Short course 50m female freestyle performance comparison between national and regional swimmers

Raúl ARELLANO, Aquatics Lab, Faculty of Sport Sciences, University of Granada, Granada, Spain
Ana RUIZ-TEBA, Aquatics Lab, Faculty of Sport Sciences, University of Granada, Granada, Spain
Esther MORALES, Aquatics Lab, Faculty of Sport Sciences, University of Granada, Granada, Spain
Ana GAY, Aquatics Lab, Faculty of Sport Sciences, University of Granada, Granada, Spain
Francisco CUENCA-FERNANDEZ, Aquatics Lab, Faculty of Sport Sciences, University of Granada, Granada, Spain
Gracia LÓPEZ-CONTRERAS, Aquatics Lab, Faculty of Sport Sciences, University of Granada, Granada, Spain

Abstract — Race analysis is a tool broadly applied to evaluate the swimmer performance and develop specific training plans. We aimed to analyse the race components differences between national and regional female swimmers taking part in 50m freestyle short course event and the relevance of individual emersion distances after the start and turn. Fifty-five national level performances (Spanish Short Course Nationals, December 2016) and 85 regionals (local competitions developed at our University swimming pool, season 2016/17) were compared, no swimmers repeated in both competitions. Each group had a mean age of 18.3 ± 2.5years and 15.8 ± 2.6years respectively. Each swimmer's mean stroke rate (SR, cyc/min), stroke length (SL, m) and stroke index (SI, m^2/s) were collected from 50Hz HD video, event time was obtained from official results (T50, s). The starting phase was obtained from the starting signal until swimmer's head crossed the 10m (T10, s) and 15m (T15, s) mark. The turning phase commenced when the swimmer's head passed through a distance of 5m out from the wall until swimmer's head crossed the 35m reference (Turn15m, s). The emersion distance and time after the start ([D_Emers1, m], [T_Emers1, s]) or after the turn ([D_Emers2, m], [T_Emers2, s]) were measured. T-test for independent samples and Pearson correlation coefficient were applied. National female swimmers obtained significantly shorter times than regional: T10 (4.49 ± 0.20 vs 5.14 ± 0.44), T15 (7.17 ± 0.20 vs 8.41 ± 0.60), T15turn (8.15 ± 0.28 vs 9.56 ± 0.63), T50 (26.94 ± 0.62 vs 31.31 ± 2.05), longer SL (1.89 ± 0.12 vs 1.67 ± 0.15) and higher SI (3.31 ± 3.22 vs 2.51 ± 0.30). Whilst, SR was not different between groups (55.86 ± 3.67 vs 54.34 ± 5.03). National swimmers attained similar emersion times than regional [T_Emers1 (3.83 ± 0.70 vs 3.91 ± 0.68), T_Emers2 (2.30 ± 0.56 vs 2.22 ± 0.58)] and significantly longer emersion distances [D_Emers1 (8.99 ± 1.42 vs 8.08 ± 1.25), D_Emers2 (5.20 ± 1.01 vs 4.54 ± 0.90)]. High and significant correlation coefficients were obtained, analysing each group separately, between 50m time and T10 (0.77 vs 0.87), T15 (0.85 vs 0.94), T15turn (0.90 vs 0.98). Low correlations were found between 50m race time and D_Emers1 (-0.14 vs -0.44), D_Emers2 (-0.02 vs -0.50), T_Emers1 (0.02 vs -0.10) and T_Emers2 (0.09 vs -0.22). Differences in performances between national and regional groups were explained by the absolute split times, SL, SI and emersion distances, while the SR and emersion times did no differentiate both groups. Additionally, individual emersion distances and times did not correlate with 50m time.

Key words: Swimming competition analysis, race components, tracking system,

1. Introduction

Performance analysis has become an essential tool for coaches, athletes, sports organizations and academic researchers intending to improve the training program (O'Donoghue. 2015). From a basic perspective, the analysis of the official split time results allows to determine the race strategy or race pace. The ability to maintain swimming velocity in a race is vital for optimizing performance (Mc Gibbon et al., 2018). In short events, with less than 30s of duration, an all-out pacing strategy is typically employed, with a rapid acceleration at the start followed by a gradual decline in swimming velocity through the race (Mc Gibbon et al., 2018). This strategy is evident at long course 50m events. Nevertheless, this situation is modified when the event is developed in a 25m swimming pool, where the turning phase is added, and an additional acceleration phase is obtained after turning.

