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EVOLUCIÓN DEL LACTATO SANGUÍNEO DURANTE LA EJECUCIÓN DE RUTINAS DE DÚO LIBRE EN NATACIÓN SINCRONIZADA

Iglesias X, Chaverri D, Rodríguez-Zamora L, Carrasco M, Irurtia A, Rodríguez FA

INEFC-Barcelona Sport Sciences Research Group, Universitat de Barcelona (Barcelona, Spain)



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Caracterización bioenergética

Análisis estructural



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Introducción





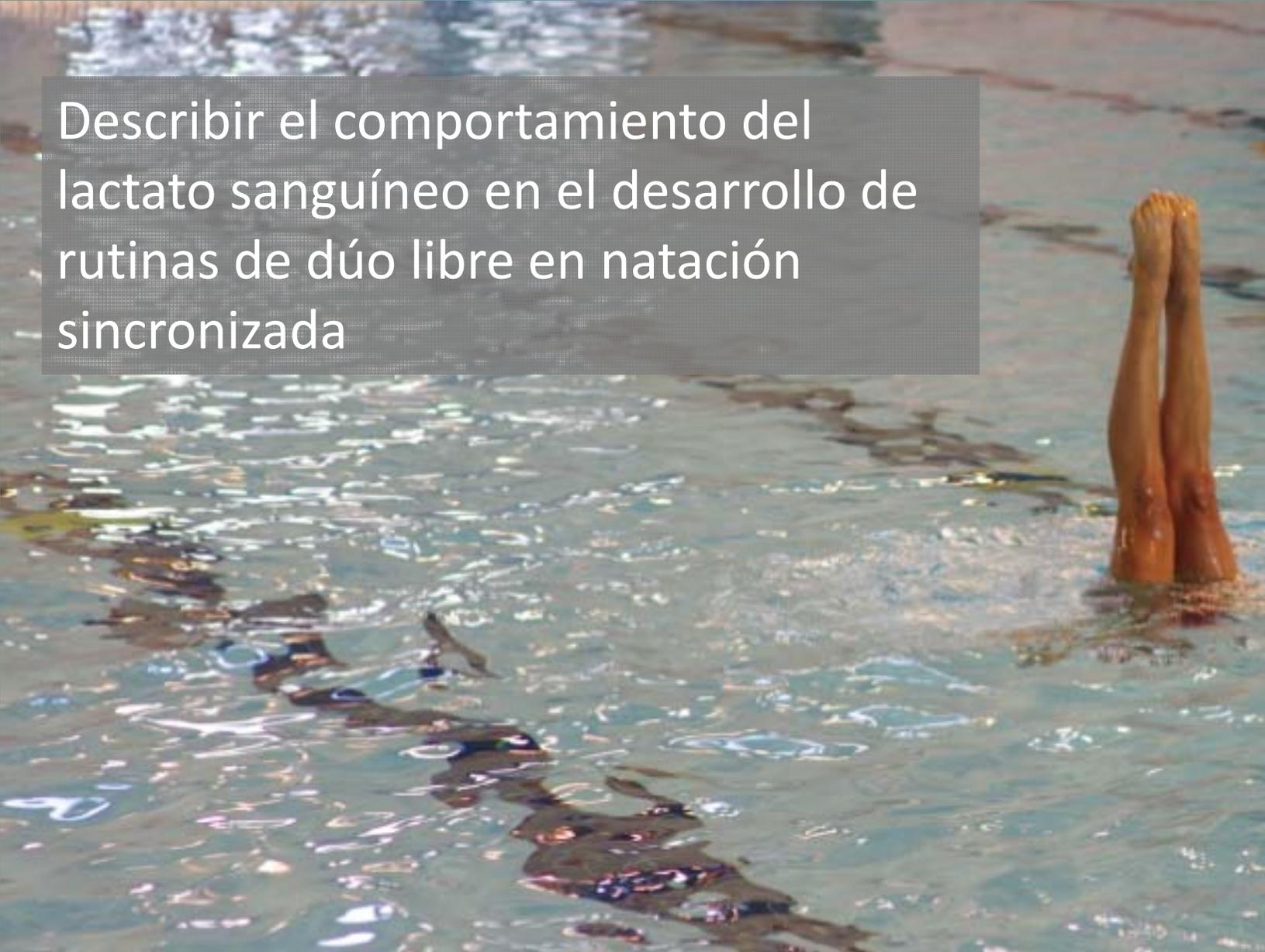
- La natación sincronizada es una disciplina que combina elevados **niveles de exigencia** de las capacidades condicionales con excelentes prestaciones de carácter artístico
- La **carga interna** es la respuesta fisiológica aguda inducida por el ejercicio y su control es fundamental para la determinación de las necesidades fisiológicas y mentales necesarias para alcanzar la excelencia deportiva
- La carga interna en dúos en **entrenamiento** es prácticamente idéntica a la de una **competición** real (Rodríguez-Zamora, Iglesias, Barrero, Torres, et al., 2014)

