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Original Article

Analysis of physical and physiological requirements in soccer trainings in young soccer players (under -10 years)

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ABSTRACT

Pascual, N., Orbea Palacios, J.A., Martinez Carbonell, J.A., & Jove Tossi, M.A. (2015). Analysis of physical and physiological requirements in soccer trainings in young soccer players (under -10 years). A review. *J. Hum. Sport Exerc., 10*(2), pp.592-601. The aim of this study is to analyse the physical and physiological factors in soccer training at different categories of training. The participants were 30 soccer players of 8-a-side soccer in the under 10's age group (9.93±0.25 years) who participated in the under 10 Provincial Tournament in Alicante. During training, the variables of covered distance, heart rate, speed (average and maximum values) as well as the methodology used and position were registered. After the statistical analysis and its related discussion, it was concluded that the players do not show differences in the covered total distance in relation to the category. Notwithstanding, there are differences with regards to speed and heart rate, which are caused by the greater physical development of the players in comparison to the under10's age group category. Regarding the methodology employed, it is worth stressing that the coaches used, to a greater extend, the global method, followed by the mixed method. **Key words**: SOCCER, CHILD, ANALYSIS, TRAINING.

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INTRODUCTION

As in every collective sport, in soccer the planning of training loads is a fundamental parameter to improve player performance. This is due to the long length of competitive periods, which usually cover an entire season, including the pre-season and some interspersed tournaments. Therefore, a deeper understanding of trainings physical demands, would make possible a more thorough planning with more specific and appropriate sessions (Barbero, Granda & Castagna, 2007).

Although physical and physiological variables have been widely studied during the competition, their effects in training sessions have rarely been studied, which makes their study more interesting (Barbero et al., 2007). It is clear that a grater control over training loads will enable the improvement of performance and it will ensure that training loads may or may not be appropriate. Besides, it should be stressed that the vast majority of studies and research are focused on adult soccer players of absolute categories, remaining outside categories of training, mainly younger age categories such as under 8's age group and under 10's age group. Although at this age specific physical preparation is not necessary, since players are in a period of full-on growth, it is very interesting to analyse training loads in these categories to compare them with other players, categories and methodologies.

Therefore, the study of analysis of physical and physiological demands in categories of training can be an interesting subject due to the importance of trainings in players' development. However, the absence of studies upon this subject greatly impedes the comparison of analysis and results. Furthermore, the recent addition of the new technologies into the world of sport makes possible the use of tools, which enable to monitor and record players' performance (Barbero et al., 2007). For this reason, it is of crucial importance to take advantage of these tools to analyse physical and physiological aspects, as without these tools it would be impossible to analyse players' external and internal load. Specifically, satellite tracking devices (GPS) and heart rate monitors are being used in research with the aim of recording heart rate (internal load), distance travelled and speed (external load). It must be emphasized that the use of heart rate as a variable is much more practical and economic than other methods, such as oxygen consumption (Mújika, 2006).

The aim of the present research is to analyse physical and physiological demands in training categories, specifically in under 10's age group.

MATERIAL AND METHODS

Participants

Thirty players of soccer 8 from under 10's age group (9.93±0.25 years; 141±0.05 cm. and 37.5± 5.3 kg.) belonging to "A" teams of three clubs, which participate in under 10's age group Provincial Tournament in Alicante, took part in this research. The participants trained two times a week, played a competition match once a week and some tournaments.

Two players were analysed in each of the 15 training sessions in which global methodology was used (Pacheco, 2004). Sessions lasted one hour and fifteen minutes and were structured in three parts: a warm-up (displacement with joint movement, games with a ball and ball handling exercises), a main part (matches with modified dimensions, possession games, competitive games and matches with modified rules) and a restoration of order (static stretching and games with low-intensity coordinative actions).

For the valuation of the pattern of activity we have established a series of categories of displacement based on proposals by Castagna et al. (2003) for players of these ages: 1ª. 0-0.4 km/h (standing), 2ª. 0.5-3 km/h (walking), 3ª. 3.1-8 km/h (low-intensity running or jogging), 4ª. 8.1-13 km/h (medium-intensity running), 5ª. 13.1-18 km/h (high-intensity running), 6ª. >18.1 km/h (maximum intensity or sprint).