Swimming competition analysis is a standard methodology applied to know the contribution of the race components on the final time. Start time, clean swimming time, turning time and finishing time are the classical race components included in most of the papers and reports on the subject (Arellano et al., 1994, Morais et al., 2018). The mean swimming speed (V, m/

s) is determined by the stroke length (SL, m) and stroke rate (SR, cyc/min). Its relationship is governed by the equation (V= SL · SR) (Craig & Pendergast. 1979).

Generally, the competition analysis system is used to identify problems with a swimmer's race performance. Therefore, coaches are able to concentrate on refining the swimmer's technique details, based on this data. Some modelling techniques has been performed by Absaliamov and Timakovoy (1990) and Arellano et al. (1996, 2000) by using regression equations, by R. Haljand (www.swim.ee) using multiple regression equations or by Kerrison (2005), developing the Speed Charts. These charts are based on the collection of international race analysis data. It allows swimmers and coaches to configure a detailed and specific pace on each section of the race, including 100m events in short course. Unfortunately, these Speed Charts information was not shared to the rest of the swimming community. The adaptation of Kerrison's data suggested an accumulated percentage time distribution to 15m, 25m, 35m, and 45m about 25.9%, 48.7%, 67.5% and 88.9% respectively in 50m short course event.

Not attention enough has been dedicated to the analysis of race components during short course events (25m). Some studies, as conducted by Wirtz et al. (1992), compared SR, SL and V of highly skilled swimmers (n=7) who participated in 50m freestyle events in short course and long course. Shorter times in 50m female group were related with the time between 20 and 30m, in short course. This section was 7.1% faster in short course than long course due to the added turning phase. In 50m short course female events the percentage's split time distribution every 10m was: 14.9%, 21.24%, 19.81%, 21.74% and 22.01%.

To the best of our knowledge, the first analysis performed in short course world class event was developed by Arellano et al. (1993) during the First World Short Course Swimming Championships in Palma de Mallorca, Spain. An example of the mean data obtained in the 50m final events is shown in the table 1.

Other previous studies analysed short course events, but only 100m races were measured. Kjendlie et al. (2006a), found a "U" shape in the SR of faster swimmers measured on each lap. It means that the SR increased during the last lap meanwhile Sidney (1999), found a more constant SR during the last 3 laps of the race. An additional characteristic was that the normalized last 5m time was better in the medallist compared with the rest of participants (Kjendle et al. 2006b).

We aimed to analyse the race components between national and regional female swimmers taking part in 50m freestyle short course event , considering the relative contribution of the following components: section's times, section's mean velocities, the split differences, relative proportions and underwater phase distances, underwater phase times, stroke frequency, stroke length and stroke index.

2. Methods

2.1. Participants

Fifty-five national level performances (Spanish Short Course Nationals, December 2016) and 85 regionals performances (Short Course Regionals, season 2016/17) were compared. No swimmers repeated in both competitions. Each group had a mean age of 18.3 ± 2.5 and 15.8 ± 2.6 years respectively. Medium levels of Pearson correlation coefficients were found between the 50m race time and each group's age: r = -0.43 and r = -.46 respectively. Level of performance and age defined the differences between groups.

2.2. Variables

Every swimmer's accumulated split times were collected from the digital video in every section along the race when the swimmers' head touches the baseline (T10, T15, T20, T25, T35 and T45, s) and the split velocities were calculated accordingly (V0_10, V10_15, V15_20, V20_25, V25_35, V35_45 and V45_50, m/s). Three consecutive strokes cycles were recorded every lap to obtain SR (cyc/min). SL (m) was calculated by dividing the mean velocity by the mean SR (Hz). The stroke index (SI, m^2/s) was calculated by multiplying the mean velocity by the SL.