- Rodriguez-Zamora, et al. (2014): **RPE**, en competición, correlaciona positivamente con duración apneas, lactato y valores de recuperación FC
- Solo y dúo son rutinas de **mayor exigencia** que las pruebas por equipos, y los programas libres más que los técnicos (Rodriguez-Zamora, et al., 2012)
- Investigaciones sobre **lactato** en sincronizada: valores anteriores y posteriores a las rutinas completas (Jamnik, et al., 1987; Rodriguez-Zamora, et al., 2012; Rodriguez-Zamora, et al., 2014)



Objetivos



A photograph of a synchronized swimmer's legs sticking out of the water, with a text overlay. The swimmer is performing a routine, and the water is rippling around the legs. The text overlay is a semi-transparent grey box with white text.

Describir el comportamiento del lactato sanguíneo en el desarrollo de rutinas de dúo libre en natación sincronizada

Metodología



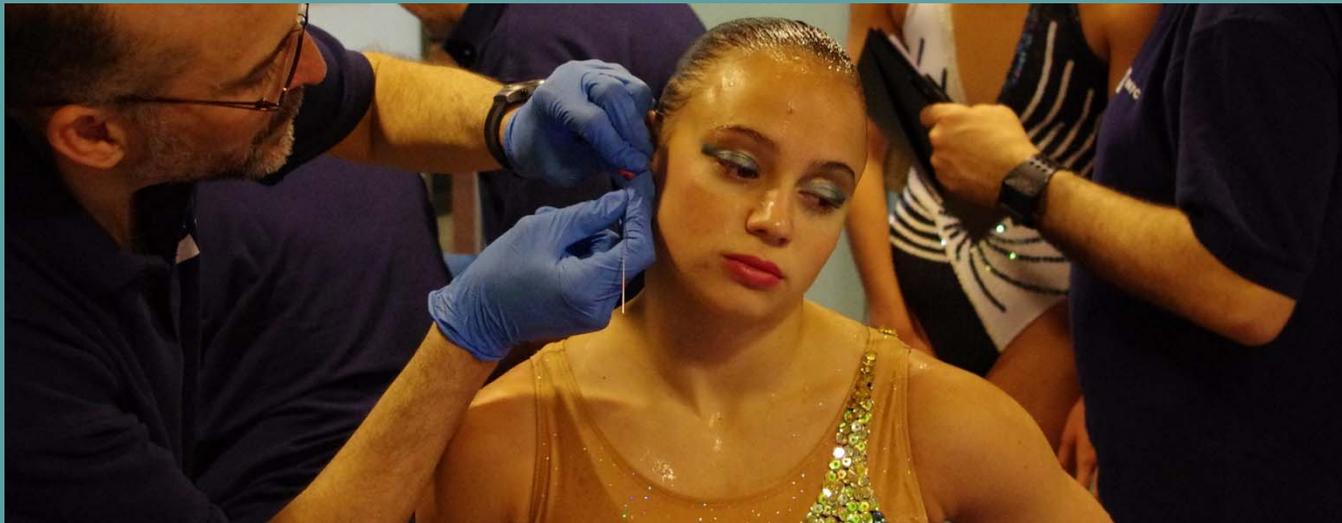
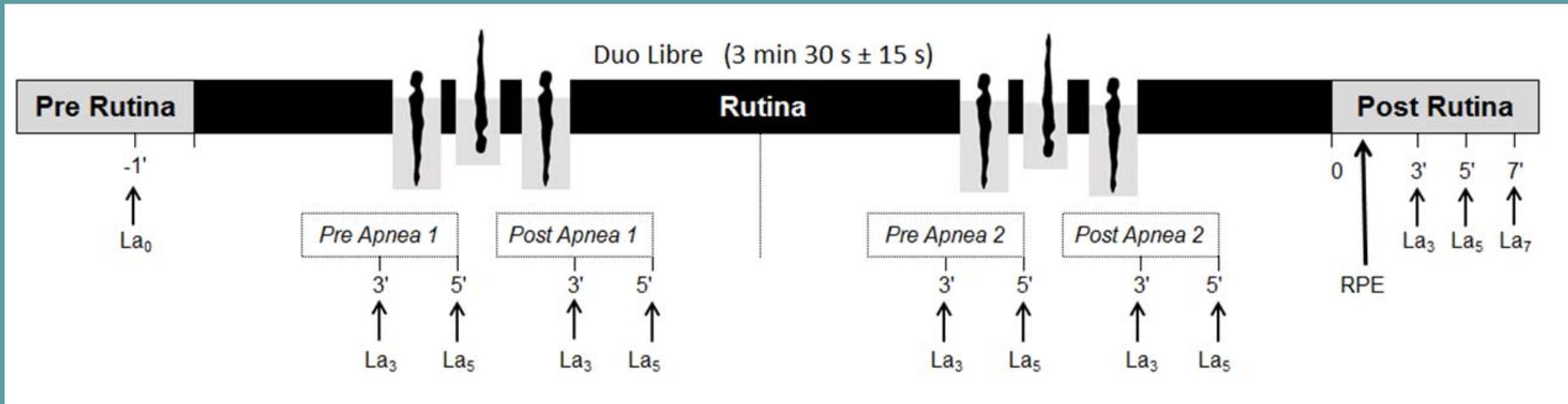
Participantes

n = 16 Nadadoras	
Altura (cm)	167 ± 7
Peso (kg)	53 ± 7.6
Edad (años)	16.5 ± 2.5
Dúos libres analizados (n)	8