Medium heart rate and peak heart rate reached during training were analysed as physiological parameters and indicators of cardiovascular stress. Peak heart rate has been considerated as maximum (Castagna et al., 2008). Furthermore, overall distance travelled, average speed (distanced travelled per minute), maximum speed (peak), distance travelled in every category, percentage with respect to the overall, number, distance and sprints duration were analysed to determine the pattern of activity. Comparisons by specific posts were also effected.

Measures

Players bore a GPS receiver called SPI Elite (GPSports Systems, Pty. Ltd., 2003, Australia) (figure 1). It is a GPS receiver device, which integrates the reception of satellite signal with a triaxial accelerometer and a chip for heart rate record.

This device weighs approximately 75 grams and can record (one record per second) time, position, speed, distance, height, direction and heart rate data (this one requires a thoracic band). The information can be downloaded in a PC and through AMS System software data can be manipulated according to researcher's interests. It enables a detailed and customized analysis of physical activity. Besides, data can be exported to Excel to perform the required statistical treatment.

Figure 1. Device GPS SPI Elite® and Polar WearLink®.

Procedures

Before beginning every training session, investigators put a little padded bag (harness) on player's back. There was a GPS SPI Elite device inside. This harness was adjusted so that it couldn't move or disturb players during the 75 minutes of game. At the end of the training, data was downloaded in a laptop computer to effect the treatment of variables, subject of study.

Statistical Analyses

Data are presented as average, average standard deviation and ranges. The mean values for displacement categories between matches were compared using analysis of variance (ANOVA), taking as signification values $p < .05$. Post hoc analysis was made using Tukey's test.

RESULTS

Distance and speed.

The average distance travelled during the 75 minutes of training was 3837.8±1045.14 m. (2391.8–7143.6 m.). If we analyse it according to the positions (figure 2), defenders travelled 3355.77±677.91 m. (2391.8-4244.5 m.), midfielders 4220.87±1438.31 m. (2430–7143.6 m.) and forwards 3936.76±811.82 m. (2915.9-5315.5 m.), with no significant difference for every position (p>.05).

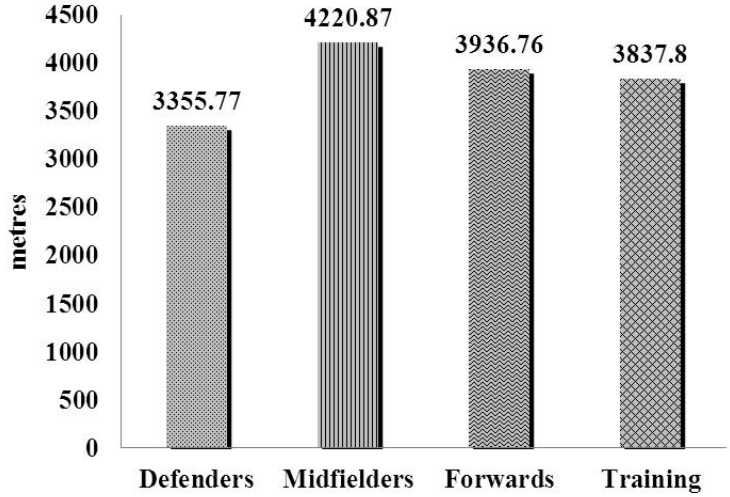


Figure 2. Distance travelled in trainings (metres).

These values amount to an average speed of 54.01±13.2 m. (31.8-86.4 m/min). According to players' positions, average speed of defenders was 42.74±7.81 m/min (31.8-53.74 m/min), midfielders' one of 60.64±14.24 m/min (40.87-86.4 m/min) and forwards' one of 58.66±9.63 m/min (46.81-71.43 m/min). The coefficient of variability in relation to the overall distance travelled was 18.27% in defenders, 23.48% in midfielders and 16.42% in forwards.

The speed peak obtained by every player during the training has been used to determine the maximum average speed, which was 19.70±1.08 km/h (17.6-21.9 km/h) whereas medium speed was 3.07±0.8 km/h.

In table 1 we observe these parameters according to the players' positions, not existing significant difference for game positions (p>.05) regarding the speed.

Table 1. Medium and maximum speed

	Medium speed	Maximum speed	% Maximum speed
Training	3.07±0.8 km/h	19.70±1.08 km/h	15.55±3.97%
Defenders	2.41±0.47 km/h	18.97±1.11 km/h	12.73±2.37%
Midfielders	3.43±0.9 km/h	19.91±0.99 km/h	17.29±4.86%
Forwards	3.36±0.57 km/h	20.23±0.80 km/h	16.64±3%

Midfielders were the players who obtained a higher medium speed in trainings, whereas forwards obtained the maximum average speed.

