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## Literature Review: Anthropometric, strength and physical capacities of senior and junior Australian footballers

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Anthropometric, strength and physical capacities of senior and junior Australian Footballers

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6 **BLUF**

7 This study demonstrates that senior Australian Football players are heavier and possess superior

8 strength characteristics without any meaningful difference in aerobic capacities when compared to

9 under 18 players.

1 **ABSTRACT**

2 The aim of this study was to compare the anthropometric and physical characteristics of state based  
3 junior and senior Australian Football (AF) players. Thirty one League (age  $23.7 \pm 2.6$  years), 19  
4 Development League (DL) (age  $20.5 \pm 1.9$  years), and 34 Under 18 (U18) players (age  $17.4 \pm 0.7$  years)  
5 were recruited from a single AF club. Assessments included height and mass, upper body (bench press  
6 and weighted pull-up) and lower body (squat) three repetition max strength, lower body power (vertical  
7 jump) and 3 x 1-kilometre time trial. Multivariate analysis with Bonferroni post hoc tests were used to  
8 examine the differences between grades and position. Cohen's *d* statistic was used to assess the  
9 magnitude of difference. Significant age and body mass differences were evident between all three  
10 grades ( $p < 0.01$ ) and large to moderate differences were evident between League and U18 players in the  
11 absolute and relative bench press and back squat characteristics. No significant difference between time  
12 trial performance was evident between grades. The results demonstrate a particular need to ensure  
13 programs develop both absolute and relative strength in younger players to prepare them to compete  
14 safely and successfully in senior competitions.

15 **Key Words:** Australian Football, Strength, Physical Capacity, Athlete Development

16

## 1 **Introduction**

2 Australian Football (AF) is an invasion style team sport which requires players to possess well  
3 rounded physical characteristics. Players are required to cover large distances at varying speeds  
4 interspersed with intense accelerations, decelerations and frequent directional changes (12). Players are  
5 also frequently exposed to heavy physical contact both when in possession of the ball and when trying  
6 to win possession. The distances and intensities at which players run vary depending on competition  
7 level (4, 5). For example, Burgess et al. (5) demonstrated that elite under 18 (U18) players run  
8 significantly less distance per minute than their elite senior counterparts ( $118.9 \pm 14.1\text{m/min}$  v  $134.0 \pm$   
9  $12.1\text{m/min}$  respectively). In addition, the U18 players complete less sprint efforts per game and have a  
10 lower total sprint distance when compared to elite senior players (5). Strength and conditioning coaches  
11 attempting to physically prepare players for the rigours of competition should consider both acute  
12 performance demands and the long-term development goals of adolescent players to ensure they are  
13 prepared for senior adult competition.

14 There are several pathways through which junior players can progress into the senior elite  
15 Australian Football League (AFL), such as the elite national U18s competition and state based underage  
16 competitions (8). The most talented underage players are typically recruited into the elite AFL while  
17 those who are not selected often continue to compete in senior semi-elite competitions. Due to the  
18 dynamic nature of match play in AF, strength and conditioning coaches attempt to develop player's  
19 athletic strength, power and aerobic energy systems to optimise performance and prevent injury.  
20 Currently, an abundance of research is available highlighting differences in aerobic and power  
21 characteristics between age-matched players of differing playing status (9, 22, 23). Recently research  
22 has also demonstrated discrepancies between the functional movement capacities of junior and senior  
23 AF players using the Athletic Ability Assessment (11, 24). At present, there is limited research  
24 exploring whole body strength changes between playing position and competition levels (3, 6, 25).  
25 Bilsborough, et al., (3) demonstrated that strength and power differences exist between junior and senior  
26 players competing in semi-elite and elite AF players. In-particular, differences were noted between one  
27 repetition maximum (1RM) relative bench pull and loaded squat jump performance (3). To the authors

1 knowledge, currently there is no information available detailing the lower body strength of underage  
2 AF players, a property considered important for performance and reducing injury risk (26).

