THE ANTHROPOMETRIC AND PERFORMANCE CHARACTERISTICS OF HIGH-PERFORMANCE JUNIOR LIFE SAVERS

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Abstract
To date, limited research has reported the physical attributes of adult life savers, and no such data exist for junior life savers. The purpose of the present investigation was to describe the anthropometric and performance characteristics of junior high-performance life savers and identify any gender differences. Thirty-three male ((Mean ± SD) age: 13.8±1.5 yrs; stature: 164.3±9.4 cm; mass: 54.5±11.2 kg) and 30 female (age: 13.5±1.6 yrs; stature: 157.7±9.1 cm; mass: 49.5±9.6 kg) high-performance life savers had anthropometric measures taken and completed a battery of performance tests. Anthropometric measurements included stature, mass and arm span, whilst the performance measures taken were vertical jump height, 5 m and 20 m sprint times, maximal velocity, hamstring flexibility, agility, maximal aerobic capacity, and chest, back and leg strength. Unpaired t-tests revealed significant (p<0.05) gender differences for stature, arm span, vertical jump height, 20 m sprint time, hamstring flexibility, agility, maximal aerobic capacity and back and leg strength. The present results provide normal values for junior high-performance life savers and indicate that male competitors are physically advanced at this level.

Key words: Adolescent, anthropometry, athletic performance

INTRODUCTION
The determination of the anthropometric and performance characteristics of athletes is invaluable to coaches and sport scientists alike as it assists with various aspects of sport such as performance enhancement, talent identification and training/recovery recommendations. Previously, the anthropometric and performance characteristics have been described within a number of athletic populations, such as basketball [13], rugby league [9], rugby union [29], soccer [11], and volleyball [2] players, cyclists [4] and runners [1]. However, limited research has examined these responses within life savers [8, 14, 25] and no research exists examining these characteristics within junior life savers (< 18 years).

The events undertaken by life savers vary in their demands, as do the skills required for success in the separate disciplines of their sport. Competitions range from the short duration beach sprints and events, which largely rely on anaerobic performance to the longer duration, aerobic-based surf boat races and multidisciplinary events [5]. Based on these demands of competition, life savers need to train various fitness components. In addition to these fitness requirements, it is important to identify anthropometric and performance characteristics that may be required for success within life saving, particularly in junior athletes. Such processes can assist in not only identifying potential high-level junior competitors, but also nurturing performance progression into open-age competitions.

Previously, the anthropometric and performance characteristics of life savers have not received extensive research attention [8, 14, 21, 22, 25]. Furthermore, this literature has detailed the attributes of senior life savers, with no information available on junior life savers. Early research by Gulbin et al [14] reported the anthropometric and performance characteristics of 55 life savers aged between 18 and 44 years. More recently, Fell and Gaffney [8] investigated these attributes in 30 male life savers. Similar tests were conducted by Reilly et al [21, 22] and Sinclair and colleagues [25], and they concluded that multidisciplinary events require more extensive conditioning than the singular events (surf boarding and swimming).

From the available research, the anthropometric and performance characteristics have been provided for a limited sample of adult life savers, with no data available detailing the characteristics of junior competitors. With the identification of these attributes within junior life savers, coaches and athletes will be able to formulate the most
appropriate training, competition and recovery strategies to maximise performance, and also implement the most accurate and effective talent identification strategies and tests [25].

Previously, the use of fitness and performance testing to effectively identify talented juniors has been incorporated into many sports including basketball [15], soccer [23], Australian rules football [16], cycling [10] and athletics [30]. Therefore, the description of anthropometric and performance measures indicative of high-performance within junior life savers is needed for such testing to be ultimately effective in the sport.

There is a definite need for research addressing the anthropometric and performance responses of junior life savers, as no clear observations have previously been made. The current study aims to investigate these responses within junior high-performance Australian life savers and identify any gender differences that may be present. This in turn will only serve to enhance the level of performance within life saving through the development and nurturing of talented junior athletes.

MATERIALS AND METHODS

SUBJECTS

Thirty-three male ((Mean ± SD) age: 13.8 ± 1.5 yrs; stature: 164.3 ± 9.4 cm; mass: 54.5 ± 11.2 kg) and 30 female (age: 13.5 ± 1.6 yrs; stature: 157.7 ± 9.1 cm; mass: 49.5 ± 9.6 kg) high-performance Australian life savers participated in the current study. All participants were currently competing within various life saving events and were invited to attend a state high-performance camp. Prior to testing, each participant was informed of the procedures and provided their own and legal guardian written consent. Participants were also screened for any medical contraindications that may have excluded them from participating in any of the tests. All research practices were granted approval by the CQUniversity Human Ethics Committee.