Valores: media ± SD



Diseño



Cronograma de la sesión de valoración

Valoración	Lactato / RPE	Tarea
1	Lactato basal (1 min pre-ejercicio)	Pre-Rutina completa
2	Lactato (3, 5, 7 min post-ejercicio) RPE (min 1 post-ejercicio)	Rutina completa
		Descanso: 45 min
3	Lactato (3, 5 min post-ejercicio)	Rutina hasta el inicio de la figura principal (pre-apnea 1) del primer periodo
		Descanso: 30 min
4	Lactato (3, 5 min post-ejercicio)	Rutina hasta el final de la figura principal (post-apnea 1) del primer periodo
		Descanso: 30 min
5	Lactato (3, 5 min post-ejercicio)	Rutina hasta el final de la figura principal (pre-apnea 2) del segundo periodo
		Descanso: 30 min
6	Lactato (3, 5 min post-ejercicio)	Rutina hasta el final de la figura principal (post-apnea 2) del segundo periodo

Material

Análisis fotométrico (Diaglobal DP100 GmbH, Berlín, Alemania) de muestras de 10 μ L de sangre capilar del lóbulo de la oreja

Percepción del esfuerzo (RPE) registrada mediante escala de Borg de nivel 0-10 (Borg, 1998), mediante una plantilla diseñada para nuestro estudio