Event time was obtained from official results (T50, s). The turning time (T15turn, s). was obtained as the time elapsed since the swimmer's head passes through a distance of 5m out from the wall (T20) until swimmer's head crossed the 35m reference (T35). The emersion distance and time after the start emersion ([D_Emers1, m], [T_Emers1, s]) and after the turn emersion ([D_Emers2, m], [T_Emers2, s]) were measured. Total swimming clean time was calculated based on absolute distances T_T_swim_abs (s) or based on individual emersion distances T_T_swim_rel (s). Percentages of the duration of every race component were based on absolute distances (%T_swim_abs, %T_start_abs, %T_turn_abs and %T_Ending_abs) or based on individual emersion distances (%T_swim, %T_start, %T_turn and %T_Ending). General race pace variables as: i) second lap split time (2ndLapT, s); ii) difference between second lap and first lap time (Diff_25s, s) and; iii) percentage duration of each lap (%25-1 and %25-2), were obtained.

The swimming clean distance obtained in each lap

Table 1: Mean values obtained by the finalist participants (n=8) in the 1993 FINA Short Course World Swimming Championships (Arellano et al. 1993).

	Start time 15m (s)	Turn time 15m (5+10m) (s)	Finish time 5m (s)	Swim time (15m)	50m Time (s)
Female	6.80	7.47	2.66	8.35	25.28
Male	5.90	6.64	2.26	7.30	22.10

divided by the SL allowed us to calculate the estimated number of strokes every lap and total number of strokes in the event (St_count1, St_count2, St_total, n).

2.3. Instruments

A system of 3 cameras (HD, 50Hz) located at the poolside (7.5m from the end of the swimming pool and in the middle) and connected to a video switcher (Roland V-1HD, Surrey, Canada) were used during Spanish Short Course Nationals. References ropes on each 5m, were recorded before the initiation of recordings sessions. The swimmer's data were obtained after detailed observations of HD videos recorded. A custom-made database was able to manually collect the time code to a specific field in the database and the report generated afterwards. A new system installed in the swimming pool Aquatics Lab (Faculty of Sport Sciences, University of Granada, Spain) allowed the collection of the performance data at regional level (Automatic Swimming Performance Analysis. - A.S.P.A.). This system is an updated version of the procedure applied in the Swimming World Championships 2003 and 2013 (Balius et al., 2008) and it were applied similar algorithms than used by Benarab et al. (2016). The system is composed by 8 cameras (Basler Aviator: 83.33Hz 1080x1080pixels) and is placed on the ceiling corridors of the swimming pool and connected through Ethernet (1Gb) to a PC Work Station in the lab. The 8 cameras video information was added in a frame using the video-stitching technique. It was collected in real time to a sequence of frames to analyze the swimmer's activity in every lane (8 simultaneously). Algorithms of image recognition allowed the event time collection. The system processes the full event in a very short time compared to the manual collection (see figure 1). Both methods were applied in this study. The variables analyzed at the Spanish Championships were studied in both cases. Both methods showed high values of concurrent validity when they were used to measure the same sample (Ruiz-Teba et al., 2016).

2.4. Statistics

T-test for independent samples (to analyse the difference between regional and national swimmers) and Pearson correlation coefficient r (to observe the relationship between the T50 and every variable measured on each group independently) were applied. For the independent samples T-test, Cohen's d is determined by calculating the mean difference between two groups, and then dividing the result by the pooled standard deviation (SDpooled). Cohen's d = (M2 - M1) ⁄ SDpooled, and SDpooled = √ ((SD12 + SD22)/2). Cohen 's d effect was evaluated with the following criteria: 0 to 0.19 trivial, 0.2 to 0.59 small, 0.6 to 1.19 moderate, 1.2 to 1.99 large, 2.0 to 3.9 very large and > 4.0 nearly perfect (Hopkins, 2002), they are included in the table 2. (Hopkins, 2002)

3. Results

Mean and standard deviation values, mean significant differences and effect sizes are compiled in the table 2. National female swimmers obtained significantly shorter times than regional in every section of the race and in the race time (T10, T15, T20, T25, T35, T45 and T50). The differences in each phase were increasing from 0.65s at T10 to 4.37s at T50. National swimmers obtained higher mean swimming velocities in each section (V0_10, V10_15, V15_20, V20_25, V25_35, V35_45, V45_50). The average of the difference in each section was 0.24 m/s. Times and velocities showed very large and large effect sizes between groups. T15turn showed a 1.41s difference between groups and a very large effect size whilst the emersion distance (D_Emers) was significantly different and averaged to 0.79m longer in national swimmers. On the other hand, the emersion times (T_Emers) were not different between groups (0.08s). In both cases the effect sizes were moderate and trivial respectively. The stroke variables showed similar values in the SR (small d) whilst the SL and SI had higher values in the national group (0.22 and 0.80 m^2/s respectively). The analysis of race component percentages based on relative emersion times showed moderated effects on %T_swim, %T_Start, %T_turn, %T_Ending, while the swimming clean time was 3.63s longer in the regional group. The situation is almost repeated when the absolute distances are used to mea-

