decelerations (> 3 m/s^2) the number of sprints, the number of repeated sprints (sprints repeated within 20s) and the player-load. The player-load is the change in acceleration in vertical, lateral and anteroposterior forces for every time interval. The validity of the GPS devices has been examined by many researchers such as Waldron et al. [14]. They concluded that the trackers can be used to quantify significant changes in sprint performance.

Procedure

The GPS device was located in a vest which the players wore during training and their games. The GPS device was placed in a way that it would stay between the scapulae. This vest was fitted tightly to reduce movement artefacts. Every player wore the vest from 15-minutes before training or the game started and took it off when finished. After data collection the Johan-app platform was used to categorize the activities of the day. These activities consisted of position games, tactical or technical training, passing exercises, small-sided games (4:4[2], 5:5, 6:6) plus goalkeepers, more-regular games (7:7, 8:8, 9:9, 10:10) plus goalkeepers and the match itself (10:10) plus goalkeepers. The field dimensions per player varied for every training form [Table 1 and 4]. Data were analyzes and provided to coaches for feedback on the physical aspects of training/games. From each training session, only the data from the small and regular sided games were taken into account for this study. The data was collected from March to June in a single playing season.

Data analysis

All the parameters were divided into two categories: those related

Table 1: Overview of the measurement for every session

Forms	Number of Measurements
4v4	6
5v5	8
6v6	12
7v7	6
8v8	7
9v9	6
10v10	6

[2]The notation 'X:X' will be used for X *vs*. X matches, e.g., 4:4 for 4 *vs*. 4

to speed zones, and those related to changes in velocity. Parameters related to changes in different speed zones were total distance, walking distance (> 7 km/ h), jogging distance (7.1 km/ h - 14 km/ h), running distance (14.1 - 20 km/h), sprinting distance (> 20.1 km/ h), number of sprints and the number of repeated sprints. We added other parameters including the Weighted Total Intensity (wti) and the percentage of repeated sprints. The weighted total intensity is a parameter that measures, in percentage, the intensity that the players achieved relative to the maximum intensity they could achieve. This parameter makes the intensity interpretable by incorporating speed zones. In this way, while some training forms and games will have the same total distance, the weighted total intensity will give a better insight into the intensity because it weights each zone so that the more intense activities have a greater influence on the overall intensity. The equation that was used for the calculation of the weighted total intensity was:

$$wti = \frac{\left(\left(walk \times 0.1\right) + \left(jog \times 0.2\right) + \left(run \times 0.3\right) + \left(tot\ sprint \times 0.4\right)\right)}{\left(total\ distance \times 0.4\right)}$$

The percentage of repeated sprints is the percentage of the number of sprints that are repeated. Because the number of sprints can fluctuate a lot between different training forms, the percentage of the repeated sprints may stay consistent.

Parameters related to changes in velocity were, accelerations, decelerations, high intensity accelerations ($> 3\,m/s^2$), high intensity decelerations ($> 3\,m/s^2$), and the player load. The equation for the player load was:

$$playerload^{TM} = \sqrt{\frac{\Delta \acute{a}_x^2 + \Delta \acute{a}_y^2 + \Delta \acute{a}_z^2}{\Delta t}}$$

Where Δa = difference in acceleration for every time interval in (x,y,z) direction and Δt = change in time.

Furthermore, we added other parameters such as the (i) actions, which is the sum of the accelerations and decelerations, (ii) high intensity actions, which are the actions $> 3\,m/s^2$), and (iii) the average power. Actions and high intensity actions are parameters that can provide information about how active one is during the session. The power provides a better insight into the intensity because it incorporates the accelerations and maximal velocity. The equation used to calculate the power was:

$p = f \times v$ where $f = m \times a$ resulting in $p = m \times a(t) \times v(t)$ the players, $a(t)$ = accelerations for every time interval, $v(t)$ = the speed for every time interval. To make the player's effort comparable between players and forms, we made power independent of the mass, by which the power could be expressed as watts per kilogram ($\frac{W}{kg}$)

$$\frac{p}{m} = \frac{m \times a(t) \times v(t)}{m}.$$

In order to make the training comparable with the game, we converted every parameter to a value per minute because the duration of training and the game were different. To do so, all the parameters were divided by the duration, except the average power which was calculated as the average of the event and expressed in seconds.