ANTHROPOMETRIC MEASURES

Three anthropometric measures were taken on all participants. Stature was measured to the nearest 0.1 cm with a portable stadiometer (Blaydon, Sydney, NSW, Australia) and body mass was calculated to the nearest 0.1 kg using previously-calibrated electronic scales (Tanita Corporation, Tokyo, Japan). Arm-span measurements were also taken to the nearest 0.1 cm using a Lufkin Executive tape (CooperTools, Apex, NC, USA). Measurements were taken from the tip of the middle finger of one arm to the tip of the middle finger of the other arm with the arms outstretched at right angles to the body [30].

PERFORMANCE MEASURES

All performance testing was conducted sequentially during the same day between 14:00 and 18:00 h. Prior to completing any of the performance tests, participants were required to complete a warm-up protocol consisting of 5 min of jogging and a standardised stretching protocol. Participants completed three trials of maximal vertical jump testing using a Swift yardstick (Swift, Lismore, NSW, Australia). Initially, each participant was required to stand next to the yardstick with their feet flat on the floor and reach as high as possible on the yardstick. The participant then bent their knees to a comfortable depth and performed a maximal vertical jump reaching as high as possible on the yardstick with no arm swing allowed. The final maximal jump height (cm) was calculated as the difference between the two recorded marks.

Participants were then required to complete two trials of 20 m sprints. A Swift Speed Light Sports Timing System (Swift, Lismore, NSW, Australia) was used to measure 5 m and 20 m split times. From these measures, maximal velocity between the split times was determined using the following equation:

\[
\text{Maximal velocity (m·s}^{-1}\) = 15 m / [20 m time (s) – 5 m time (s)]
\]

Participants began each trial with their leading foot up to the starting line. They commenced each trial upon their own volition, thus eliminating errors associated with tester reaction time.

Following this test, participants completed three trials of a hamstring flexibility test using a sit-and-reach apparatus. Prior to testing, participants were required to sufficiently stretch their hamstrings and lower back. Participants sat on the floor in front of the sit-and-reach apparatus with legs fully extended, placing their feet flat against the apparatus. Participants performed two practices using medium effort to ensure the hamstrings/lower back were warm. Participants slid their hands along the slide ruler on the apparatus as far as possible for at least 2 seconds. The distance the fingers were beyond and behind the toes was recorded as positive and negative scores respectively. Flexibility measurements were recorded as the sum of the three trials for each participant.

Agility was measured using the Agility 5-0-5 Test on a non-slip surface. Agility times were measured using a Swift Speed Light Sports Timing System (Swift, Lismore, NSW, Australia) which was set up 10 m from the starting line and 5 m from the turning point. When ready, each participant sprinted from the starting line, through the timing system gates to the turning point at 15 m, where they turned on a nominated foot and accelerated as quickly as possible back 5 m through the electronic timing gates. The time taken from
the timing system gates to the turning point and back through the gates was recorded to the nearest 0.01 s. Each participant completed two trials with their fastest time recorded.

Participants also completed a maximal multistage fitness test (MSFT) to estimate maximal aerobic capacity (VO₂max). During the test, participants were required to run between two markers placed 20 m apart at increasing speeds. The test began at a running speed of 8.0 km-h⁻¹ and the second stage was at 9.0 km-h⁻¹, and thereafter increased by 0.5 km-h⁻¹ each minute. Change in running pace corresponded with a change in level and was represented by an audio cue through a compact disc player. Participants were required to place one foot on or behind the end marker at the occurrence of each audio cue. Participants who failed to achieve this on two successive occasions were deemed to have attained their VO₂max, which was taken as the level and shuttle number previous to the cue on which they finished. Each participant’s VO₂max was then estimated using previously established relationships between MSFT scores and laboratory measures [20]. The MSFT protocol has been reported to be a valid [12] and reliable [26] indicator of VO₂max.