3 Typically, playing positions can be broken into nomadic (midfielders, half backs and forwards  
4 and pocket players) and non-nomadic (ruck, centre half forward and back and full forward or back)  
5 positions. It has previously been shown that anthropometric and physical characteristics differ between  
6 playing positions in AF (17, 19). Further AF research has also identified significant differences between  
7 playing position, match movement demands and match performance indicators (13). Senior elite non-  
8 nomadic players have been shown to be taller, heavier, stronger and more powerful while nomadic  
9 players are typically smaller, fitter and more agile (17, 19). It is currently unclear if strength  
10 characteristics differ between positions at the junior level. The primary purpose of this study was to  
11 assess the anthropometric and physical characteristics of semi-elite junior and senior AF players. It was  
12 hypothesised that senior players would possess superior performance qualities relative to their junior  
13 counterparts. A secondary aim of the study was to explore how physical characteristics differed between  
14 playing positions.

### 15 **Approach to the Problem**

16 This cross-sectional investigation compared the anthropometric, upper and lower body strength,  
17 lower body power and aerobic capacity of U18 and senior AF players from a single semi-elite AF team.  
18 In total 84 players were recruited from three grades of a single club. Players completed a battery of tests  
19 including anthropometric assessment, countermovement jump (CMJ), three repetition maximum (3RM)  
20 strength testing and a 3 x 1-kilometre time trial. All testing was completed in the final weeks of the  
21 preseason preparation phase. To reduce the effects of fatigue on performance the testing was completed  
22 across three sessions over a two-week period. Session one assessed anthropometric, 3RM pull-up and  
23 squat. The second session assessed CMJ and 3RM bench press. The time trial was completed in the  
24 final session. Prior to each testing session players completed a general warm-up, consisting of light  
25 jogging, unilateral and bilateral countermovement jumps and dynamic stretching. Session warm-ups  
26 and assessments were all monitored and recorded by the clubs strength and conditioning staff.

## 1           **Subjects**

2           Thirty one League (age  $23.7 \pm 2.6$  years, mass  $84.9 \pm 9.2$  kg, stature  $1.86 \pm 0.07$  m), 19 DL  
3 (age  $20.5 \pm 1.9$  years, mass  $80.9 \pm 9.6$  kg, stature  $1.82 \pm 0.07$  m), and 34 U18 players (age  $17.4 \pm 0.7$   
4 years, mass  $77.0 \pm 9.2$  kg, stature  $1.82 \pm 0.06$  m) were included in the study. Players were classified  
5 based on their highest level of selection at the club and as either nomadic or non-nomadic based on the  
6 position played most frequently.

7           During the preseason the League and DL players typically completed 2-3 resistance training  
8 sessions and 2 mixed skills/conditioning sessions per week. The U18 players had progressed through a  
9 series of strength education and screening processes to ensure sound technique in their strength  
10 assessments. Any player that did not pass the screening process was not included in the study. The U18  
11 players typically completed 2 resistance training sessions and 2 mixed skills/conditioning sessions a  
12 week. Senior and junior resistance training programs utilised common variations of strength (squat,  
13 deadlift, bench press and pull-up), plyometric and prophylactic exercises. The methods for this study  
14 were approved by the university ethics committee and by the club involved. Players were provided with  
15 plain language statements detail the relevant risks and benefits of taking part in the study and were  
16 required to provide consent for their data to be included. If the player was under the age of eighteen  
17 consent was also required by their legal guardian.

## 18           **Procedures**

19           Anthropometric measures of stature and mass were measured to the nearest 0.01 m and 0.1 kg  
20 using a stadiometer (PE, Sportforce, Australia) and electric scales (Model UC-321, A&D Mercury Pty.  
21 Ltd., Australia). Lower body power was assessed via a countermovement jump (CMJ). Players were  
22 instructed to stand under a Vertec vertical jump device (Swift Performance Equipment, Lismore,  
23 Australia), then with both feet flat on the ground reach up and displace the highest vane possible. Players  
24 were then asked to perform three CMJ's with two minutes rest between jumps. The highest of the three  
25 attempts were recorded minus the individuals reach height. The interclass correlation coefficients and  
26 typical error measurements were 0.98 and 1.64% respectively.



