Original Article

Time-motion analysis in professional championships of Valencian handball

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Abstract:
Valencian handball is a sport with long tradition in the eastern coast of Spain. Among different variants of the game, this study has been focused in the professional version, also known as *escala i corda*. The aim was to determine the time distribution of periods of active play and rest time during matches. The variables studied were the total duration of the matches, games and game actions, differentiating real or active playing time from passive or rest time. We also quantified the number of games and the number of motor actions per match and per game in top professional competitions (Professional *Escala i Corda* Leagues and Cups, 2008-2011). Duration of an *escala i corda* match was between 57 min 43 s and 1 h 53 min 15 s, while the duration of active time was between 25 min 5 s and 50 min 46 s. The number of games per match varied between 11 and 17, and these had a mean duration of 4 min 35 s of active playing time. There are significant differences ($p < 0.05$) in the duration of games, specifically between the three first periods (1-3, 4-6 and 7-9). Meanwhile, the mean time spent on the completion of each rally was 17.61 s $\pm$ 1.78 s. An improved understanding of players' absolute and actual game time can provide valuable information for planning specific *escala i corda* training exercises with respect to the duration and number of rallies.
Key words: duration time, performance analysis, active time, passive time..

Introduction

Valencian ball (called *Pilota Valenciana*) is considered the traditional sport of the Region of Valencia, although authors such as Iñurria (1987) have located the origins of the game in the Greco-Roman classical period. Valencial ball is one of two traditional sport in the east of Spain together with fixed-seat rowing (Penichet-Tomas, Pueo, Jimenez-Olmedo, 2016).

According to Llopis (1999), besides being the professional variant of the game, *escala i corda* is also the version in which all players necessarily master the other variants since it is this one which exerts the most physical, technical and tactical demands. The game is played on a rectangular court (the *trinquet*) which is enclosed on all four sides by walls and covered at the top by a wire mesh, and which measures 56 m long, 9.5 m wide and 12 m high. A singular feature of the court is that it has a spectator stand located within the game area.

Despite this sport's long history, very little research has been conducted on it in terms of internal and external load. In recent years, the game has changed due to modifications in the rules governing professional leagues. For example, it is no longer allowed to hit the ball so that it comes to rest in the spectator galleries located above the end walls of the court, and in the latest change, if the ball goes directly into the lateral spectator stand once it has passed over the rope, it is stopped and play is resumed at the point where the ball entered the stand but on the first step.

For this research, we focused on determining the distribution of absolute and actual playing time during the match, the games and the points in professional three-a-side *escala i corda* competitions (2007-2011). In a literature review on the same research topic, we found only four publications on Valencian handball; Soler *et al.* (2007), Moragues *et al.* (2007), Montaner, Llana, Gamez and Montaner (2013) and finally Martinez-Carbonell, Perez, Chinchilla and Jimenez-Olmedo (2013). The latter presented differences as regards results reported and the use of a single match as the sample, compared to the 26 matches analysed in the present study.

Material and Methods

Since this research concerned top-level competition, we restricted the method and design to a descriptive study. Thus, it was examined the ways in which the game is played, without employing any experimental manipulation. Therefore, the research design was based on an observational model, which ensured no interference with the natural context (Gillet et al., 2010; Gomes et al., 2011; Hughes et al., 2002; Nevill et al., 2002).

Sample

The study sample consisted of the total population of professional *escala i corda* players, comprising a total of 35 players: 13 players in the 1st game line (known as the *resto* position), 10 players in the 2nd game line

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(the *mitger* position) and 12 players in the 3rd game line (the *punter* position). Recordings were made of 26 matches in the most important professional championships, the Professional *Escala i Corda* League and Cup and the City of Valencia Masters (2008-2011). All of these were three-a-side games, and thus a total of 156 players were recorded, 52 in each position, obtaining different data on the same players from different matches.