Finally, isokinetic dynamometers (Smedley’s Dynamometer, TTM, Tokyo, Japan) were used to measure chest, back and leg strength. To measure chest strength, participants were required to grip the handles of the dynamometer in front of their chest with their forearms horizontal. Participants had to push the handles together with maximal force whilst maintaining horizontal elbow posture. To measure back strength, participants were required to follow the same procedures as described for chest strength, but pull the handles apart with maximal force instead of pushing. Participants remained upright throughout each trial. Leg strength was measured with participants assuming an upright position with knees (115-125˚) and torso (10-15˚) slightly flexed. Body weight was balanced and participants stood on the dynamometer platform with their feet either side of the chain. The length of the handle attachment was adjusted to suit each participant. Participants were required to grip the handle of the dynamometer with arms fully extended and exert maximal force through their legs with their knees straightening during the lift. Two trials were completed for each of the strength tests with the highest score recorded for each participant.

**Statistical Analysis**

Means and standard deviations were calculated for each measure, and unpaired t-tests were used to identify any gender differences in any of the measures. All statistical analyses were conducted using Microsoft Excel (Microsoft Corporation™, Redmond, Washington, USA). The alpha level was set at $p < 0.05$.

**RESULTS**

The results of the anthropometric and performance results for males, females and the entire sample are presented in Table 1. Males were observed to possess a significantly ($p < 0.05$) greater stature, arm span, vertical jump height, estimated VO₂max, and back and leg strength than females, whilst also possessing significantly faster 20 m sprint and agility times. Females were observed to have significantly ($p < 0.05$) greater hamstring flexibility than males.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Males</th>
<th>Females</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>13.8 ± 1.5</td>
<td>13.5 ± 1.6</td>
<td>13.6 ± 1.5</td>
</tr>
<tr>
<td>Stature (cm)</td>
<td>164.3 ± 9.4</td>
<td>157.7 ± 9.1*</td>
<td>161.1 ± 9.7</td>
</tr>
<tr>
<td>Body mass (kg)</td>
<td>54.5 ± 11.2</td>
<td>49.5 ± 9.6</td>
<td>52.1 ± 10.7</td>
</tr>
<tr>
<td>Arm span (cm)</td>
<td>162.6 ± 11.9</td>
<td>153.2 ± 11.3*</td>
<td>158.2 ± 12.5</td>
</tr>
<tr>
<td>Vertical jump height (m)</td>
<td>36.3 ± 7.3</td>
<td>30.3 ± 7.2*</td>
<td>33.5 ± 7.8</td>
</tr>
<tr>
<td>5 m sprint time (s)</td>
<td>1.23 ± 0.11</td>
<td>1.28 ± 0.07</td>
<td>1.26 ± 0.10</td>
</tr>
<tr>
<td>20 m sprint time (s)</td>
<td>3.45 ± 0.35</td>
<td>3.65 ± 0.31*</td>
<td>3.55 ± 0.35</td>
</tr>
<tr>
<td>Peak velocity (m·s⁻¹)</td>
<td>6.45 ± 0.51</td>
<td>6.26 ± 0.63</td>
<td>6.35 ± 0.58</td>
</tr>
<tr>
<td>Agility time (s)</td>
<td>2.58 ± 0.18</td>
<td>2.75 ± 0.18*</td>
<td>2.66 ± 0.20</td>
</tr>
<tr>
<td>Estimated VO₂max (ml·kg⁻¹·min⁻¹)</td>
<td>45.1 ± 6.8</td>
<td>38.7 ± 5.4*</td>
<td>42.0 ± 6.9</td>
</tr>
<tr>
<td>Chest strength (kg)</td>
<td>13.3 ± 8.7</td>
<td>10.9 ± 5.6</td>
<td>12.2 ± 7.4</td>
</tr>
<tr>
<td>Back strength (kg)</td>
<td>14.5 ± 8.3</td>
<td>10.5 ± 5.7*</td>
<td>12.6 ± 7.4</td>
</tr>
<tr>
<td>Leg strength (kg)</td>
<td>80.1 ± 30.2</td>
<td>59.2 ± 17.2*</td>
<td>70.1 ± 26.8</td>
</tr>
</tbody>
</table>

* Significant ($p < 0.05$) gender difference
DISCUSSION

The current study is the first to investigate the anthropometric and performance characteristics of high-performance junior life savers. Descriptive statistics were provided for stature, mass, arm span, vertical jump height, 5 m and 20 m sprint times, speed, hamstring flexibility, agility, estimated maximal aerobic capacity and chest, back and leg strength. Gender differences were observed in many of the measures, with males achieving significantly ($p < 0.05$) greater physical (stature and arm span), and performance (vertical jump height, 20 m sprint, agility, estimated $V_O^{2_{max}}$, back strength, and leg strength) scores in most tests. However, females did achieve significantly ($p < 0.05$) higher flexibility scores than males.