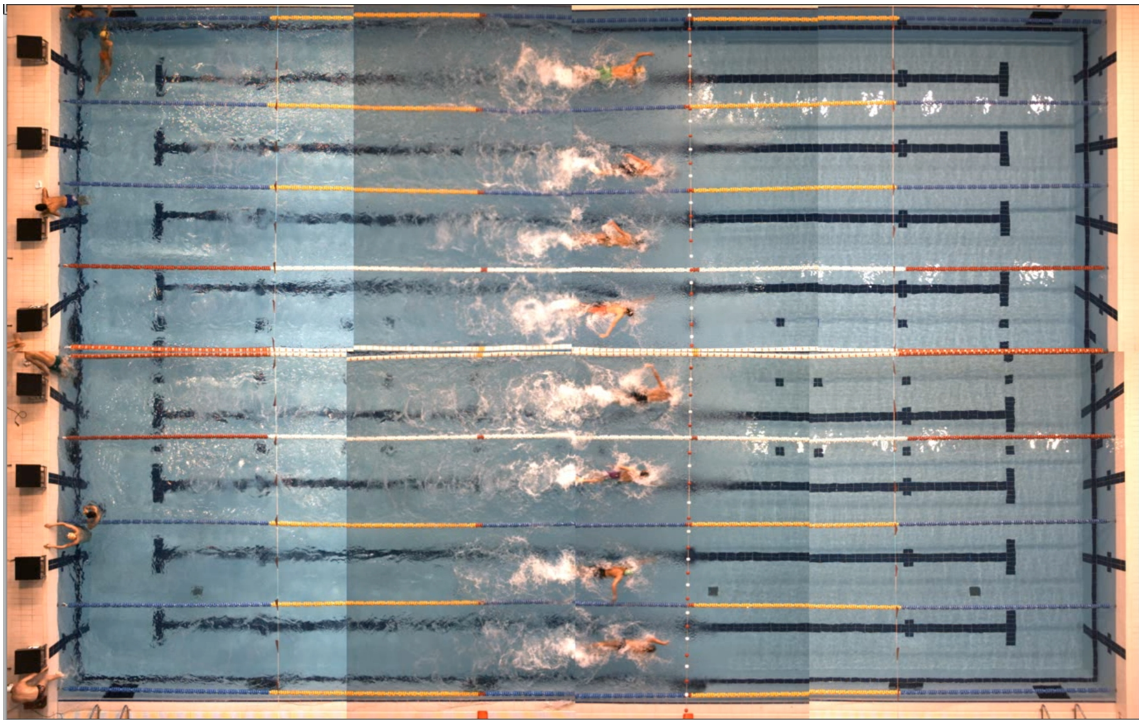

Figure 1: Example of the Automatic Swimming Performance Analysis. A.S.P.A. while it records the 50m freestyle event performance.

sure the race percentages of duration %T_swim_abs, %T_Start_abs, %T_turn_ab, %T_Ending where the effects were moderate and small. In this case the swimming clean time was reduced to 1.75s but the effect size was very large (see table 2). Formal race pace variables as 2ndLapT and Diff_25s showed very large and moderate effect sizes. While the percentage of duration of each lap %_25-1 and %25-2 were similar in both groups (see table 2). Stroke count showed a reduction of 3.54 strokes in the race on the national group with a large effect in all the related variables.

High and significant correlation coefficients were obtained, analysing each group separately, between 50m time and all the race section splits and race section mean velocities (see table 3). Low correlations values were found between 50m time and EmerS, EmerT, EmerTS and EmerTT. All the stroke variables were low correlated with the race time obtaining lower values in the national group. Second lap time correlated very well with race time whilst the 25m lap times differences were lower related. Percentages of duration of each lap almost no related with race time. Absolute and relative duration of each race component demonstrated medium and low correlation values with the race time obtaining lower values in the national group.