Análisis estadístico

- Los resultados se describen mediante la media aritmética, la desviación estándar (\pm DE) y los valores máximo y mínimo (rango)
- La normalidad de los datos se comprobó mediante el test de **Shapiro-Wilk**
- Para el análisis de las diferencias se utilizó una **ANOVA** de medidas repetidas, con ajuste de **Bonferroni** para comparaciones múltiples
- Para la comparación entre tiempos de apnea se aplicaron estadísticos no paramétricos (prueba de los rangos con signo de **Wilcoxon**)
- La **correlación** entre los valores finales de lactato y el RPE se determinó calculando el coeficiente de correlación de Pearson
- El nivel de confianza preestablecido para los contrastes fue del 95% y la significación estadística se estableció en $p < 0,05$

Resultados

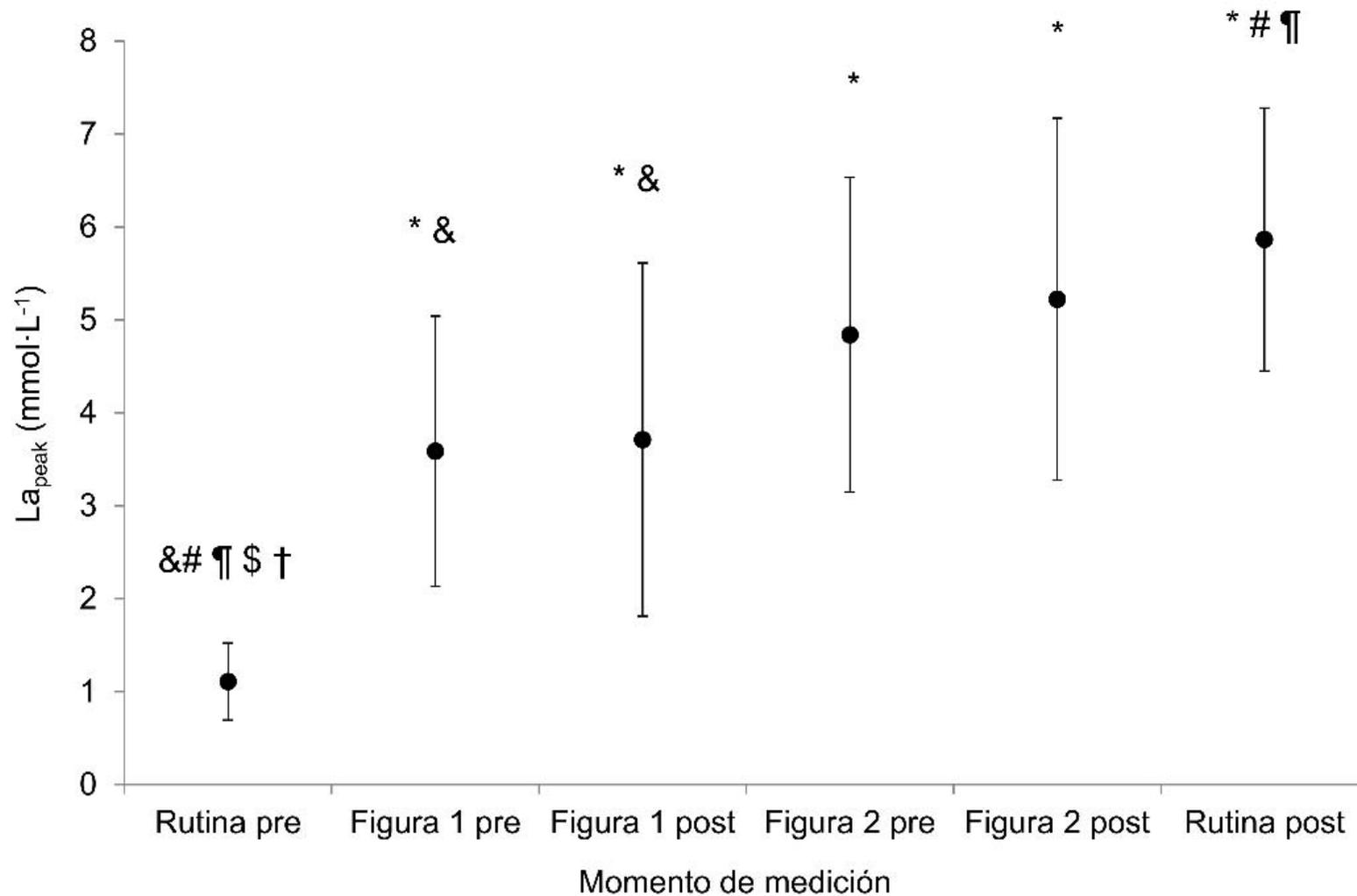




Dúo libre (n=16)	Lactato (mmol·L ⁻¹)	Duración (s)	RPE (Borg 1-10)
Valor basal	1,04 ± 0,49 &#¶\$†	-	-
Rutina completa	5,93 ± 1,41 *#¶	197,74 ± 10,40	6,56 ± 1,50
Pre-apnea 1	3,66 ± 1,60 *&	66,69 ± 20,58	-
Apnea 1	-	13,83 ± 4,42	-
Post-apnea 1	3,79 ± 2,18 *&	80,52 ± 21,45	-
Pre-apnea 2	4,94 ± 1,87 *	170,59 ± 24,70	-
Apnea 2	-	12,86 ± 2,90	-
Post-apnea 2	5,66 ± 2,02 *	183,46 ± 23,00	-

Valores son media ± SD;

* = Diferencias con valor basal; & = diferencias con rutina completa; # = diferencias con pre-apnea 1; ¶ = diferencias con post-apnea 1; \$ = diferencias con pre-apnea 2; † = diferencias con post-apnea 2 ($p < 0,05$)



* = Diferencias con valor basal; & = diferencias con rutina; # = diferencias con pre-apnea 1; ¶ = diferencias con post-apnea 1; \$ = diferencias con pre-apnea 2; † = diferencias con post-apnea 2

Discusión