Instruments and data collection

Two video cameras Sony DCR-cx 280 with a focal length equivalent of 29.8 to 953.6 mm and a resolution of 1920x1080p/50fps was used. They were located in the spectator galleries at the extreme ends of the court, and each camera recorded the opposite end of the court, providing a longitudinal view of the game. The two cameras were positioned at a height of 7 m above the court and 3.5 m from the side wall (Soler et al., 2007). Each camera was calibrated using four markers in such a way as to enable the creation of a frame of reference for observing the ball in the event that it hit the walls surrounding and forming part of the playing court. In turn, the cameras were synchronised in order to perform the analysis using both recordings simultaneously (Pueo, 2016).

The analysis of videos was carried out using the *SportsCode PRO v8.5.2* software. Transcoding of the video material using the open source software *Handbreak* was needed to adequate the characteristics of the files with the software tools. The combination and analysis of categories and subcategories were made with the implementation of SportsCode Pro v8.5.2.

Procedure and design

An experienced observer made the visualization and analysis of the video recordings. During the study, displays of two intra-operator were performed to prove the reliability of the observation (Jimenez-Olmedo, Pueo and Penichet-Tomas, 2016) throughout coefficient of variation (CV).

To carry out the time-motion analysis, different categories of observation, that would allow collecting the necessary frequencies to answer research questions, were established. First, we analyzed the time-moments of the match (Table 1)

Table 1. Time-motion categories.

Operation	Definition
TT	Total time. Time from start until finished match, using signal's referee.
AT	All time that the ball are in game, using signal's referee.
PT	All rest time during match. It includes: rest time between points and rest time between games.
PTp	Rest time between points.
TPg	Rest time between games.

On the other hand, the analysis of time-motion was categorized by play games:
- Games 1 to 3
- Games 4 to 6
- Games 7 to 9
- Games 10 to 13
- Games to 14 to 17

Since 17 is the maximum number of games that can be played in the championship matches analysed (9 games for the winning team and 8 for the losing team), we divided this total of 17 possible games into five periods to determine whether there is any differences in the duration of games in the course of *escala i corda* matches.

Finally, the procedure that was employed to obtain all time-motion data was: a) recording of images, b) transcoding video material with Handbreak software, c) digitisation of the images using *SportsCode PRO V8.5.2* software, d) creation of the first matrix of codes, based on the time factor, e) identification of images for each of the previously established matrix codes based in time-motion categories established in analysis, f) combination of the matrix codes, obtaining different quantifications for each category, and g) statistical analysis

Statistical analysis

Data were analysed using SPSS v.22 to perform descriptive statistics. After Kolmogorov-Smirnov normal test, the statistical test applied was T-Student to compare means. Besides, to compare difference between observer analysis, coefficients of variation (CV) were used. This coefficient of variation was under 5% in all data time analysed.

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Results

Results have been subdivided into total duration of active time and of passive time between points and between games, and their mean percentages. Secondly, we obtained and analysed the duration of the games in the course of a match, the number of periods of active (AT) and passive time (PT) and their mean duration and standard deviation (SD) (McEarlan et al., 2000; Palao et al., 2012).

Total active and passive times

Within the total or absolute match time (TT), we have distinguished between active or actual playing time (AT) and passive time (PT). We obtained a mean for total or absolute match time (TT) of 1h 17min 11 s, and for active or actual playing time (AT), when the ball was in play, of 33 min 8 s. The mean passive time (PT) was 44 min 3 s, which were differentiated between passive times between the ends and start of points (TPp) (30 min 22 s), and between the end and start of points within each game (TPg) (13 min 41s) (Table 2).

Table 2: Time-motion result by time category.

Operation	Minimum (s)	Maximum (s)	Mean (s)	SD
TT	3463	6795	4631.05 (1h17'11.05")	1037.75
AT	1505	3046	1988 (33'8")	472.58
PT	1794	3932	2643,05 (44'3.05")	604.75
PTp	1275	2963	1822.01 (30'22.01")	478.06
PTg	552	1220	821,04 (13'41.04")	167.27

Note: TT: Total time; AT: Active time; PT: Pasive time; PTp: Rest time between point; PTg: Rest time between games

Percentage-wise, total passive time (PT) accounted for 57.1% of the matches, compared to 42.9% of active time (AT). Thus, there was a greater percentage of time when the ball and the players were not in play.