Table 2: Mean, standard deviation, mean differences analysis and effect sizes of all the variables analysed in the study.

	REGIONAL			NATIONAL					
	n	Mean	(SD)	n	Mean	(SD)	Diference	d	Effect Size
T10 (s)	85	5.14	(0.44)	55	4.49	(0.20)	0.65**	1.81	Large
T15 (s)	85	8.41	(0.60)	55	7.17	(0.20)	1.24**	2.56	Very large
T20 (s)	85	11.70	(0.78)	55	10.03	(0.18)	1.66**	2.68	Very large
T25 (s)	85	15.25	(0.97)	55	13.20	(0.29)	2.05**	2.64	Very large
T35 (s)	85	21.25	(1.38)	55	18.18	(0.40)	3.07**	2.77	Very large
T45 (s)	85	28.10	(1.86)	55	24.08	(0.57)	4.02**	2.81	Very large
T50 (s)	85	**31.31**	**(2.05)**	**55**	**26.94**	**(0.62)**	**4.37****	**2.65**	**Very large**
V0_10 ($m\bullet s^{-1}$)	85	1.96	(0.16)	55	2.23	(0.10)	-0.27**	-1.96	Very large
V10_15 ($m\bullet s^{-1}$)	85	1.54	(0.09)	55	1.87	(0.07)	-0.33**	-3.85	Very large
V15_20 ($m\bullet s^{-1}$)	85	1.53	(0.09)	55	1.75	(0.06)	-0.22**	-2.70	Very large
V20_25 ($m\bullet s^{-1}$)	85	1.41	(0.09)	55	1.59	(0.10)	-0.17**	-1.78	Large
V25_35 ($m\bullet s^{-1}$)	85	1.68	(0.13)	55	2.01	(0.06)	-0.33**	-3.15	Very large
V35_45 ($m\bullet s^{-1}$)	85	1.47	(0.10)	55	1.70	(0.06)	-0.23**	-2.54	Very large
V45_50 ($m\bullet s^{-1}$)	85	1.41	(0.11)	55	1.57	(0.07)	-0.17**	-1.72	Large
T15turn (s)	85	9.56	(0.63)	55	8.15	(0.28)	1.41	2.71	Very large
D_Emers1 (m)	85	8.08	(1.25)	55	8.99	(1.42)	-0.92**	-0.70	Moderate
D_Emers2 (m)	85	4.54	(0.90)	55	5.20	(1.01)	-0.66**	-0.70	Moderate
T_Emers1 (s)	85	3.91	(0.68)	55	3.83	(0.70)	0.08ns	0.11	Trivial
T_Emers2 (s)	85	2.22	(0.58)	55	2.30	(0.56)	-0.08ns	-0.13	Trivial
SR1 ($cyc\bullet min^{-1}$)	85	56.20	(5.90)	55	57.61	(3.93)	-1.41ns	-0.27	Small
SR2 ($cyc\bullet min^{-1}$)	85	52.48	(4.96)	55	54.10	(3.87)	-1.62*	-0.35	Small
SRm ($cyc\bullet min^{-1}$)	85	54.34	(5.03)	55	55.86	(3.67)	-1.51*	-0.33	Small
SL1 (m)	85	1.65	(0.18)	55	1.89	(0.13)	-0.24**	-1.44	Large
SL2 (m)	85	1.69	(0.14)	55	1.89	(0.13)	-0.20**	-1.48	Large
SLm (m)	85	1.67	(0.15)	55	1.89	(0.12)	-0.22**	-1.61	Large
SI1 ($m^2\bullet s^{-1}$)	85	2.53	(0.34)	55	3.41	(0.26)	-0.88**	-2.85	Very large
SI2 ($m^2\bullet s^{-1}$)	85	2.48	(0.30)	55	3.21	(0.27)	-0.72**	-2.53	Very large
Sim ($m^2\bullet s^{-1}$)	85	2.51	(0.30)	55	3.31	(0.22)	-0.80**	-2.98	Very large
T_T_ swim_rel (s)	85	18.42	(2.15)	55	14.79	(1.23)	3.63**	1.97	Very large
%T_swim	85	58.67	(4.07)	55	54.88	(4.36)	3.79**	0.91	Moderate
%T_Start	85	12.54	(2.40)	55	14.22	(2.62)	-1.68**	-0.68	Moderate
%T_turn	85	18.51	(2.03)	55	20.27	(2.12)	-1.76**	-0.85	Moderate
%T_Ending	85	10.28	(0.54)	55	10.63	(0.44)	-0.35**	-0.70	Moderate
St_count1	85	10.37	(1.42)	55	8.52	(0.94)	1.86**	1.48	Large
St_count2	85	12.21	(1.22)	55	10.53	(0.90)	1.68**	1.52	Large
St_total	85	22.58	(2.51)	55	19.04	(1.66)	3.54**	1.60	Large
T_T_swim_abs (s)	85	10.13	(0.69)	55	8.76	(0.20)	1.37**	2.48	Very large
%T_swim_abs	85	32.34	(0.57)	55	32.53	(0.62)	-0.19ns	-0.32	Small
%T_start_abs	85	26.86	(0.63)	55	26.61	(0.39)	0.25**	0.45	Small
%T_turn_abs	85	30.52	(0.40)	55	30.23	(0.54)	0.29**	0.63	Moderate
%T_ending_abs	85	10.28	(0.54)	55	10.63	(0.44)	-0.35**	-0.70	Moderate
2ndLapT (s)	85	16.07	(1.13)	55	13.75	(0.36)	2.32**	2.54	Very large
Diff_25s (s)	85	0.82	(0.48)	55	0.55	(0.19)	0.27**	0.68	Moderate
%25-1	85	48.70	(0.73)	55	48.98	(0.35)	-0.28**	-0.45	Small
%25-2	85	51.30	(0.73)	55	51.02	(0.35)	0.28**	0.45	Small