- Descripción por primera vez en la literatura del comportamiento del lactato capilar en nadadoras de sincronizada **durante** la ejecución de rutinas de dúo libre y su relación con periodos de intensidad elevada y apnea prolongada
- Valores **máximos** de $5,9 \text{ mmol}\cdot\text{L}^{-1} (\pm 1,6)$, inferiores a los encontrados en competición (Rodríguez-Zamora, et al., 2012), de $7,3 \text{ mmol}\cdot\text{L}^{-1} (\pm 2,0)$, pero más cercanos a las nadadoras júnior de esta última muestra ($6,9 \pm 1,7 \text{ mmol}\cdot\text{L}^{-1}$)
- **Sin correlación** entre $\text{La}_{\text{post-rutina}}$ y RPE, contrariamente a estudios anteriores en competición real (Rodríguez-Zamora et al., 2014).

PLASMA BLOOD LACTATE AND PERCEIVED EXERTION IN SYNCHRONIZED SWIMMING ROUTINES DURING

Rodríguez-Zamora L., Iglesias X., Barrero A., Chaves

Conclusiones

Introduction & Aim

Synchronized swimming (SS) athletes need to combine sets of both aerobically very demanding exercises, leading to breathing freely and holding breath (BH) for almost 100% in each program, swimmers competing at elite level perform both a technical and a free routine that is characterized by the physiological responses.

The aim of this study was to examine the cardiovascular, blood lactate and perceived exertion responses to competitive routines in synchronized swimming.

Materials & Methods

14 elite (14.4 ± 3.0 y) and junior (15.9 ± 1.0 y) synchronized swimmers performed a total of 36 routines during an international competition in the technical sets (TS), free sets (FS), free duet (FD), technical team (TT), and free team (FT).

Heart rate (HR) was monitored using a waterproof monitor (Corda Sense, Sportland).

Blood lactate (La_{ven}) was obtained from venous capillary samples during recovery (minutes 3, 5, 7, and 10).