Game duration

Each game that the team wins brings them closer to their goal. Therefore, we calculated the duration of the games over the course of the matches to determine whether the length of these varied during the match.

As regards to the number of games per match, data obtained from the sample indicated a mean of 14.15 $\pm$ 2.20, with a minimum and maximum of 11 and 17 games played, respectively. Table 3 gives the mean and standard deviations for the duration of the total games and of the established periods in the 368 games analysed.

Table 3: Mean duration of games.

Operation	Mean (s)	SD (s)
Total games	247.75 (4'34.75")	152.73
Games 1-3	247.78* (4'7.78")	135.39
Games 4-6	261.3* (4'21.30")	156.22
Games 7-9	279.24* (4'39.24")	136.44
Games 10-13	293.54 (4'53.54")	176.54
Games 14-17	292.68 (4'52.68")	143.92

Note: *= significance difference <0.05

The three first periods are from the 1st to the 3rd game, from the 4th to the 6th, from the 7th to the 9th (78 games analysed in each period). We can find significant difference in the duration of the games between 1-3 and 7-9 periods (p<0.05) and between 4-6 and 7-9 period (p<0.05). The most significant difference that we have found is between 1-3 and 4-6 periods (p<0.05).

The minimum and maximum mean duration of active time (MDAT), mean duration of passive time between points (MDPTp) and mean time of passive time between games (MDTPg) were calculate to know the duration of each rally and mean rest time (Table 4).

Table 4:Mean time per point.

Operation	Minimum (s)	Maximum (s)	Mean (s)	SD
DMAT	14.89	20.95	17.61	1.78
MDPTp	15.6	22.12	18.41	2.07
MDPTg	50.18	81.02	63.05	8.69

Note: DMAT: Mena duration active time; MDPTp: Mean duration passive time between points; MDPTg: Mean duration passive time between games

In addition to the passive times analysed above, other passive time situations may occur, such as a ball change (BC) by the players, which refers to passive time when changing and testing the ball. This action did not occur in all matches, and the maximum number of periods of time spent on ball changes was 10 s. The mean number of ball changes was 3.38±2.53, and the mean duration of ball changes (MDBC) was 54.75±19.78. Table 5 provides a summary of the most relevant data about periods of time spent on ball changes.

Table 5: Employed time in ball changes.

Operation	Minimum (s)	Maximum (s)	Mean (s)	SD (s)
BC	0	10	3.38	2.53
MDBC	30.92	104.44	54.75	19.78

Note: BC: Ball change; MDBC: Mean duration employed in change ball.

Active and passive periods
Of the 26 matches analysed in this study, we obtained a total of 2941 periods of active time (AT), and 2940 of periods of passive time (PT). The mean number of periods of active time per game (NA) was 113.12 ± 24.44 whilst the mean number of periods of passive time was always one less. In order to investigate this further, we differentiated between periods of passive time between points and of passive time between games (between the end of one game and start of another). The mean number for periods of passive time between points (NPp) was 99.08 ± 22.92, and for periods of passive time between games (NPg) it was 13.15 ± 2.11 (Table 6).

Table 6: Mean actions per game.

Operation	Minimum (s)	Maximum (s)	Mean (s)	SD (s)
NA	67	159	113.12	24.44
NPp	56	142	99.08	22.92
NPg	10	16	13.15	2.11

Note: NA: Number of periods of active time per game; NPp: Periods of passive time between points; NPg: Periods of passive time between games