Statistical analyses

The data are presented as means (standard deviations). The Kolmogorov-Smirnov test was used to test whether the data were normally distributed and the Levene's test was used to test for homogeneity of variances. A one-way repeated measures Analysis of Variance (ANOVA) was executed, with the parameters related to changes in velocities and speed thresholds as the dependent variables and the different forms as the independent variables. When the data were normally distributed and homogenous, a Bonferroni post-hoc test was applied to examine the significant differences between the parameters in the training forms and the game. When the data were not homogenous, the Welch test was performed with a Games-Howell post-hoc test. A non-parametric one-way repeated measures (ANOVA) Kruskal-Wallis test was used when the data were not normally distributed, with a Bonferroni post-hoc test to examine the significant difference between the parameters in the training forms and the game. If there were any parameters that did not differ statistically in all training forms and game then Spearman's correlation coefficient was used to assess the relationship between those parameters. All statistical analyses were performed using IBM SPSS Statistics 24. The statistical significance was set at $p < 0.05$.

RESULTS

Parameters related to changes in velocity

Table 2 shows the parameters related to changes in velocity. Average power was significantly greater in the 5:5, 6:6 and 7:7 games in comparison to the match (17.39 ± 1.9 17.14 ± 2.22, 16.69 ± 0.84, 13.18 ± 0.70 respectively; $p < 0.01$). The player load was significantly greater in the 5:5, 6:6, 7:7 and 9:9 in comparison to the match (6.43 ± 0.86, 6.91 ± 0.48, 6.54 ± 0.33, 6.49 ± 0.49, 5.71, respectively; $p < 0.01$), and higher in the 10:10 in comparison to the match (6.41 ± 0.43, 5.71 ± 0.24, respectively; $p < 0.05$). The number of accelerations were significantly greater in the 4:4, 5:5, 6:6, 7:7 in comparison to the match (3.04 ± 0.39, 2.64 ± 0.42, 2.60 ± 0.30, 2.26 ± 0.15, 1,49±0.11, respectively; $P < 0.01$) The number of decelerations were significantly greater in the 4:4, 5:5, 6:6, 7:7 in comparison to the match (2.71 ± 0.45, 2.47 ± 0.39, 2.38 ± 0.26, 2.16 ± 0.09, 1.37 ± 0.10 respectively; $p < 0.01$) The number of actions performed in the small sided game forms was significantly greater in comparison to the game, i.e., for the 4:4, 5:5, and 6:6 games (5.76 ± 0.83, 5.11 ± 0.81, 4.99 ± 0.55, 2.86 ± 0.23, respectively; $P < 0.01$ and in the 7:7 game (4.42 ± 0.20, 2.86 ± 0.23, respectively; $P < 0.05$). Furthermore, there was a highly significant difference between the number of high intensity actions executed during small sided games in comparison to the game (1.6 ± 0.19, 1.36 ± 0.37, 1.49 ± 0.19, 0.89 ± 0.07, respectively; $p < 0.01$).

Parameters related to different speed zones

Table 3 shows the parameters related to different speed thresholds. We found that the total distance was significantly greater in the 6:6, 10:10 ($p < 0.01$) and 9:9 ($p < 0.05$) forms in comparison to the game (117.7 ± 11.3, 121.6 ± 5.3, 119.3 ± 7.0, 105.4 ± 4.3). Interesting was the findings that the weighted total intensity, which incorporates speed thresholds, was not significantly different between training forms and game. We found that the sprint distance in small sided games was less than the game, especially in the 4:4 and 5:5 forms which were significantly less when compared to the game, (2.0 ± 0.8, 8.0 ± 1.0, 4.9 ± 1.6, respectively; $p < 0.01$). Another interesting finding was that, while the number of sprints varied between training forms, the 4:4 game was significant less than the game (0.48 ± 0.14 0.81 ± 0.05, respectively; $P < 0.05$), but the ratio of the repeated

Table 2: Means and standard deviations of external load parameters related with changes in velocities in every training form and match.

Parameters Per minute	Match	4:4	5:5	6:6	7:7	8:8	9:9	10:10
Average power (Watts/Kg)	13.18 ± 0.70	16.01 ± 2.85	17.39 ± 1.99**	17.14 ± 2.22**	16.69 ± 0.84**	15.40 ± 1.66	15.26 ± 1.62	15.04 ± 1.74
Player load (m/s^2)/min	5.71 ± 0.24	6.23 ± 0.79	6.43 ± 0.86**	6.91 ± 0.48**	6.91 ± 0.48**	6.11 ± 0.44	6.49 ± 0.49**	6.41 ± 0.43*
Accelerations (m/s^2)/min	1.49 ± 0.11	3.04 ± 0.39**	2.64 ± 0.42**	2.60 ± 0.30**	2.26 ± 0.15*	1.85 ± 0.34	1.93 ± 0.31	1.78 ± 0.16
High accelerations (m/s^2)/min	0.43 ± 0.04	0.87 ± 0.10**	0.74 ± 0.11**	0.74 ± 0.12**	0.61 ± 0.06	0.53 ± 0.12	0.53 ± 0.07	0.47 ± 0.10
Decelerations (m/s^2)/min	1.37 ± 0.10	2.71 ± 0.45**	2.47 ± 0.39**	2.38 ± 0.26**	2.16 ± 0.09**	1.75 ± 0.29	1.84 ± 0.26	1.78 ± 0.20
High decelerations (m/s^2)/min	0.47 ± 0.04	0.72 ± 0.17	0.64 ± 0.29	0.75 ± 0.09**	0.65 ± 0.05**	0.52 ± 0.09	0.54 ± 0.10	0.51 ± 0.0
Actions (m/s^2)/min	2.86 ± 0.23	5.76 ± 0.83**	5.11 ± 0.81**	4.99 ± 0.55**	4.42 ± 0.20*	3.60 ± 0.62	3.78 ± 0.56	3.57 ± 0.
High actions (m/s^2)/min	0.89 ± 0.07	1.60 ± 0.19**	1.36 ± 0.37**	1.49 ± 0.19**	1.27 ± 0.08	1.05 ± 0.19	1.08 ± 0.15	0.98 ± 0.17