1 All strength measures of back squat, bench press and pull-up were assessed to a 3RM using  
2 standard Olympic bars and free weights. After the general warm-up players completed a specific warm-  
3 up protocol using the player's previous 3RM data for each of the prescribe lifts. Players completed 8  
4 repetitions with the bar (20kg or body weight), 6 repetitions at 60% of 3RM, 4 repetitions at 70% of  
5 3RM, 3 repetitions at both 80% and 90% of 3RM, followed by 3 repetition maximum testing. If  
6 successful on the 3RM attempt players were instructed to incrementally increase the loads by 2.5 kg  
7 with three to five minute rest period between each attempt. The bench press protocols required players  
8 to self-select handgrip width and lower the bar to touch the chest then press the bar into full elbow  
9 extension. Pull-up protocols required players to complete the movement with over-hand position at a  
10 self-selected handgrip width. Players began the movement in a fully extended hanging position and  
11 were required to pull themselves to a height in which the chin was level with the bar. Players were  
12 verbally encouraged to limit swinging movements, with excessive swinging disqualifying the attempt.  
13 The back squat protocols required players to attain a depth in which the hip crease aligned with the top  
14 of the knee. Players could self-select stance width. Adherence to testing protocols was assessed by the  
15 club's strength coaches, with failure to complete a repetition to required range resulting in the attempt  
16 being disqualified. Testing was terminated if players failed on a particular movement twice.

17 The club's 3 x 1-kilometre time trials is a novel assessment of aerobic capacity as more  
18 commonly 3-kilometre time trials or Multi-Stage Fitness Tests (MSFT) are used in AF literature (10,  
19 16, 18). The 3 x 1-kilometre time trial requires players to complete each 1-kilometre trial as quickly as  
20 possible running around a grassed oval. Each subsequent trial began 7:30 minutes after the start of the  
21 preceding trial. The total time taken to complete the three trial represented the criterion measure. The  
22 club uses the repeated trial protocols for three reasons; firstly there is a strong correlation ( $r=-0.82$ ,  
23  $p<0.01$ ) and agreement (Figure 1) between time trial and MSFT performance measures. Test-retest  
24 reliability assessed using interclass correlation coefficients ( $ICC=0.97$ ,  $p<0.01$ ) and typical error  
25 measurements (4.36%) are also considered acceptable. Secondly, the higher average running speeds  
26 elicited in the repeated trial protocols better represents the high intensity running zone ( $<250\text{m}/\text{min}^{-1}$ )  
27 which has been linked to winning possession of the ball more frequently in AF (15). For example, the

1 3-kilometre time trial results previously reported using a similar demographic averaged 252.8 m/min-1  
2 (16) while the average speed of the players in the 3 x 1-kilometre time trial in this study was 283.0  
3 m/min<sup>-1</sup>. Finally, coaches expect players in matches to perform high intensity short bursts of effort  
4 interspersed with frequent short breaks on the bench to recover (often time recovering on the bench is  
5 <3 min). The repeated trial protocols resulted in an average rest period less than 4 min and is deemed  
6 by coaches to be more representative of the game environment than the standard 3-kilometre time trial.

### 7 **Statistical Analysis**

8 All data is reported as means  $\pm$  *SD*. Parametric assumptions of normality and homogeneity of  
9 variance were tested before all analyses. Multivariate analysis (MANOVA) with Bonferroni post hoc  
10 tests were run to examine the differences between grades (League, DL, U18). Similarly, an MANOVA  
11 was used to examine the differences between nomadic and non-nomadic players across the different  
12 grades. The magnitude of effects were examined using the Cohen's *d* effect size (7). The magnitude of  
13 effect was interpreted using a scale where values <0.2 are deemed trivial, 0.2–0.6 small, 0.6–1.2  
14 moderate, 1.2–2.0 large and >2.0 very large (14). Statistical significance for all analyses was defined as  
15  $p < 0.05$ .

### 16 **RESULTS**

17 Significant age and body mass differences were evident between all three grades ( $p < 0.01$ , Table  
18 1), however there was no notable height differential between grades. There were no notable differences  
19 in CMJ's between grades. Small to large differences (range,  $d = 0.67$ -1.48) were evident between grades  
20 in the absolute and relative bench press, absolute pull-up and back squat characteristics. Bench press  
21 was the only strength test where League players significantly outperformed the DL players with both  
22 the absolute ( $d = 0.89$ ) and relative ( $d = 0.45$ ) performances superior. There was a large difference  
23 between the League and U18 ( $d = 1.95$ ) and the DL and U18 ( $d = 1.39$ ) players for total weight lifted. No  
24 meaningful differences were evident in time trial performance between groups.

25 **\*\*\* TABLE 1 AROUND HERE\*\*\***

1           Players classified as nomadic demonstrated moderate to very large differences (range,  $d= 1.13-$   
 2 3.85, Table 2) between all grades for age and body mass characteristics. Moderate to very large  
 3 differences (range,  $d= 1.11-2.46$ ) were evident between grade for all absolute strength measures, with  
 4 the exception of back squat which demonstrated a large difference between League and U18 players  
 5 ( $d= 1.64$ ). Total weight lifted varied between League and U18 ( $d=2.05$ ) and DL and U18 ( $d=1.42$ )  
 6 players.

