Prediction of 100 m freestyle performance adopting anthropometric parameters and hand grip strength in elite master swimmers aged 43-80 years

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Introduction
The relationship between anthropometric characteristics and swimming performance has been the object of several investigations. Most of these previous studies, however, focused on young subjects. This study was conducted on elite master swimmers, aged between 43 and 80 in order to examine the relationships among some conventional anthropometrical parameters (age, stature, weight, arm and forearm length and volume) muscle strength, and the 100 m freestyle swimming performances. The main aim was to verify the possibility of adopting the above mentioned relationship to predict swimming performance in older athletes.

Methods
The study was based on measurements carried out during the 10th World Masters Championships, held in Riccione Italy, June 3-11, 2004. Thirty master athletes of both genders were included: 14 men (range 43-80 years) and 16 women (range 43-77 years). All participants were healthy and with no symptoms or signs of relevant pathologies affecting the neuromuscular system or the cardio-respiratory system. The time performance (expressed in sec.), was recorded, in the 100m free style event. Anthropometric and hand grip strength values were recorded either one day before or after the actual competition in a field laboratory organised beside the swimming pool. Standing stature (m) was measured with precision of 0.1cm with a stadiometer, weight (kg) recorded with a scale to the nearest 100g. Hand grip strength was measured using a Jamar Dynamometer (Asimov Engineering Co., Los Angeles, USA). The maximum grip strength, of the dominant limb, was determined in two consecutive attempts separated by at least 1 min resting interval. An unpaired Student t-test was adopted for the between genders comparison. A multivariate linear regression model (MANOVA) was applied assuming time as dependent variable, and calculated as a linear combination of the other variables. The significant variables resulted to be: age, weight, stature and mean hand grip (hgm), selected by a backward multiple regression method which eliminates step by step the less significant variables, giving the lowest change of R², with to the higher probability (p ≤0.10) for the Fisher variable.

Results
The (means ± SD) considered for the 30 Master Swimmers. (A=age; W=weight; h=height; Hgm=hand grip strength; Lfa=forearm length; La=arm length; Vct=total volume arm; 100m fe= 100 m freestyle performance).

<table>
<thead>
<tr>
<th>subjects</th>
<th>n</th>
<th>A(yrs)</th>
<th>W(Kg)</th>
<th>h(m)</th>
<th>Hgm(N)</th>
<th>Lfa(cm)</th>
<th>La(cm)</th>
<th>Vct(cm³)</th>
<th>100m fe(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>males</td>
<td>14</td>
<td>61.6±10.5</td>
<td>81±7.6</td>
<td>1.76±0</td>
<td>501±7.6</td>
<td>26.8±1.9</td>
<td>58.6±3.1</td>
<td>1324.2±198</td>
<td>72.9±12.4</td>
</tr>
<tr>
<td>females</td>
<td>16</td>
<td>57.6±11.5*</td>
<td>63.1±7.4*</td>
<td>1.66±0*</td>
<td>365.1±5.7*</td>
<td>24.9±1.4*</td>
<td>54.5±3.6*</td>
<td>929.7±100*</td>
<td>84.6±7.9*</td>
</tr>
</tbody>
</table>

tab. 1. All parameters considered for the 30 Master Swimmers. (A=age; W=weight; h=height; Hgm=hand grip strength; Lfa=forearm length; La=arm length; Vct=total volume arm; 100m fe= 100 m freestyle performance).

The regression equations obtained were for males: t100 = 125.933+0.64 age+0.294 weight–54.063 height–0.418 hgm ( R² = 0.77) and for females: t100 = -103.954+1.427 age+0.63 weight–50.076 height–0.456 hgm ( R² = 0.87).

The age, in both genders, significantly contributed to describe all the swimming performances.

Discussion/Conclusion
This study provides for the first time information on the relationship between anthropometry, muscle strength (hand grip) and swimming performances in elite master swimmers (males and females). Not surprisingly and in agreement with previous works, men swim faster than women. The weight was one of the most important time predictors for female. It is well known that women require a 30 % lower rate of energy production than men to maintain a given velocity and it has been suggested that females did not need to expend as much energy in staying afloat, because of their higher mean percentage at fatty tissue. Moreover women have a higher economy of swimming, attributed to smaller body size (resulting in smaller body drag), smaller body density and greater fat percentage, resulting in a more horizontal and streamlined position. In conclusion, this study showed that some conventional anthropometric variables (age, weight, stature) and a physical capacity (hand grip strength) can represent a simple, inexpensive and non invasive technique for the estimation of swimming performances in this population of old athletes.

References