Repeated-Sprint Ability and Team Selection in Australian Football League Players

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Purpose: To investigate the relationship between selected physical capacities and repeated-sprint performance of Australian Football League (AFL) players and to determine which physical capacities contributed to being selected for the first competition game. Methods: Sum of skinfolds, 40-m sprint (with 10-, 20-, 30-, and 40-m splits), repeated-sprint ability (6 × 30-m sprints), and 3-km-run time were measured during the preseason in 20 AFL players. The physical qualities of players selected to play the first match of the season and those not selected were compared. Pearson correlation coefficients were used to determine the relationship among variables, and a regression analysis identified variables significantly related to repeated-sprint performance. Results: In the regression analysis, maximum velocity was the best predictor of repeated-sprint time, with 3-km-run time also contributing significantly to the predictive model. Sum of skinfolds was significantly correlated with 10-m (r = .61, P < .01) and 30-m (r = .53, P < .05) sprint times. A 2.6% ± 2.1% difference in repeated-sprint time (P < .05, ES = 0.88 ± 0.72) was observed between those selected (25.26 ± 0.55 s) and not selected (25.82 ± 0.80 s) for the first game of the season. Conclusions: The findings indicate that maximum-velocity training using intervals of 30–40 m may contribute more to improving repeated-sprint performance in AFL players than short 10- to 20-m intervals from standing starts. Further research is warranted to establish the relative importance of endurance training for improving repeated-sprint performance in AFL football.

Keywords: acceleration, speed, aerobic endurance, physical qualities, performance

Time–motion analyses of Australian football matches have shown that players are required to perform significant amounts of high-intensity running and sprinting during a game, often with minimal recovery between efforts. Dawson et al. used video analysis of Australian Football League (AFL) matches and identified 150 high-intensity efforts of less than 6 seconds duration; high-intensity activity made up 4–6% of total game time. The intensive efforts included high-intensity running and ground ball contests. Using global positioning system (GPS) technology, Brewer et al. confirmed the recently increased intensity of elite-level competition, reporting 271 high-intensity efforts in a game, with an average of 3 efforts per minute. Seventy-seven (~28%) of these high-intensity efforts were sprint efforts above 20 km/h. Wisbey et al. also used GPS technology to describe the physical demands of competition; players covered on average 12 km/game, with 240 moderate accelerations and 10 high accelerations per game.

The physical demands of Australian football have increased over recent seasons, with mean running speed increasing and playing time decreasing, indicating that players require high levels of aerobic power and an ability to perform short bursts of high-intensity efforts. Aughey demonstrated that distance covered and the number of intense efforts increased in finals matches, with total distance increasing 9%, high-intensity running increasing 9%, and maximal accelerations increasing 97%. These findings suggest that repeated-sprint ability and aerobic capacity may be critical physical qualities required by players to perform the repeated sprints, short accelerations (that may not reach the velocity threshold of a “sprint”), and high-intensity running that occur during a game, as well as rapidly recover between efforts and sustain these efforts over the course of a game.

Identifying the physical qualities that discriminate players of different skill levels can provide insight into the factors that are important for playing selection at the elite level. Young et al. found that AFL players who were selected to play the first game of the season were older and had significantly greater leg power, sprinting speed, and prolonged high-intensity intermittent-running ability (Yo-Yo Intermittent Recovery Test) than nonselected players. The selected players were significantly faster than the nonselected players in both the 10-m time (representing acceleration) and the flying 30-m time (representing maximum velocity). Veale et al. supported these findings by demonstrating significant differences in endurance performance between elite and subelite AFL players. While these studies provided important
information on some of the physical qualities important to team selection in AFL, no information was provided on the repeated-sprint ability of players. In addition, studies identifying the physical qualities that contribute to repeated-sprint ability are limited.7 Spencer et al8 and others9 have found that repeated-sprint ability was strongly associated with both acceleration and maximal running speeds; however, measures of aerobic power were poorly correlated. To date, the relative contribution of speed and endurance to repeated-sprint performances remain unclear. With this in mind, the aims of this study were to investigate which performance variables characterized players selected for the first competition game and to determine the relationship between repeated-sprint performance and selected physical-performance variables in professional AFL players.

**Methods**

**Participants**

Preseason physiological performance data were collected on 20 professional AFL players (mean ± SD age 21.7 ± 2.4 y, height 187.8 ± 6.1 cm, mass 87.5 ± 8.2 kg). The following performance variables were measured: sum of skinfolds, 40-m sprint (with 10-, 20-, 30-, and 40-m splits), repeated-sprint ability (6 × 30-m sprints leaving every 20 s), and 3-km-run time. The players selected from the team list for this study were those who completed all of these tests during preseason training. Injured players and older players who were susceptible to injuries from maximal-effort repeated sprints or maximal sustained endurance efforts were not required to perform the tests. The players in this study were highly motivated and competing for selection in the same professional AFL team. Players underwent fitness testing in December and January as part of their preseason training program. All players received a clear explanation of the study, including the risks and benefits of participation, and written consent was obtained. The ethics committee of the host institution approved all experimental procedures.