7                                 **\*\*\* TABLE 2 AROUND HERE\*\*\***

8           There was a very large difference in the ages of the non-nomadic League ( $d=3.39$ ) and DL  
 9 ( $d=2.57$ ) groups when compared to the U18 group. In regards to anthropometry, the only significant  
 10 difference between groups was the moderate difference ( $d=1.15$ ) between the League and U18 players.  
 11 The non-nomadic League and U18 players demonstrated moderate to large differences (range,  $d= 1.09-$   
 12 1.40) in bench press and back squat performance. Relative measures of bench press and back squat  
 13 demonstrated moderate differences ( $d= 1.07$ ) between the League and U18 players and large differences  
 14 ( $d= 1.64$ ) between the DL and U18 respectively. Total weight lifted between league and U18 players  
 15 demonstrated a moderate difference ( $d= 1.48$ ).

16                                 **\*\*\* TABLE 3 AROUND HERE\*\*\***

17   **DISCUSSION**

18           As hypothesised the differences between age and body mass between League and U18 players  
 19 concurs with previous research which also reported that elite and sub elite seniors were older and  
 20 heavier than their elite junior counterparts (3, 21). Interestingly, despite the League players being on  
 21 average much older and heavier than their DL and U18 counterparts, no differences in height between  
 22 the groups were noted. This likely due to the majority of these players being at or close to full biological  
 23 maturity and as such they would have already attained full adult height.

24           The significant difference demonstrated in upper body strength between League, DL and U18  
 25 is in agreement with previous research in both AF and rugby union (1, 3, 25). Similar strength trends  
 26 were also demonstrated when participants were analysed by playing positions, with the exception of

1 non-nomadic DL players who demonstrated small to moderate differences when compared to league  
2 and U18 players. Direct comparisons to other studies is difficult however Bilsborough et al. (3)  
3 demonstrated that semi-elite senior AF players possessed superior upper body strength ( $96.5 \pm 16.6\text{kg}$ )  
4 when compared to junior counterparts ( $87.9 \pm 12.7\text{kg}$ ) in one repetition maximum bench press values.  
5 Differences in bench press performance between the two studies may be a result of variation in testing  
6 protocols, player age and specific training foci of individual teams. To the authors' knowledge this was  
7 the first study to report lower body strength characteristics of junior and senior AF players. Lower body  
8 strength results showed a similar trend to results reported of rugby union players with senior players  
9 possessing advanced strength characteristics over their junior counterparts (1).

10         The difference in strength and body weight demonstrated between groups are likely due to  
11 physical maturity and adaptations associated with increased training age. Training age refers to the  
12 duration of time players have spent within a supervised and monitored training program (1). Recent  
13 research examining training age in adolescent rugby league demonstrated that strength gains occur  
14 annually when involved in formalised training programs and that the training age of individuals was a  
15 likely reason for these strength improvements (20). Whilst not quantified in this study, the League  
16 players had generally been involved in club talent development programs since their early teenage years  
17 with formalised strength training beginning in the U18 program. Therefore it can be presumed that the  
18 League players, who are significantly older, have a greater training age than DL and U18 players. Long-  
19 term participation in structured strength training, can improve performance in force and power tasks by  
20 increasing muscle hypertrophy, inhibition of force regulators (2) and movement efficiency (e.g., greater  
21 synchronization of motor units and decreased antagonist co-activation) (24). The development of both  
22 absolute and relative strength may help to safeguard athletes against injury as match movement  
23 velocities and distances increase from junior to senior competition (5) and may provide competitive  
24 advantage in contested situations.

25         The influence of aerobic capacity on match performance in senior AF is generally well  
26 understood (15, 16). As such, many AF development training programs place a high emphasis on  
27 developing aerobic capacity. In the current study this is particularly evident by the small improvements

1 in time trial performance when comparing League and U18 players. This represents a much smaller  
2 magnitude of improvement than evident in strength measures and is likely due to a prioritisation on  
3 running capacity in junior training programs. As a result, it would appear the scope for improvement in  
4 running capacity appears to be relatively low once junior players reach the U18 level. Currently it is  
5 unclear if strength characteristics influence match performance in AF. As such it is debatable if the  
6 emphasis often placed on developing running capacities in junior AF training is truly warranted. Future  
7 research should explore links between strength and match performance to further inform the  
8 development of junior training methods in AF.