Perceived exertion (RPE) was measured using the Borg Scale (Borg, 1998).

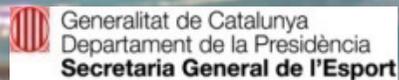
Results

Pre-exercise mean HR (beats min^{-1}) was 120.1 ± 13.2 , and quickly increased during the exercise to attain mean peak values of 182.0 ± 8.0 , with frequent interspersed bradycardic events down to 80.0 ± 20.3 (Figure 2). Mean La_{ven} (mmol L^{-1}) was 7.3 ± 3.0 . On average RPE was 7.0 ± 1.4 ranged from 5.0 (TT) to 8.1 (FD) and was higher in juniors.

Table 1. Heart rate parameters during the routines and peak blood lactate and RPE after exercise.

	Technical sets	Free sets	Technical team	Free team	Technical duet	Free duet
HR_{pre}	120.1 ± 13.2	120.1 ± 13.2	120.1 ± 13.2	120.1 ± 13.2	120.1 ± 13.2	120.1 ± 13.2
HR_{peak}	182.0 ± 8.0	182.0 ± 8.0	182.0 ± 8.0	182.0 ± 8.0	182.0 ± 8.0	182.0 ± 8.0
HR_{min}	80.0 ± 20.3	80.0 ± 20.3	80.0 ± 20.3	80.0 ± 20.3	80.0 ± 20.3	80.0 ± 20.3
HR_{avg}	120.1 ± 13.2	120.1 ± 13.2	120.1 ± 13.2	120.1 ± 13.2	120.1 ± 13.2	120.1 ± 13.2
HR_{max}	182.0 ± 8.0	182.0 ± 8.0	182.0 ± 8.0	182.0 ± 8.0	182.0 ± 8.0	182.0 ± 8.0
HR_{min}	80.0 ± 20.3	80.0 ± 20.3	80.0 ± 20.3	80.0 ± 20.3	80.0 ± 20.3	80.0 ± 20.3
HR_{avg}	120.1 ± 13.2	120.1 ± 13.2	120.1 ± 13.2	120.1 ± 13.2	120.1 ± 13.2	120.1 ± 13.2
HR_{max}	182.0 ± 8.0	182.0 ± 8.0	182.0 ± 8.0	182.0 ± 8.0	182.0 ± 8.0	182.0 ± 8.0
HR_{min}	80.0 ± 20.3	80.0 ± 20.3	80.0 ± 20.3	80.0 ± 20.3	80.0 ± 20.3	80.0 ± 20.3
HR_{avg}	120.1 ± 13.2	120.1 ± 13.2	120.1 ± 13.2	120.1 ± 13.2	120.1 ± 13.2	120.1 ± 13.2
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HR_{max}	182.0 ± 8.0	182.0 ± 8.0	182.0 ± 8.0	182.0 ± 8.0	182.0 ± 8.0	182.0 ± 8.0
HR_{min}	80.0 ± 20.3	80.0 ±				

- El lactato sanguíneo en la ejecución de las rutinas de dúo libre de natación sincronizada presenta unos valores finales cercanos a los $6 \text{ mmol}\cdot\text{L}^{-1}$, a los que se llega a través de un **incremento gradual** y progresivo del lactato durante la ejecución de la rutina, con valores desde los $3,7 (\pm 1,6)$ a $5,9 (\pm 1,4) \text{ mmol}\cdot\text{L}^{-1}$.
- La **ausencia de diferencias** entre los valores de lactato **pre y post-apnea** en las principales figuras de las rutinas de dúo libre sugiere que la acumulación de lactato en sangre se produce esencialmente como resultado de la elevada demanda energética durante el ejercicio y no de las apneas prolongadas.



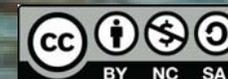
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Xavier Iglesias
xiglesias@gmail.com

<http://inefcresearch.wordpress.com>
@Xavieriglesias



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