Discussion
Total time, active time and passive time
The first time factor we calculated concerned the duration of the match, in other words, the total time of the match. The mean total time was 1h 17min 11 s, and from this time we obtained the mean active and passive times, which were 33 min 8 s and 44 min 3 s, respectively. We compared these findings with those of other studies on Valencian handball; for example, in their study of a single match of *raspall*, Moragues, Soler and Campos (2007) reported a total time of 1h 14 min 52 s, with 43 min 45 s of active time and 31 min 7 s of passive time. In a study of 6 *escala i corda* matches conducted by Astorgano (2007), the mean total time obtained was 1h 21 min and the mean active time was 39 min 30 s in comparison to a mean passive time of 41 min 30 s.
In the Basque Country version of the game, Basque *pelota*, Bringas (2003) obtained a total duration of 51 min 43 s for the handball variant (known as *trinquete a mano*) and 24 min 43 s for the left-wall variant (*trinquete*). Solozábal et al. (2000) recorded a total duration of 1 h 10 min for the handball variant, whilst Echeverria (1993) obtained total duration times of 1 h 10 min for the racquet and rubber ball variant known as *paleta goma*, 56 min for the racquet and leather ball variant known as *paleta cuero* and 50 min for the fusion between Basque handball and tennis known as *frontenis*.
As regards active and passive times, Solozábal et al. (2000) obtained 38 min active time and 32 min passive time for handball, whilst Echeverria (1993) obtained 55 min active time and 15 min passive time for the *paleta goma* variant, and 28 min active time and 28 min passive time for the *paleta cuero* variant.

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The results of these studies showed that it is only in the *escala i corda* variant that there is a lower percentage of active time compared to passive time. Thus, the difference was greater in our study (9.5 min compared to the 2 min obtained by Astorgano).

Discussion on game duration

Turning to the mean duration of the games, Moragues et al. (2007) obtained a mean of 6 min 56 s for the *raspall* variant, with a maximum of 10 min 34 s, whilst we obtained a mean of 4 min 35 s ± 2 min 33 s. With respect to passive time between games, Moragues et al. (2007) recorded a mean of 2 min 19 s, compared to the mean value of 1 min 4 s obtained in our study. However, it should be noted that *raspall* matches have a maximum of 9 games, compared to the possible 17 games in *escala i corda*.

Discussion on active and passive time

Regarding the mean duration of periods of active or playing time and periods of passive or recovery time between points, we obtained a mean of 17.61 s and 18.41 s, respectively. Meanwhile, Astorgano (2007) reported means of 23 s for active time and 17 s for passive time, differing considerably with our results for the mean duration of periods of active time.

In their study, Moragues et al. (2007) reported a mean of 24 s, obtained for the 68 periods of active time which occurred in the match they analysed, whereas in our study the mean for periods of active time was 113.12 s.

In the study on Basque handball, Bringas (2002) obtained a mean duration for periods of active time of 17 s in singles variants of handball (*trinquete a mano*) and left-wall handball (*frontón*). In singles tennis, Fernández et al. (2006) reported similar durations of active times, with 6 s and 15 s being those which occurred most frequently throughout a match, whilst the figures were generally lower for the duration of passive times, at 6.3 s to 10.2 s. However, it should be noted that these figures refer to singles tennis rather than three-a-side *escala i corda*, where the court is larger and enclosed by walls.

Conclusions

The duration of an *escala i corda* match is between 57 min 43 s and 1h 53 min 15 s, the mean duration being 1h 17 min 11 s. Active time accounted for the interval between 25 min 5 s and 50 min 46 s, with a mean of 33 min 8 s (43%), whilst the mean for passive or recovery time was 44 min 3 s (57%).

On average, matches lasted for 14.15 games, and the mean duration of actual playing time in games was 4 min 35 s ± 2 min 32 s. The number of periods of active time was on average 113 per match, whilst the average time spent on the completion of each game action was 17.61 ± 1.78 s, barely differing from the 18.41 s duration of periods of passive time between points. Lastly, the mean duration of periods of passive time between games was 1 min 3 s.

Therefore, the results obtained as regards an improved understanding of players' absolute and actual game time provide valuable information for planning specific *escala i corda* training exercises with respect to the duration and number of game actions. Nevertheless, further research is required in order to contextualise the sport, use a larger sample, and study couples and singles variants.

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