9         There are limitations in the study methodology that need to be acknowledged. Firstly, the cross-  
10 sectional design means all data comes from a single club during preseason which potentially limits the  
11 application of the results. Future work should seek to longitudinally track players as they progress from  
12 junior to senior competition and compare in-season and preseason results. Secondly, the clubs 3 x 1-  
13 kilometre time trial has yet to be validated against match performance outcomes. Future research could  
14 explore the relationship between the time trial measure and match performance in comparison to other  
15 commonly used fitness measures.

## 16 **PRACTICAL IMPLICATIONS**

17         This work demonstrates that semi-elite League AF players are significantly older, heavier and  
18 stronger in both upper and lower body measures than their U18 counterparts. No significant differences  
19 are evident between time trial performances between groups. In AF formalised strength training is often  
20 not included in junior training programs until they reach U18s; rather developing aerobic capacity is  
21 prioritised. As such, smaller scope for improvement in running capacity are likely to be evident when  
22 players progress into senior competition when compared to strength outcomes. This study highlights a  
23 practical need to ensure strength and conditioning coaches provide formalised strength programs to U18  
24 AF players to ensure the appropriate physical development for senior levels of competition.

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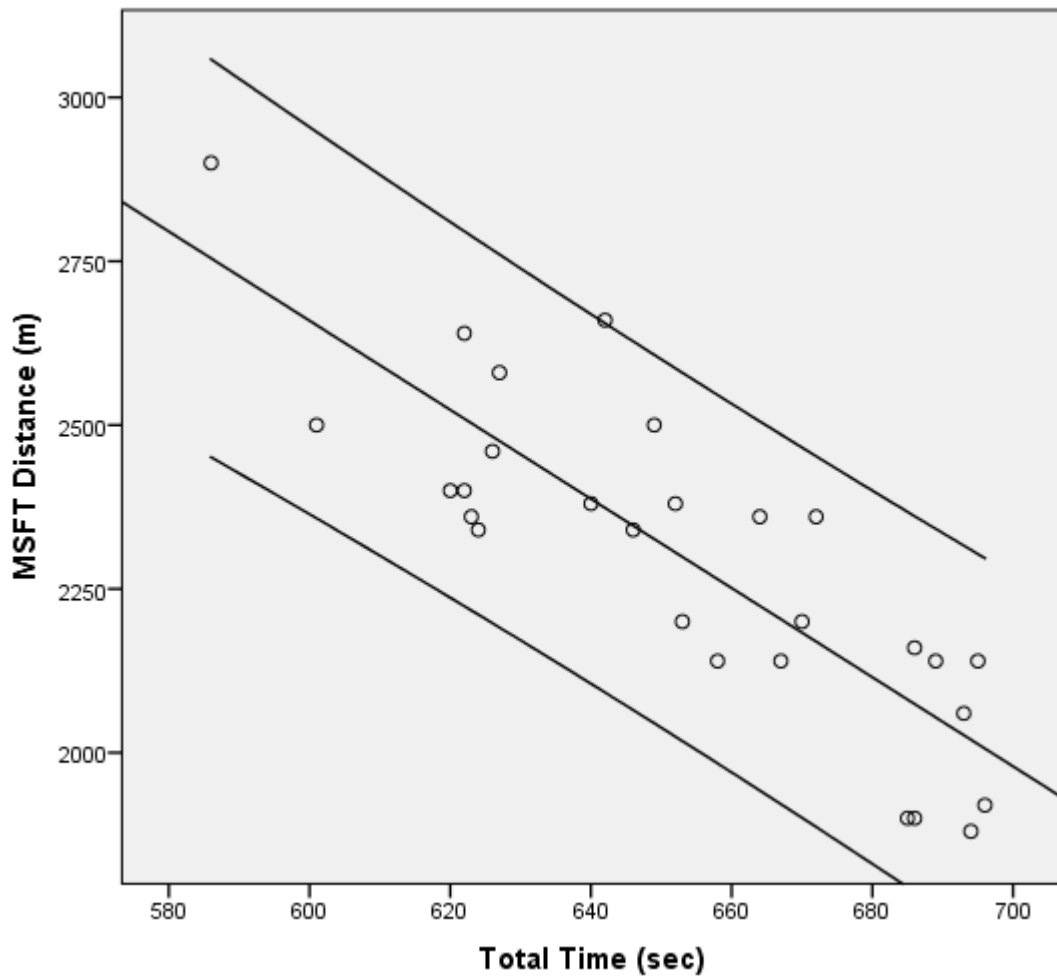
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2 Figure 1. Bland-Altman plot with 95% prediction intervals.

