ABSTRACT

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Upper limbs actions in successive front crawl swimming at sprint pace

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INTRODUCTION

Propulsive swimming mechanics mainly depends on upper limbs' actions that perform three-dimensional movements in each cycle. Considering that hydrodynamic drag is proportional to the square of velocity, technical execution of segmental displacement at maximal exertions should be effective to ensure high and stable propulsive forces per cycle. Nevertheless, human movement is characterized by constraints that imply variability of motor solutions to optimise kinematic patterns and performance (Newell, 1986). The aim of the study is to characterize upper limbs phases when swimming front crawl at maximal velocity.

METHODS

Thirteen high-level swimmers participated in the study (16.2 ± 0.7 years of age and 171.6 ± 6 cm of height) that took place in a 25 m indoor pool after the main competition of the macrocycle. After a standardized warm-up, swimmers performed a 25 m front crawl at maximal intensity and were recorded in the sagittal plane for 2D kinematical analyses using a double camera set-up (Go Pro 6, 120 Hz) fixed laterally and pushed on a chariot. Upper limbs cycles were divided by counting frames using Blender software, and phases (entry, downsweep, insweep, upsweep, and recovery) were identified. The first seven cycles of each swimmer were analysed, and the relative duration of each phase was obtained as a percentage of the cycle duration. A repeated-measures ANOVA was used to verify differences between cycles, and ICC allowed investigating the relationship between them. The significance level was set at 5%.

RESULTS

Figure 1 presents the relative duration of front crawl upper limbs phases (entry, downsweep, insweep, upsweep, and recovery = 18, 12, 20, 23, and 26 % respectively), being possible to observe that downsweep was the shortest even though non-propulsive phases prevailed in relation to the propulsive ones. Table 1 presents the mean values ± SD of the relative duration of seven successive upper limbs cycles. Although swimmers have presented variable relative duration of front crawl upper limbs phases, no differences were reported between cycles. Complementarily, ICC demonstrated high consistency in intraindividual performance (entry, downsweep, insweep, upsweep and recovery = 0.97, 0.90, 0.97, 0.93. 0.90, respectively).

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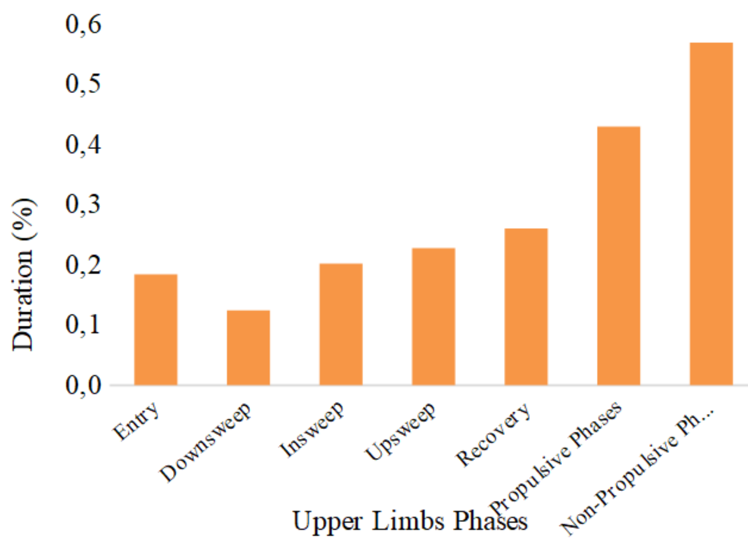

Figure 1. Relative duration of upper limbs phases

Table 1. Mean values ± SD of upper limbs phases relative duration (%) from seven successive cycles

	C1	C2	C3	C4	C5	C6	C7
Entry	0.18±0.05	0.2±0.06	0.19±0.06	0.19±0.06	0.18±0.06	0.18±0.06	0.19±0.06
Downsweep	0.14±0.04	0.12±0.04	0.12±0.04	0.12±0.04	0.12±0.03	0.12±0.04	0.12±0.04
Insweep	0.2±0.05	0.21±0.06	0.21±0.07	0.2±0.05	0.20±0.06	0.2±0.06	0.2±0.06
Upsweep	0.23±0.04	0.22±0.04	0.22±0.04	0.23±0.04	0.23±0.04	0.24±0.03	0.23±0.03
Recovery	0.26±0.02	0.26±0.02	0.26±0.03	0.26±0.02	0.27±0.03	0.26±0.03	0.25±0.02

DISCUSSION

Despite the well-known decrease of non-propulsive phases at sprint pace due to the fastest hand velocity/acceleration (McCabe et al., 2011), a predominance was still observed. These results were expected since a higher increase in the relative duration of the propulsive phases could reduce the efficiency, and consequently, could be a technical mistake if its increase was not mandatory for the swimmers' high velocity. In becoming skilled, the neuromuscular system ensures that movement is performed consistently well while, at the same time, develops the ability to adapt to changing constraints. In the present study, we highlighted this statement, as a slight variability is observed between cycles. However, ANOVA and ICC showed a great consistency during the swimming, supporting that the relative duration of upper limbs phases was maintained, probably due to the swimmers' high level in response to the swimming constraints.

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