**Anthropometry**

Skinfold thickness was measured at 7 sites (biceps, triceps, subscapular, suprailliac, abdomen, thigh, and calf) using a Harpenden skinfold caliper. The same experienced tester, accredited with the International Society for the Advancement of Kianthropometry, conducted all skinfold measurements. The typical error of measurement for the sum of 7 skinfolds was calculated from our data as 1.1% (90% confidence limits, 0.8–1.6%).

**Speed**

Players’ speed was evaluated by the best 40-m-sprint time from 3 trials using dual-beam electronic timing gates (Swift Performance Equipment, NSW, Australia). The starting position was standing with the toe of the front foot immediately behind the start line. Split times were recorded at 10 m, 20 m, 30 m, and over the 40-m distance. The 20- to 40-m split time was calculated. All tests were conducted outdoors on a polyurethane and rubber synthetic surface. As testing was conducted in the morning under still conditions, wind speed was considered to have a negligible effect on the split times. The typical error of measurement for the 40-m-sprint distance was calculated from our data as 1.0% (90% confidence limits, 0.8–1.6%).

**Repeated-Sprint Ability**

Repeated-sprint ability was assessed using a repeated 30-m-sprint10 test on the same day starting 45 minutes after the 40-m-sprint test. This protocol is the same as that used for talent identification in the AFL national draft. The starting position was standing with the toe of the front foot immediately behind the start line. Players performed 6 maximal-effort sprints over a 30-m distance, with each sprint performed on a 20-second cycle. A passive rest was provided between maximal efforts. Each player’s total sprint time was calculated and used as the repeated-sprint score. The total sprint time of a similar 6 × 30-m protocol has been shown to be very reliable, with a typical error of measurement of 0.7% (90% confidence limits, 0.5–1.2%).

**Endurance**

Running endurance was measured using a timed 3-km run. The 3-km endurance test was selected as it was used in another study11 as part of a talent-identification battery of tests for junior U18 players and is similar to the continuous running nature of AFL football. The testing consisted of a maximal-effort 3-km continuous run on a 400-m synthetic track. Robertson et al12 reported a typical error of measurement of 1.3% (1.0–2.1% 90% confidence limits) for an endurance time trial over 4.5 km in well-trained runners.

**Statistical Analyses**

In relation to aim 1, players selected to play in the first competition game of the season were compared with those not selected. (1) Univariate analysis was used to examine the independent physical qualities of players selected to start the first match of the season (n = 10) and those not selected (n = 10) based on t tests. Given the practical nature of this study, and the relatively small sample size, calculation of Cohen effect size (ES) statistics was used to show differences in the physical qualities of selected and nonselected players. Effect sizes of <0.2, 0.2 to 0.6, 0.6 to 1.2, and 1.2 to 2.0 were considered trivial, small, moderate, and large, respectively.13 (2) Based on a multivariate model, the sensitivity and specificity of the performance measures in relation to game selection were calculated using the discriminant function procedure in SPSS.
In relation to aim 2, a cross-sectional comparison of the physiological and anthropometric qualities of elite AFL players was performed. (1) Univariate analyses were conducted to examine the interrelationships among the selected physiological and anthropometric qualities using Pearson product–moment correlations. (2) Multivariate analysis was used to examine the relative importance of these performance measures when the covariance among the measures was taken into account. A linear-regression model was developed between repeated-sprint ability, acceleration, speed, 3-km time-trial performance, and sum of skinfolds to establish the variables that were significantly related to repeated-sprint performance. The level of significance was set at $P < .05$. All data are reported as mean ± SD.

Results

Selected Versus Nonselected Players

The only variable that was significantly different ($P < .05$, ES = 0.88) between selected and nonselected groups was repeated-sprint time. Classification of players into the selected and nonselected categories produced a sensitivity level of 80% and a specificity level of 90%, correctly identifying 17 out of 20 cases. Small to moderate differences were demonstrated between selected and nonselected players for the 3-km time trial (ES = 0.49) and 10-m (ES = 0.66), 20-m (ES = 0.53), and 30-m (ES = 0.56) sprint times (Table 1).