******p*<0.05, *******p*<0.01, *ns = not significant differences*

Table 3: Pearson correlation coefficient values between 50m race time and the variables analysed in the study separating the study's group

	REGIONAL	NATIONAL
T10 (s)	0.87	0.77
T15 (s)	0.94	0.85
T20 (s)	0.96	0.74
T25 (s)	0.97	0.95
T35 (s)	0.99	0.97
T45 (s)	0.99	0.98
T50 (s)	**1.00**	**1.00**
V0_10 ($m \cdot s^{-1}$)	-0.87	-0.79
V10_15 ($m \cdot s^{-1}$)	-0.91	-0.16
V15_20 ($m \cdot s^{-1}$)	-0.92	0.35
V20_25 ($m \cdot s^{-1}$)	-0.75	-0.84
V25_35 ($m \cdot s^{-1}$)	-0.92	-0.75
V35_45 ($m \cdot s^{-1}$)	-0.96	-0.85
V45_50 ($m \cdot s^{-1}$)	-0.76	-0.49
T15turn (s)	0.98	0.90
D_Emers1 (m)	-0.44	-0.14
D_Emers2 (m)	-0.50	-0.02
T_Emers1 (s)	-0.10	0.02
T_Emers2 (s)	-0.22	0.09
SR1 ($cyc \cdot min^{-1}$)	-0.35	-0.10
SR2 ($cyc \cdot min^{-1}$)	-0.53	-0.18
SRm ($cyc \cdot min^{-1}$)	-0.47	-0.14
SL1 (m)	-0.17	0.15
SL2 (m)	-0.20	-0.24
SLm (m)	-0.20	-0.05
SI1 ($m^2 \cdot s^{-1}$)	-0.56	0.18
SI2 ($m^2 \cdot s^{-1}$)	-0.69	-0.57
Sim ($m^2 \cdot s^{-1}$)	-0.67	-0.25
T_T_ swim_rel (s)	0.87	0.28
%T_swim	0.52	0.00
%T_Start	-0.43	-0.11
%T_turn	-0.51	0.13
%T_Ending	-0.08	-0.01
St_count1	0.39	0.02
St_count2	0.42	0.20
St_total	0.43	0.12
T_T_swim_abs (s)	0.97	0.66
%T_swim_abs	0.03	-0.42
%T_start_abs	0.09	0.03
%T_turn_abs	-0.09	0.47
%T_ending_abs	-0.08	-0.01
2ndLapT (s)	0.98	0.97
Diff_25s (s)	0.35	0.34
%25-1	-0.24	-0.28
%25-2	0.24	0.28

Significant r values are obtained based on the subjects' samples of each group with the next values: regional ($p<0.05$ $r>=0.22$, $p<0.01$ $r>=0.28$) and national ($p<0.05$ $r>=0.27$, $p<0.01$ $r>=0.35$).

