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ORIGINAL ARTICLE

Selected anthropometrical, muscular architecture, and biomechanical variables as predictors of 50-m performance of front crawl swimming in young male swimmers

Influence des paramètres anthropométriques, physiologiques ou biomécaniques sur la performance de jeunes nageurs masculins sur un 50 m nage libre

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Muscular architecture;
Anthropometry;
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Front crawl

Summary
Background. — Swimming performance may be influenced by anthropometric, physiology and biomechanical factors.
Purpose. — The purpose of this study was to examine the influence of different parameter on 50-m front crawl swimming performance in young male swimmers.
Methods. — Selected anthropometrical (body height, body mass, body mass index, arm span, shoulders width, thigh, leg, and upper arm lengths), muscle architectural (muscle thickness (MT), pennation angle (PA), and fascicle length (FL)), and biomechanical (stroke rate (SR), stroke length (SL), and stroke index (SI)) parameters have been measured on 50-m front crawl swimming performance in young male swimmers 13.86 ± 0.86 years of age ($n = 23$).
Results. — Stepwise regression analysis revealed that biomechanical parameters (84%) characterized best 50-m front crawl swimming performance, followed by muscular architecture (52%) and anthropometrical (22%) parameters. Also, SI, SL, and MT of Vastus Lateralis (VL) explained 89% of 50-m front crawl swimming performance variability in these young male swimmers.

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Conclusion. — These results suggest that 50-m front crawl swimming performance can be generally explained by biomechanical and muscular architecture parameters than anthropometrical factors in young male swimmers.

MOTS CLÉS
Architecture musculaire ;
Anthropométrie ;
Échographie ;
Fréquence de mouvements de bras ;
Nage libre

Résumé Les performances en natation peuvent être affectées par les caractéristiques anthropométriques des nageurs, des facteurs physiologiques et/ou biomécaniques.
Objectifs. — Le but de cette étude a été d'évaluer l'influence de différents paramètres sur les performances de jeunes nageurs de sexe masculin sur un 50 m nage libre.
Méthodes. — Différentes caractéristiques anthropométriques ont été mesurées, comme la taille, le poids corporel, l'index de poids corporel, l'envergure des bras, la largeur des épaules, les longueurs des cuisses, jambes et bras. D'autres variables ont été mesurées, représentatives de l'architecture musculaire (épaisseur de muscles spécifiques, MT, angle de pennation, longueur des faisceaux) ou de nature biomécanique (fréquence des mouvements de bras, longueur parcourue pour un cycle mouvements de bras, SL, index de mouvement de bras, SI). Ces mesures ont été réalisées au cours d'un 50 m nage libre chez 23 jeunes nageurs d'un âge moyen de 13,86 ± 0,86 ans.
Résultats. — Les analyses de régression pas à pas permettent de suggérer que les facteurs biomécaniques expliquent à 84 % les meilleures performances au 50 m nage libre. L'architecture musculaire et les caractéristiques anthropométriques expliquent moins complètement les performances en nage libre (respectivement 52 % et 22 %). De même, les valeurs de SI, SL et MT du vaste externe expliquent 89 % de la variabilité des performances au 50 m nage libre entre les jeunes nageurs.
Conclusions. — Les résultats obtenus suggèrent que chez les jeunes nageurs, les performances au 50 m nage libre peuvent être principalement expliquées par des facteurs biomécaniques et liés à l'architecture musculaire, alors que les facteurs anthropométriques jouent un rôle moins important.

1. What this study adds to existing knowledge

This study investigated the influence of different anthropometrical, muscular architecture and biomechanical parameters on 50-m swimming performance in young male swimmers. To our best knowledge, this study might be the first one to investigate muscle architectural parameters with anthropometrical and biomechanical factors as the indicator of front crawl swimming performance in young male swimmers.

2. Introduction

Generally, swimming performance is determined by the swimmers physiology (capacity for energy output, metabolic processes), morphology (size of the hands, frontal area, determining active drag), neuromuscular properties (capacity for generating force, doing work, delivering power, all of which relate to technique and coordination), and psychological profile (arousal, anxiety, motivation, etc.) [1]. Also, performance in high level swimming has been depended by components like technique (stroke technique, coordination, starts and turns), physical conditioning (aerobic conditioning, anaerobic conditioning, flexibility, and strength), and psychological conditioning (stress control, motivation) [2].

To be successful at the international level of swimming competition, it is believed that intensive training must begin before puberty [3], and performance in swimming has been related to different anthropometrical, physiological, and biomechanical parameters in children [4,5]. Therefore, the relationship among human somatic traits, physical capacity, and performance in athletes at various ages has always been a source of interest for many scientists. For example, several investigations have studied the anthropometric characteristics of young swimmers [6—11,15,19,28,33].

Besides the anthropometrical parameters, biomechanical aspects should also be considered as determinants of the best swimming performance [12]. Mean swimming velocity is a result of successive arm and leg actions during stroking, and consequently it can be described by its mechanical elements: SL and SR [13]. Increase or decrease in swimming velocity are due to a combined increase or decrease in SR and SL [1,13]. Accordingly, most of the biomechanical studies that have been carried out in swimmers have concerned the relationship between SR (cycle/min), SL (m/cycle), and swimming performance [8—13,15,17,19,25,28,33] and are often used by coaches in the evaluation of training process [14]. In case of various swimmers, depending on training status and distance covered, these parameters reach different levels. Mainly in youth groups, depending on training character, their impact on front crawl swimming speed may change [15]. In addition, Costill et al. [16] used SI as an indicator of swimming economy because it describes the ability to move at a given velocity with the fewest number of strokes, which could be used as the major indicator of swimming efficiency in adults [16] and also in children [17]. It has to be taken into account that anthropometric parameters among