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Table 1. Anthropometric and physical capacities of League, Development League (DL) and Under 18 (U18) Australian Football players (mean (SD)).

	League	DL	U18	Main Effect <i>p</i>	Cohens <i>d</i> (95% CI) League v DL	Cohens <i>d</i> (95% CI) League v U18	Cohens <i>d</i> (95% CI) DL v U18
Age (years)	23.8 (2.8)‡§	20.7 (2.0)†§	17.4 (0.7)†‡	<0.01	1.23 (0.59-1.82)	3.2 (2.44-3.90)	2.51 (1.74-3.20)
Height (m)	1.86 (0.07)	1.82 (0.07)	1.82 (0.06)	0.10	0.57 (-0.02-1.14)	0.62 (0.11-1.11)	0.01 (-0.56-0.56)
Body Mass (kg)	85.9 (8.1)§	80.3 (7.7)	75.5 (7.6)†	<0.01	0.70 (0.11-1.28)	1.33 (0.77-1.85)	0.63 (0.05-1.19)
CMJ (m)	0.62 (0.07)	0.63 (0.05)	0.59 (0.05)	0.13	-0.16 (-0.73-0.42)	0.50 (0.01-0.99)	0.80 (0.21-1.37)
Bench Press (kg)	93.2 (14.2)‡§	81.4 (12.2)†§	67.4 (11.9)†‡	<0.01	0.88 (0.27-1.46)	1.98 (1.36-2.54)	1.17 (0.55-1.75)
Back Squat (kg)	113.4 (19.6)§	110.0 (17.0)§	89.2 (11.4)†‡	<0.01	0.18 (-0.39-0.75)	1.53 (0.96-2.06)	1.52 (0.87-2.13)
Pull-Up (kg)	103.2 (11.7) ‡§	97.4 (12.8)†§	89.0 (8.5)†‡	<0.01	0.48 (-0.11-1.05)	1.40 (0.84-1.92)	0.82 (0.23-1.39)
Bench Press (kg·kg <sup>-1</sup> )	1.09 (0.16)‡§	1.02 (0.15)†§	0.89 (0.11)†‡	<0.01	0.45 (-0.14-1.02)	1.47 (0.90-2.00)	1.04 (0.43-1.61)
Back Squat (kg·kg <sup>-1</sup> )	1.32 (0.21)	1.38 (0.24)§	1.19 (0.18)‡	0.02	-0.27 (-0.84-0.31)	0.67 (0.16-1.16)	0.93 (0.33-1.51)
Pull-Up (kg·kg <sup>-1</sup> )	1.22 (0.13)	1.24 (0.13)	1.18 (0.06)	0.23	-0.15 (-0.72-0.42)	0.40 (-0.10-0.89)	0.66 (0.07-1.22)
Total Weight (kg)	307.4 (37.4)§	286.8 (34.7)§	242.4 (28.8)†‡	<0.01	0.57 (-0.02-1.14)	1.96 (1.35-2.53)	1.43 (0.79-2.03)
Time Trial (sec)	621.9 (33.1)	641.6 (50.5)	634.7 (35.0)	0.27	-0.49 (-1.06-0.10)	-0.38 (-0.86-0.12)	0.17 (-0.4-0.73)

CMJ = counter movement jump

† significantly different to League

‡ significantly different to DL

§ significantly different to U18

Table 2 Anthropometric and physical capacities of Nomadic League, Development League (DL) and Under 18 (U18) Australian Football players (mean (SD)).