4. Discussion

The main aim of the study was to examine the races components of two groups of female swimmers (national and regional), racing 50m freestyle events at short course, and the relevance of individual emersion distances after the start and turn. There was an overall significant level effect in all race components. Small or moderate level effect were observed in SR and pace or percentage of duration of each race time related with the race time.

Each split time was significantly different between groups confirming the performance level: 408 and 641 FINA points respectively on average. An analysis of these splits as a percentage of total race time denoted a mere average difference of 0.1%. This was confirmed later in the analysis of the percentage of the race's components times. The highest differences between groups were centered on total clean swimming time (relative and absolute), whilst the lowest differences were in the emersion times after the start and the turn. Race pace percentage calculating the percentage of the first and second lap were accordingly similar. No differences were found between groups at SR results.

Our 50 m national's group time results were faster than the mean data taken at the 1992 Olympics in Barcelona (26.94s vs 27.05s). However, the influence of the pool dimension, short course vs long course, and the changes in the equipment since1992 have contributed to this small difference. The start time in 10 m was longer for National and 92 Olympic (4.49s and 4.08s), even though the swim start data collected on the present study was performed in the new starting blocks (Arellano et al., 1994).

Comparing our data to the obtained at the European Championships finalists in 2016, the start mean time (15m) in 100 m Freestyle was 6.68s while our national swimmer's mean was 7.17s during the 50 m short course event .The emersion distance after the start was 10.74m at the European and it was 8.99m in our study, while the emersion distance after the turn were 6.61m at the European and 5.20m in the present study. These differences can be considered large if the distance of the event is additionally considered (Morais et al., 2018).

Fifty meters long course events are characterized by an all-out strategy with a gradual decline in swimming velocity through the race, as was described by McGibbon at al. (2018). The current study showed an increase of mean velocity during the turn-out phase and a small decrease of the clean swimming velocity in the second lap. A split difference was found between laps of 0.55 (national) and 0.82 (regional), with both groups moderately different. A similar relative (but significant) race strategy was obtained regardless the swimmer's level.

The correlation values between the variables and the final 50 m race time were similar to those obtained by Arellano et al. (1994) regardless of the pool length. Split times and average velocities were strongly related to final race time, while cyclic variables (SR. SL and SI), showed lower correlations. All the relative values expressed in percentages were not related to the final race time. Emersion distances and times did not correlate with the final time.

The use of individual emersion distances has been recently suggested by Veiga et al. (2013) as a complementary information of the absolute or fixed distances procedures traditionally applied in swimming competition analysis. Their study, with a similar sample of swimmers than our national group but collected in 100m events, showed low correlations between both methods in freestyle start and turn. However, no data was provided about the correlation with the final race time. In our study all fixed distance time results (T10, T15 and T15turn) highly correlated with final race time whilst individual emersion distances and emersion times showed low correlations in both groups.

At international level, a latter study correlated race 100m freestyle times with start and turn emersion distances obtaining r values of -0.08 and -0.13 respectively in the female group of finalists and semifinalists (Veiga et al., 2016). These results were similar than the obtained in our study considering the different competitive level of the samples. Additionally, the emersion distances where similar in both studies considering the national group in our case, being about 8m in the start and about 5m after the turn. These results indicated that an additional analysis or a different approach should be included in future publications on the subject, trying to find the how these variables can affect the final race performance.

5. Conclusions

Differences in performances between national and regional groups (considering the age differences) were explained by the absolute split times, SL, SI and emersion distances, while the SR and emersion times did no differentiate both groups. Additionally, individual emersion distances and times did not correlate with 50m time. The use of longer underwater distances in freestyle female short events needs a deeper analysis to consider its generalization.

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