ABSTRACT

https://doi.org/10.6063/motricidade.25295

The effect of using a parachute on the propulsive force and stroke mechanics during pace-controlled swimming: a case study with an international level swimmer

Catarina Costa Santos[1,2,3], Mário Jorge Costa[2,3], Daniel Paiva[1], Pedro Rodrigues[1], Daniel Almeida Marinho[1,3]

Biomechanical analysis in swimming has been widely undertaken with propulsion and add-resistance materials. This approach tried to understand how coordination and stroke mechanics were influenced by using such aids. To date, just one study aimed to understand the effect of parachute on the propulsive force at different water flows in a flume (Schnitzler, Brazier, Button, Seifert, & Chollet, 2011). Thus, the aim of the current study was to analyse the effect of using a parachute on the kinetic and kinematic variables at different swimming velocities. An international female swimmer (age: 18 years-old) was recruited to perform three all-out trials in front-crawl at different swimming velocities (0.80, 1 and 1.20 $m \cdot s^{-1}$). This was done in two different conditions: free-swimming (FS) and swimming with a parachute (SP). The swimming velocity were controlled by a visual light pacer (DigiSwim Pacing System, Digiwest, PT) and the propulsive force (PF, N), was measured with a differential pressure system (Aquanex 4.1, STR, USA) allowing retrieve PF values for the dominant (PF_D) and non-dominant (PF_{ND}) upper-limbs. The Symmetry Index (SyI, %) was calculated as reported elsewhere (Robinson, Herzog, & Nigg, 1987). The stroke frequency (SF, HZ) was assessed with a chrono-frequency meter (FINIS 3x300, Finis Inc., USA) and, therefore, the stroke length (SL, $m \cdot c^{-1}$) and stroke index (SI, $m^2 \cdot c^{-1} \cdot s^{-1}$) were estimated. Swimming with the parachute required higher propulsive forces in both limbs, as the velocity increased (Table 1). The SyI showed a tendency to decrease, as the velocity and

Table 1. Kinetic and kinematic variables at different swimming velocities.

Conditions		PF_D (N)	Variables				
			PF_{ND} (N)	SyI (%)	SF (Hz)	SL ($m \cdot c^{-1}$)	SI ($m^2 \cdot c^{-1} \cdot s^{-1}$)
0.80 ($m \cdot s^{-1}$)	FS	38.02	25.91	37.89	0.41	1.94	1.55
	SP	52.98	42.01	23.10	0.51	1.58	1.26
1 ($m \cdot s^{-1}$)	FS	52.42	42.30	21.31	0.55	1.82	1.82
	SP	68.67	60.03	13.43	0.59	1.69	1.69
1.20 ($m \cdot s^{-1}$)	FS	61.81	58.13	6.14	0.60	2.00	2.40
	SP	75.04	67.65	10.36	0.73	1.65	1.98

%: percentage; FS: free-swimming; SP: swimming with a parachute; PF_D: propulsive force of dominant limb; PF_{ND}: propulsive force of non-dominant limb; SyI: Symmetry Index; SF: stroke frequency; SL: stroke length; SI: stroke index; N: Newton; $m \cdot c^{-1}$: meter per cycle; $m \cdot s^{-1}$: meter per second.

[1]Universidade da Beira Interior – Covilhã, Portugal.
[2]Instituto Politécnico da Guarda – Guarda, Portugal.
[3]Centro de Pesquisa em Ciências do Esporte, Centro de Investigação em Desporto, Saúde e Desenvolvimento Humano – Vila Real, Portugal.
*E-mail: catarina.costa.santos@ubi.pt

Conflict of interests: nothing to declare. **Funding:** National Funds through the Portuguese Foundation for Science and Technology (FCT), I.P. (2020.08326.BD and UIDB04045/2020.

propulsive force increased. It seems that when the velocity is near to the maximum (50-m best personal record), a decrease in the deficit of the force applied by both limbs is shown, representing a more comfortable swim pace to use. Only the velocity of 1.20 $m \cdot s^{-1}$ showed a SyI bellow of 10% (cut-off value), being considered as a symmetric stroke. The SL and SI were lower in the parachute condition since the additional resistance led to a greater effort and SF. The SF presented an incremental increase within the different velocities. Swimming coaches should be aware of the hypothetical significant differences in kinetic and kinematic variables when using a parachute. The lower velocities should be avoided to maintain the integrity of the force applied and to reach a more symmetric motor pattern.

REFERENCES

Robinson, R. O., Herzog, W., & Nigg, B. (1987). Use of force platform variables to quantify the effects of chiropractic manipulation on gait symmetry. *Journal of Manipulative Physiology Therapy, 10*(4), 172-176.

Schnitzler, C., Brazier, T., Button, C., Seifert, L., & Chollet, D. (2011). Effect of velocity and added resistance on selected coordination and force parameters in front crawl. *Journal of Strength Cond Research, 25*(10), 2681-2690. https://doi.org/10.1519/jsc.0b013e318207ef5e