Pattern of activity

Pattern of activity based on the distance travelled for every established category is reflected in table 2. A great similarity is observed in all positions, finding significant differences in distance travelled in high intensity (13.1-18 km/h).

Table 2. Distance travelled in different intensities (metres)

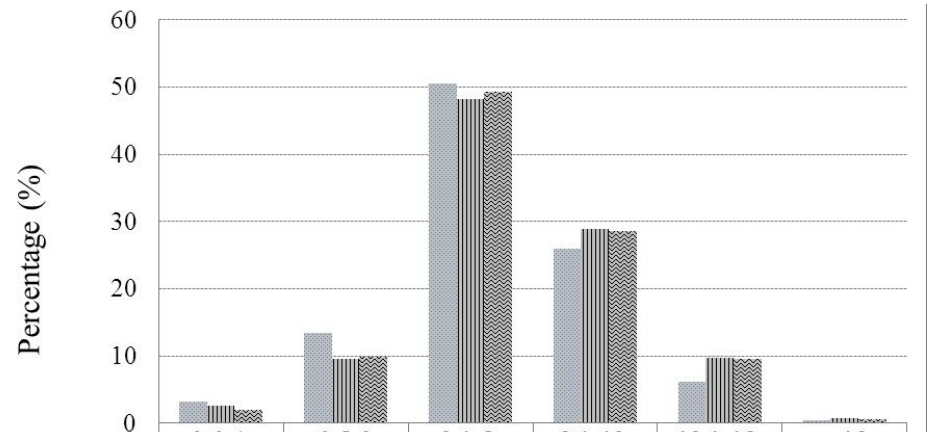
	0-0.4 km/h	0.5-3 km/h	3.1-8 km/h	8.1-13 km/h	13.1-18 km/h	> 18 km/h
Training	100.88±28.99	413.70±97.54	1891.29±529.93	1072.09±464.49	334.05±163.28	25.79±23.43
Defenders	110.64±16.29	449.84±83.75	1694.91±338.43	873.01±450.80	210.27±127.97 #$	17.09±16.32
Midfielders	112.79±24.05	402.54±57.76	2037.11±722.8	1219.21±610.72	413.36±161.96 #	35.86±33.59
Forwards	79.2±33.64	388.73±137.73	1941.84±475.75	1124.03±261.38	378.53±136.9 $	24.43±15.06

Note = The values are reflected as the average ± standard diversion.

Significant difference *(p=.02)* between defenders and midfielders.

$ Significant difference *(p=.04)* between defenders and forwards.

In figure 3 we can see the percentage (%) of the overall distance travelled in different intensities carried out in trainings according to tactical positions. It should be emphasized that a great number of meters is effected trotting, representing 50.51% in defenders, 48.26% in midfielders and 49.33% in forwards, of the overall distance travelled.



	0-0.4	0.5-3	3.1-8	8.1-13	13.1-18	> 18
Defenders	3.30	13.41	50.51	26.02	6.27	0.51
Midfielders	2.67	9.54	48.26	28.89	9.79	0.85
Forwards	2.01	9.87	49.33	28.55	9.62	0.62

Figure 3. Percentage (%) of the overall distance travelled in different intensities

If we consider categories 1, 2 and 3, in which the intensity is minor, as periods of "recovery", whereas we name categories 4, 5 and 6 "work" or "activity", obtained results indicate that the rate of work/rest or relation activity/recovery (work-rest ratio) was 1:2.02 in training. According to players' positions, ratio was 1:2.74 in defenders, 1:1.7 in midfielders and 1:1.63 in forwards.

Regarding to the maximum intensity profile of efforts or sprints (the player reaches speeds exceeding 18 km/h), there is verified that during the trainings, there was an average of 3.68±2.36 sprints (1-11), the average duration was 1.76±0.89 s and the distance of sprints average was 9.19±5.15 m. (4.7-24 m.). In table 3 we can observe space-time characteristics of sprints according to players' positions, not finding significant differences in any of the studied aspects.