Note: Post Hoc Bonferroni test: all training forms with the game $^{*}P < 0.05$ and $^{**}P < 0.01$

Table 3: Means and standard deviations of external load parameters related with different speed zones in every training form and match

Parameters Per minute	Match	4:4	5:5	6:6	7:7	8:8	9:9	10:10
Total distance Meters/min	105.4 ± 4.3	104.4 ± 10.1	112.8 ± 6.6	117.7 ± 11.1*	115. ± 7.8	111.6 ± 11.3	119.3 ± 7.0*	121.6 ± 5.3*
Sprint distance Meters/min	8.0 ± 1.0	2.0 ± 0.8**	4.9 ± 1.6**	6.4 ± 2.8	6.4 ± 2.3	6.3 ± 3.1	8.0 ± 2.5	8.6 ± 2.8
Run distance Meters/min	17.1 ± 2.1	15.8 ± 5.0	18.5 ± 3.1	21.1 ± 5.2	19.1 ± 3.4	17.7 ± 4.6	20.9 ± 3.4	22.5 ± 1.6*
Jog distance Meters/min	41.1 ± 3.1	45.8 ± 7.5	48.3 ± 5.7	50.6 ± 6.3**	48.4 ± 6.6	45.4 ± 7.3	50.8 ± 6.2*	52.1 ± 3.1*
Walk distance Meters/min	40.5 ± 1.6	40.6 ± 3.1	41.4 ± 3.1	39.9 ± 2.5	42.0 ± 2.5	43.1 ± 3.5	40.7 ± 3.1	39.6 ± 0.37
Weighted total intensity Percentage (%)	49.6 ± 1.1	44.8 ± 2 .6	48.3 ± 1.0	50.0 ± 2.0	48.0 ± 2.4	48.2 ± 3.2	49.6 ± 2.3	50.5 ± 1.5
Number of sprints Discrete number/ min	0.81 ± 0.05	0.48 ± 0.14*	0.91 ± 0.13	0.99 ± 0.18	0.79 ± 0.24	0.74 ± 0.17	0.89 ± 0.16	0.88 ± 0.19
Repeated sprints Discrete number/ min	0.55 ± 0.05	0.30 ± 0.14	0.61 ± 0.11	0.68 ± 0.13	0.53 ± 0.21	0.46 ± 0.12	0.60 ± 0.12	0.59 ± 0.15
Ratio of rep sprints Percentage (%)	67.1 ± 2.67	60.5 ± 11.99	66.7 ± 6.15	68.1 ± 8.43	65.8 ± 5.4	61.8 ± 5.19	67.4 ± 3.47	66.4 ± 5.69

Note: Post Hoc Bonferroni test: all training forms with the game $^{*}P < 0.05$ and $^{**}P < 0.01$

sprints did not differ significantly between training forms and the game.

DISCUSSION

The aim of this study was to examine which external load parameters were different between all training forms and matches. Although many studies have examined the external load parameters in the match, so far as we know, no study has examined differences between training forms and matches. Our main findings were that parameters related to changes in velocity were significantly different in small sided games than matches. These differences show that the load in small sided games is higher than the load during matches and therefore the coaches have to design the training carefully. We found also that some parameters didn't differ. These parameters were the repeated sprints, the number of repeated sprints, and the weighted total and intensity and can provide us information on the intensity of the game that is practiced in every training.