Relationships Between Physiological Qualities

Significant associations were found between repeated-sprint time and 30-m ($r = .64$, $P < .01$) and 20- to 40-m sprint times ($r = .78$, $P < .01$). Significant associations were also found between sum of skinfolds and 10-m ($r = .60$, $P < .01$) and 30-m sprint times ($r = .53$, $P < .01$). The 10-m sprint, 30-m sprint, and 20- to 40-m velocity were all significantly associated with each other (Table 2). The regression analysis between repeated-sprint ability and other performance measures resulted in a statistically significant model with 20- to 40-m sprint times ($P < .001$) and 3-km time-trial performances ($P = .038$) explaining 64.3% of the variance in repeated-sprint ability.

Discussion

This study investigated the relationship between repeated-sprint performance and selected physical-performance variables in professional AFL players. Furthermore, we

### Table 1 Performance Variables in the Selected and Nonselected Groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>Selected, mean ± SD</th>
<th>Nonselected, mean ± SD</th>
<th>% difference*</th>
<th>Effect size*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sum of skinfolds (mm)</td>
<td>47.1 ± 8.0</td>
<td>51.5 ± 9.7</td>
<td>9.1 ± 14.2</td>
<td>0.49 ± 0.77</td>
</tr>
<tr>
<td>10-m sprint (s)</td>
<td>1.72 ± 0.06</td>
<td>1.75 ± 0.05</td>
<td>2.2 ± 2.5</td>
<td>0.66 ± 0.75</td>
</tr>
<tr>
<td>20-m sprint (s)</td>
<td>2.94 ± 0.08</td>
<td>2.99 ± 0.08</td>
<td>1.4 ± 2.1</td>
<td>0.53 ± 0.77</td>
</tr>
<tr>
<td>30-m sprint (s)</td>
<td>4.08 ± 0.11</td>
<td>4.14 ± 0.10</td>
<td>1.5 ± 2.0</td>
<td>0.56 ± 0.76</td>
</tr>
<tr>
<td>20- to 40-m speed (m/s)</td>
<td>8.93 ± 0.23</td>
<td>8.81 ± 0.26</td>
<td>1.4 ± 2.3</td>
<td>0.48 ± 0.77</td>
</tr>
<tr>
<td>Repeated-sprint ability (s)</td>
<td>25.26 ± 0.55*</td>
<td>25.92 ± 0.80</td>
<td>2.6 ± 2.1</td>
<td>0.88 ± 0.72</td>
</tr>
<tr>
<td>3-km time trial (s)</td>
<td>631 ± 35</td>
<td>666 ± 69</td>
<td>5.4 ± 6.6</td>
<td>0.63 ± 0.76</td>
</tr>
</tbody>
</table>

* Percentage difference and effect size ± 90% confidence limits.

*Significantly different ($P < .05$) from nonselected players.

### Table 2 Pearson Correlations Between Physiological and Anthropometric Qualities

<table>
<thead>
<tr>
<th></th>
<th>30-m time</th>
<th>20- to 40-m velocity</th>
<th>Repeated-sprint ability</th>
<th>3-km time trial</th>
<th>Sum of skinfolds</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-m time</td>
<td>.89**</td>
<td>.60**</td>
<td>.38</td>
<td>.16</td>
<td>.61**</td>
</tr>
<tr>
<td>30-m time</td>
<td>—</td>
<td>.87**</td>
<td>.64**</td>
<td>.06</td>
<td>.53*</td>
</tr>
<tr>
<td>20- to 40-m velocity</td>
<td>—</td>
<td>—</td>
<td>.78**</td>
<td>.03</td>
<td>.30</td>
</tr>
<tr>
<td>Repeated-sprint ability</td>
<td>—</td>
<td>—</td>
<td>.29</td>
<td>.15</td>
<td>.35</td>
</tr>
<tr>
<td>3-km time trial</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
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</tr>
</tbody>
</table>

*Significant relationship between variables ($P < .05$). **Significant relationship between variables ($P < .01$).
investigated which performance variables characterized players selected for the first competition game. The results demonstrate moderate differences in repeated-sprint ability between selected and nonselected players, with selected players having significantly better repeated-sprint performance than nonselected players. In addition, a discriminant analysis of the performance variables correctly predicted playing status in the first game of the season, with a sensitivity of 80% and a specificity of 90%. From a practical perspective, these results demonstrate for the first time the importance of repeated-sprint ability to team selection in elite AFL players.

Our results demonstrate small to moderate differences between selected and nonselected players for 30-m-sprint times and 3-km time-trial performances. These findings are generally consistent with those of Young et al., who found that running tests of acceleration, speed, and prolonged high-intensity intermittent-running ability were significantly related to selection for the first game of the AFL season. Those authors also reported that vertical jump height and endurance measures were not significantly related to team selection. Veale et al. analyzed a group of junior players competing for selection in an elite under-18 AFL squad and found that vertical jump was the only variable significantly related to squad selection. Those authors also reported that squad selection was related to generally higher performances across a range of physical tests. Differences between the Young et al. and Veale et al. studies may be accounted for by higher levels of maturity and consistency in physical capacities of the older players compared with juniors. Indeed, Spencer et al. found that associations between fitness characteristics were variable throughout the teenage years, with stabilization of these characteristics occurring by age 18.