Table 3. Space-time characteristics of sprints (>18 km/h)

	Sprints number				Sprints duration (s)				Sprint distance (m.)			
	Minimum	Maximum	Average	DE	Minimum	Maximum	Average	DE	Minimum	Maximum	Average	DE
Training	1	11	3.68	2.36	1	4	1.76	8.89	4.7	24	9.19	5.15
Defenders	1	6	3.6	2.07	1	2	1.44	0.53	5	11.3	7.49	2.88
Midfielders	1	11	4	3.27	1	4	2.08	1.12	4.7	24	10.9	6.66
Forwards	2	7	3.43	1.72	1	3	1.67	0.78	4.7	16.7	8.62	4.37

The player who effects more sprints with a greater duration and distance, is the one who plays in midfielders' position.

Heart rate.

Heart rate during the training was 157.62±19.28 lpm. (122-201 lpm.), these values amount to 70.16±6.29 % (58.9-84.45 %) of the maximum obtained in the training and whose average value was 224.24±12.26 lpm. In table 4 we observe medium heart rate, maximum heart rate and its percentage, according to players' positions.

Table 4. Heart rate

	Med. HR. (lpm.)	Max. HR. (lpm.)	% Max. HR.
Training	157.62±19.28	224.24±12.26	70.16±6.29%
Defenders	145±13.08 #	218.86±15.65&	66.28±4.19%
Midfielders	150.14±12.02 $	220±8.77	68.25±4.77%
Forwards	177.71±14.19 #$	233.86±4.06&	75.97±5.49%

Note = The values are reflected as the average ± standard diversion.

Significant difference *(p=.001)* between forwards and defenders.

$ Significant difference *(p=.002)* between forwards and midfielders.

&Significant difference *(p=.04)* between forwards and defenders.

Forwards are the players who reach the maximum heart rate in the training, as they work in an average heart rate higher than the other game positions.

In table 5 we observe the time a player has been during the training in every proposed heart rate area. Time in areas 1, 2 and 3 (3200.85±981.28 s) is higher than time in areas 4, 5 and 6 (1399.30±721.33 s), finding significant differences in some HR areas among the different players' positions.

Table 5. Time in HR. areas

	Area 1 < 60 % max. HR	Area 2 60–70 % max. HR	Area 3 70 – 80 % max. HR	Area 4 80 – 85 % max. HR	Area 5 85 – 95 % max. HR	Area 6 > 95 % max. HR
Training	1490.7±682.97 s (31.87 %)	893.45±358.08 s (19.18%)	816.7±275.95 s (17.83%)	399.15±159.97 s (8.73%)	399.15±213.54 s (8.88%)	600.65±574.81s (13.51 %)
Defenders	1964.29±501.29 s (39.17%) #	1185.86±277.54 s (23.39%)&	927.14±227.91 s (18.28%)	394.14±198.03 s (7.73%)	320.29±230.57 s (6.23%)	268.00±243 s (5.2%) ¢
Midfielders	1491.33±751.86 s (32.86 %)	943.67±227.49 s (21.37%) £	853.33±266.28 s (19.61%)	418.17±192.42 s (9.20%)	358±160.07 s (7.87%)	404±277.69 s (9.09%) ¥
Forwards	1016.57±480.39 s (23.71%) #	558±228.73 s (13.09%)& £	674.86±301.75 s (15.87%)	388.86±102.21 s (9.32%)	513.29±213.86 s (12.40%)	1101.86±679.81 s (25.61%) ¢ ¥

Note = The values are reflected as the average ± standard diversion.

Significant difference *(p=.004)* between forwards and defenders.

&Significant difference *(p=.000)* between forwards and defenders.

£ Significant difference *(p=.006)* between forwards and midfielders.

¢ Significant difference *(p=,02)* between forwards and defenders.

¥ Significant difference *(p=,03)* between forwards and midfielders.

We can see through time percentages that players have different heart rates during the whole training (table 5), estimating that forwards are the players who remain more time higher than 80% of maximum heart rate, whereas defenders are those who remain more time lower than 80% of maximum heart rate.

DISCUSSION

The shortage of studies relating to variables treated in this research during the trainings in training categories supposes a limitation at the moment of comparing data and results.