From the parameters related to changes in speed zones it was interesting to observe that the total distance covered in the 6:6, 9:9, 10:10 was significantly greater than the game, whereas the weighted total intensity, which includes walking, jogging, running and sprinting, was not different. Through this, it can be concluded that the total distance can been seen as a volume parameter and not as an intensity parameter since it increases proportionally in jogging and running meters, whereas the weighted total intensity can be seen as an intensity parameter since it shows the distribution of these speed

Table 4: Field dimensions per player for every training form in square meters	
Training Form	m^2
4 *vs* 4	168
5 *vs* 5	192,5
6 *vs* 6	216
7 *vs* 7	241
8 *vs* 8	292
9 *vs* 9	316
10 *vs* 10	315

zone parameters. Another interesting finding was the fact that the number of sprints varied in all training forms and was found to be significantly lower in the 4:4 form than in the game, whereas the percentage of repeated sprints was not significantly different between training forms and games. We can conclude that, even though the number of sprints between small and regular sided games varies, the percentage of the repeated sprints will be consistent between 60-68 percent.

From the parameters related to changes in velocity it was found that almost all parameters were significantly higher in small-sided games. The player load was higher in small and regular sided games (5:5, 6:6, 7:7, 9:9, 10:10), and by combining this information with the information about the parameters related to speed zones, we can conclude that the 8:8 was the training form with the lowest intensity. From observations it can be seen that the training form 8:8 is the transition point where none of the parameters are statistically different from the game. It could be that team cohesion is a factor, i.e. players solve problems of distance by passing more. If this is the case, the physical performance aspects have to be combined with video analysis for further quantification. By examining the average power and combining it with the weighted total intensity it can be concluded that the 6:6 and 10:10 formats were the training forms with the highest intensity. When comparing results of the average power and those of the accelerations we can observe that accelerations have greater influence on the average power than maximum velocity. For this reason, future studies may benefit from this parameter because it shows how important accelerations are, but also narrows down the significant difference of small sided games. The actions were statistically greater in the same training forms as accelerations and decelerations, therefore it would be beneficial to use this parameter for future studies because it provides useful information about the activity of the player.

From the results, it can be concluded that different training forms have different characteristics. In small-sided games, the parameters changes in velocity were higher than in big-sided games whereas the parameters related in speed zones were lower than in big sided-games. This conclusion is in line with the study of Hill-Haas et al. [15] who found that in 4:4 the total distance, the distance in sprint meters and the time being in sprint meters were less than in a 6:6. This can be explained by the idea that, in small sided games, the pitch size is smaller resulting in a higher player density and therefore making more often and short passes. This increases the number of actions and decreases the maximal velocities. In big-sided games, the players keep their own positions which decreases the number of actions and, because of the larger pitch size, players can generate maximal velocities when needed. Furthermore, it's interesting to mention that studies which examined the internal load found that small-sided games are beneficial for tactical skills and for aerobic interval training [16]. Through our results examining external load, we have to interpret the usefulness of small-sided games carefully, because the number of actions in training are twice as many as the number in the game, providing an overestimation of the true demands of the game.

Overestimating the demands of the match during training is desirable when training with a higher intensity than the match requires. One reason therefore is that small and big-sided games are designed in multiple intermittent regimes, in which it is easier to maintain a higher intensity, whereas the game is designed in two continuous regimes. Hill-Haas et al. [17] found that in intermittent small-sided games the total distance was the same as continuous small-sided games, but the distance covered in high-speed zones and the number of sprints were higher. Another reason for higher intensity during training is because the effective playing time (the time without stops) is higher during the training. This has to do with the nature of the sport, which is slower during the game since usually the winning team slows down the effective playing time.

One of the limitations in this study was the fact that we collected an unequal number of games for each training form, with no data from 3:3 small-sided games. Another limitation was the fact that the data were not normally distributed and therefore the intensity in every form varied. The first reason for the variation in the intensity was due to coach encouragement, as it is known that when coaches encourage athletes during training their performance is enhanced [2]. The second factor that caused variation in the intensity was the dimensions of the pitch size, because it was not consistent in every training form made the circumstances not identical. Research that has been done comparing pitch size dimensions found a significant difference in the intensity, as the running and sprinting meters were higher when the pitch size increased [13]. Furthermore, another limitation in this study was the fact that the results have been averaged across all players. This is a limitation as it is known from literature that different positions have different characteristics, meaning that the wide middle fielders and attackers cover greater distances in running and sprinting zones than central defenders [1,4,18]. This can lead to an overestimation or an underestimation of the true demands of specific playing positions.

A recommendation for future research will be to investigate whether these parameters are consistent in different playing positions since it is known that every position requires different characteristics and demands. When this is known, the next step will be to examine the fatigue in these parameters and to discover at which point the players can maintain the highest intensity for the longest time. Furthermore, since this study examined only the physical aspects of performance, a recommendation for future research will be to examine the player's performance in a holistic approach by combining the information of the physical aspects with technical and tactical aspects. In this way, a complete spectrum of football will be taken into account where conclusions about the player's performance will be more precise.

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