The use of the repeated-sprint test to characterize selected and nonselected players for the first game of the season should be viewed with caution given the small sample size and the fact that the tests were only used for a single team. However, the specificity of this test in relation to the intermittent nature of the game suggests that it is a useful tool for comparing the repeated-sprint performances of players and providing a goal for athletes to work toward in preseason training. While excess subcutaneous fat is likely to hinder performance, there was only a small difference between the selected and nonselected players for skinfold thickness. Despite the fact that higher skinfolds were associated with poorer acceleration performances \( (r = .61\) between 10-m sprint and skinfold thickness), the small difference in skinfold thickness between selected (47.1 mm) and nonselected (51.5 mm) players and the homogeneous nature of the Australian footballers in this study suggest that reductions in skinfolds below a benchmark value (eg, 50 mm) is unlikely to improve one’s chance of selection.

The main quality that was significantly related to repeated-sprint performance was velocity between 20 and 40 m. The common variance between these 2 variables was 61%. When a regression analysis was completed using key physical qualities to predict repeated-sprint performance, endurance, as measured by the 3-km time trial, added significantly to the model and increased the common variance to 64%. These results indicate that maximum velocity is the main determinant of repeated-sprint performance but that endurance performance significantly contributes after this effect has been taken into account. Acceleration (as measured from the first 10 m of the 40-m sprint) did not contribute significantly to repeated-sprint performance. This finding is at odds with those of Pyne et al., who found a strong relationship \( (r = .66)\) between repeated-sprint-test performance and 20-m sprint times. Pyne et al. did not measure maximum speed between 20 and 40 m. Mendez-Villanueva measured 10-m, 20-m flying (20- to 40-m time), and repeated-sprint ability \( (10 \times 30-m)\) in under-14, under-16, and under-18 highly trained soccer players and found that repeated-sprint performances were more strongly related with maximum speed (flying 20-m) than acceleration (10-m time) qualities. The differences in results between the current and previous studies may reflect subtle differences in the high-speed-running demands between soccer and AFL, which may have resulted in different speed qualities’ contributing to repeated-sprint performances. Alternatively, the difference may be explained by the small differences between repeated-sprint protocols. Further research is required to systematically evaluate the relative importance of acceleration, maximum velocity, and endurance qualities to repeated-sprint performance for high-intensity intermittent team sports such as AFL.

**Conclusions**

Total repeated-sprint time was the only variable that differed significantly between players selected to play in the first competition game and those not selected. Small to moderate effect-size differences indicating practical importance were found between selected and nonselected groups for 10-m and 30-m sprints and 3-km run time. Times for the 20- to 40-m sprint were the best predictor of repeated-sprint ability, with 3-km time-trial performance being a significant, small contributor to repeated-sprint performance. These findings indicate that maximum-velocity training over 30- to 40-m distances may be more important than short acceleration sprints of 10 to 20 m from standing starts for improving repeated-sprint performance in Australian football players. While endurance-running training is also likely to be important for improving repeated-sprint performance, further research is needed to more clearly establish its relative importance.

**Practical Applications**

There are practical applications from this study that are relevant to applied physiologists and strength and conditioning staff. First, the differences in repeated-sprint ability between selected and nonselected players suggest
that the development of this physical quality should be prioritized in preseason training for AFL players. Based on the physical demands of competition, these repeated-sprint sessions could include repeated-efforts of up to 6 seconds in duration, with minimal (<20 s) recovery between efforts.1,2

Second, while no statistically significant differences were observed between selected and nonselected players for most physical qualities, well-developed maximum velocity and endurance contributed significantly to the prediction of repeated-sprint ability, explaining 64% of the common variance among tests. While specific repeated-sprint training may improve repeated-sprint ability,16 the development of maximum speed and endurance qualities is also likely to facilitate further improvements in repeated-sprint ability. To this end, specific speed training that encompasses longer rest periods17 and high-intensity interval (eg, maximal aerobic speed) training that incorporates shorter rest periods could be effectively integrated into the conditioning programs of AFL players.

Finally, a significant association was found between acceleration qualities and skinfold thickness; players with smaller skinfolds had faster times over 10 m and 30 m. While skinfold thickness did not differ statistically between selected and nonselected players, these findings suggest that maintaining low skinfold thickness (~50 mm) is likely to increase the power-to-weight ratio for the short sprints required by these athletes.

References