GROUP INFERENCES

The provision of anthropometric and performance data enables normal and standard values to be created. These data can assist coaches and athletes in improving performance, formulating the most effective training/recovery regimes and monitoring performance progression. Furthermore, particularly within juniors, these data enable coaches and support staff to identify athletes with the most potential within a given sport.

Whilst the provision of the data gives some indication of normal values associated with Australian high-performance junior life savers, the age range of the participants may limit the specific application of the results. Participants ranged in age from 13 to 17 years, and the pronounced differences in individual growth and maturation amongst participants within this age category have been well documented [3, 17, 18]. It has been naturally observed that a junior athlete’s performance characteristics are affected by their growth, maturation and development [17]. This is especially evident during adolescent years (approximately 10 to 18 years of age) for performance tasks involving bursts of strength, power and speed [17]. The growth and maturation variability evident within the life savers participating in the present study limits the applicability of the results to juniors of a specific age.

GENDER DIFFERENCES

Numerous gender differences were evident in the anthropometric and performance tests carried out in the present study. Males exhibited a significantly ($p < 0.05$) greater body stature and arm span within the anthropometric measures and performed significantly ($p < 0.05$) better than females in many of the performance measures including vertical jump height, 20 m sprint time, agility time, aerobic endurance and back and leg strength. However, females possessed significantly ($p < 0.05$) greater hamstring flexibility than males.

The higher performance scores of the males indicate that they are likely to perform greater workloads during competition and compete at a higher physical level. This has important implications for both junior life saving training and performance. Junior male life savers may be able to tolerate greater intensities and volumes of training, therefore needing tailored training programs that progress at a differing rate than females of a similar age. Coaches will need to consider this when developing training programs for junior life savers of mixed genders.

Given the age of the participants, these differences are also likely to reflect the varying nature of growth and maturation between genders [17, 28]. Furthermore, the age-ranges of the participants suggests that they are at varied stages of maturation. Previously, males have been reported to possess greater muscle mass and force generation compared with girls within this age group [19]. Hormonal development, mainly the higher levels of testosterone in males and its muscle-anabolic effect, has been put forward as the main contributor to these gender differences during maturation [24]. Previously, Round et al [24] observed that the testosterone levels in males could explain most of the gender differences in maximal isometric force during puberty. To add to this, males on average were taller than females in the current study, which has been suggested to be an important determinant of muscle mass and force development due to greater bone lengths [24, 27]. These developmental responses may have ultimately had an effect on the strength- and power-based performance results in the present study, such as sprint times, vertical jump height and back and leg strength.

The gender differences observed in the estimated $V_O^{2_{max}}$ responses are also likely to be explained by hormonal development. Previous researchers [18] have suggested that the high aerobic trainability in adolescent males is related to hormonal changes leading to greater development of the cardiorespiratory and musculoskeletal systems. Investigators have reported that greater quantities of growth hormone are secreted from the pituitary gland as a long-term adaptation to enhanced aerobic fitness in males when compared with females [6, 7]. The authors also suggested that further investigation into the roles of testosterone and estrogen on $V_O^{2_{max}}$ during maturation is warranted.

To gather a more definitive and specific set of data describing the anthropometric and performance responses of junior life savers, future research should include narrower participant age-ranges. This would enable the results to be more applicable to junior athletes competing at a certain age. Additionally, future studies should describe the physical and performance responses within junior athletes from separate life saving disciplines. Such data would highlight any differences between junior life savers competing in various events and provide more specific information for coaches to use in maximising athlete performance.
CONCLUSION AND PRACTICAL APPLICATION
The current study is the first to describe the anthropometric and performance characteristics of high-performance junior life savers. This information is useful for coaches and athletes in enhancing performance, identifying talented individuals and formulating training/recovery regimes. It also provides an initial range of normal values for future reference; however, more research is needed in this area to develop a definitive base of standard values within this population of athletes.

ACKNOWLEDGEMENTS
This study could not have been completed without the assistance of Mr Craig Holden of Queensland Surf Life Saving and Mr Brian Carroll of Tannum Sands Surf Life Saving.

REFERENCES
28. Thompson, A., Baxter-Jones, A., Minwald, R., & Bailey,