The overall medium distance travelled in training sessions was 3837.8±1045.14 m., this result is similar to the obtained one by Barbero et al. (2007) during the trainings of 11 players of juvenile category (17.3±0.8 years) which show an overall distance travelled of 4044±346.4 m. Our information also coincides with another study Barbero et al. (2007), in which 8 players of infantile category (12.2±0.6 years), travelled an overall medium distance of 3986.6±170.5 m. during three matches of 40 minutes. Another study Castagna et al. (2003) showed an overall distance travelled of 6.175 ±318 m. in trainings of higher categories, due probably to the duration and typology of these categories. Thus, in spite of the difference of age and/or difference between match and training, it is possible to observe that there aren't significant differences in the overall medium distance travelled by the subjects. It is necessary to emphasize other information of reference, as the study made by Rosemary et al. (2011), in which they analysed the overall distance travelled by professional players in situation of limited game. They obtained 1745.3 total metres in a limited game of 4x4 and 1667.5 total metres in situations of 7x7.

Regarding to medium duration for sprints (2.08±1.12 s) effected during the training, it is similar study Barbero et al. (2007) for players of infantile categories (2.4 ± 1.3 s), and also to the studies of other authors (Castagna et al., 2003; Bansgo et al., 1991; Reilly, 1996) made for young and adult players.

Regarding to speed, the studied subjects obtained a medium speed of 3.07±0.8 km/h, whereas the average of maximum speed was of 19.7±1.08 km/h. This information moves away from the results obtained by Barbero et al. (2007), in which 11 juvenile players (17.3 ±0.8 years) obtained a medium speed of 5.8±0.5 km/h, whereas the maximum speed was of 25.8±1.7 km/h. In another research Impellizzeri et al. (2004), in which the speed of 17.6±0.7-year-old players was analysed, a maximum speed of 17±1.1 km/h was obtained. This fact is caused by the difference of age between subjects of both researches, since juvenile players show a degree of muscular and cardiovascular development higher than the youngest children, so that they can reach maximum speeds. Furthermore, the difference between medium speed was not significant, as it shows research Barbero et al. (2007), in which 8 players of infantile category (12-13 years) were analysed, obtaining a medium speed of 6±0.3 km/h.

Regarding to heart rate, the obtained results show a medium heart rate of 157.62±19.28 lpm., whereas the maximum heart rate presented an average of 224.24±12.26 lpm.. The information relating to medium heart rate did not present differences with regard to study Barbero et al. (2007), in which subjects of juvenile category (17.3 ±0.8 years) obtained a medium heart rate of 163±11.5 lpm.. As for maximum heart rate, the same study shows lower results, obtaining a peak heart rate of 192±11.6 lpm. Nevertheless, in another study of Fernandez-Gonzalo et al. (2010), two groups of players from 11.8 ± 0.2 and 9.4±0.3 years, obtained a maximum heart rate of 207.9±9.1 lpm. and 206.5±14.7 lpm., respectively. The valued differences are caused by the decrease of heart rated provoked by the increase of the subjects' age. This explains the raised results as for maximum heart rate. Another study Impellizzeri et al. (2004), in which 19 players from 17.6±0.7 years were analysed, a maximum heart rate of 189.6±5.7 lpm. was obtained.

CONCLUSIONS

The results obtained in the present study show that in under 10's age group (9.93±0.25 years) training session of 75 minutes applying the global methodology, the average distance travelled is 3837.8 meters. The average speed of every player is 54.01 m/min. The player who travels more meters in a medium speed higher than other players is the midfielder, though there are no significant differences between the game different positions regarding these two variables.

Pattern of activity in training sessions reflects that a great part of the overall distance travelled (49.28 %) is carried out trotting (3.1-8 km/h). There are significant differences in distances travelled in high intensity (13.1-18 km/h), where midfielders are the players who travel more meters in this intensity during the trainings.

The method of global training used in trainings implies a rate work/rest of 1:2.02. It means that players have enough time to recover themselves, since for every minute of work they rest the double of time.

As for sprints effected during trainings, every player makes more or less the same number of maximum intensity efforts of the same duration and distance, though midfielder is the player who makes more maximum efforts.

The physiological exigency (heart rate) of trainings based on the global method, supposes that players are working in a heart rate of 157.62 lpm., though according to players' positions significant differences between the players have been observed. Forward is the player who works in a higher medium heart rate.

In this method of training, the player is most of the time (68.88 %) in less than 80 % of maximum heart rate obtained during the accomplishment of the session, which has been of 224.24 lpm. According to games positions, there have been significant differences during the time a player is in less than 70 % and in more than 95 % of his maximum heart rate.

Regarding to the practical application, the results underline the idea that a under 10's age group player cannot be considered as an adult in and training loads must be specific and adapted to the reality of the competition itself.

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