	Nomadic			Main Effect <i>p</i>	Cohens <i>d</i> (95% CI) League v DL	Cohens <i>d</i> (95% CI) League v U18	Cohens <i>d</i> (95% CI) DL v U18
	League	DL	U18				
Age (years)	24.2 (2.9)†§	19.9 (1.1)†§	17.2 (0.7)†‡	<0.01	1.72 (0.71-2.63)	3.22 (2.11-4.18)	3.16 (1.82-4.27)
Height (cm)	1.82 (0.05)	1.78 (0.04)	1.79 (0.03)	0.04	0.85 (-0.05-1.69)	0.72 (-0.02-1.41)	-0.30 (-1.15-0.58)
Body Mass (kg)	82.1 (5.7)†§	76.4 (4.6)†§	72.6 (4.7)†‡	<0.01	1.06 (0.14-1.91)	1.81 (0.94-2.58)	0.81 (-0.1-1.67)
CMJ (m)	0.63 (0.06)	0.62 (0.05)	0.6 (0.06)	0.28	0.18 (-0.67-1.01)	0.50 (-0.22-1.19)	0.35 (-0.52-1.2)
Bench Press (kg)	90.7 (12.7)†§	79.4 (6.8)†§	64.0 (9.1)†‡	<0.01	1.01 (0.09-1.85)	2.39 (1.43-3.23)	1.83 (0.77-2.76)
Back Squat (kg)	114.3 (18.2)§	105.0 (16.7)	90.0 (11.3)†	<0.01	0.52 (-0.35-1.36)	1.58 (0.75-2.33)	1.12 (0.17-2.00)
Pull-Up (kg)	102.6 (11.0)†§	90.8 (9.0)†	85.8 (6.3)†	<0.01	1.13 (0.20-1.99)	1.84 (0.97-2.62)	0.68 (-0.22-1.54)
Bench Press (kg·kg <sup>-1</sup> )	1.11 (0.16)§	1.04 (0.06) §	0.88 (0.11)†‡	<0.01	0.51 (-0.36-1.34)	1.66 (0.81-2.41)	1.66 (0.63-2.58)
Back Squat (kg·kg <sup>-1</sup> )	1.39 (0.2)	1.38 (0.24)	1.24 (0.17)	0.09	0.05 (-0.80-0.89)	0.80 (0.06-1.50)	0.71 (-0.19-1.57)
Pull-Up (kg·kg <sup>-1</sup> )	1.26 (0.14)	1.26 (0.1)	1.18 (0.06)	0.07	0.01 (-0.84-0.84)	0.73 (-0.01-1.42)	1.06 (0.11-1.93)
Total Weight (kg)	305.3 (39.5)†§	271.3 (22.3) †§	236.3 (26.7)†‡	<0.01	0.97 (0.06-1.81)	2.02 (1.13-2.82)	1.38 (0.39-2.27)
Time Trial (sec)	612.6 (26.6)	620.5 (33.3)	624.2 (33.1)	0.56	-0.27 (-1.11-0.58)	-0.39 (-1.08-0.32)	-0.11 (-0.97-0.75)

CMJ = counter movement jump

† significantly different to League

‡ significantly different to DL

§ significantly different to U18

Table 3 Anthropometric and physical capacities of Non-Nomadic League, Development League (DL) and Under 18 (U18) Australian Football players (mean (SD)).

	Non- Nomadic			Main Effect <i>P</i>	Cohens <i>d</i>	Cohens <i>d</i>	Cohens <i>d</i>
	League	DL	U18		(95% CI) League v DL	(95% CI) League v U18	(95% CI) DL v U18
Age (years)	23.1 (2.4)§	21.7 (2.5)§	17.7 (0.7)†‡	<0.01	0.57 (-0.49-1.57)	2.74 (1.24-3.95)	2.18 (0.62-3.40)
Height (cm)	1.92 (0.05)	1.88 (0.05)	1.89 (0.05)	0.25	0.80 (-0.29-1.80)	0.60 (-0.46-1.60)	-0.20 (-1.32-0.95)
Body Mass (kg)	92.3 (7.6)§	85.7 (8.2)	82.9 (8.7)†	0.08	0.84 (-0.25-1.85)	1.17 (0.03-2.19)	0.33 (-0.83-1.44)
CMJ (m)	0.61 (0.08)	0.64 (0.05)	0.58 (0.04)	0.36	-0.42 (-1.42-0.62)	0.44 (-0.61-1.44)	1.33 (-0.01-2.46)
Bench Press (kg)	97.5 (16.4)§	84.2 (17.4)	75.8 (14.6)†	0.04	0.79 (-0.29-1.79)	1.38 (0.19-2.41)	0.52 (-0.67-1.63)
Back Squat (kg)	112.0 (22.6)§	116.7 (16.3)	87.3 (12.5)†	0.03	-0.23 (-1.23-0.8)	1.26 (0.10-2.28)	2.02 (0.51-3.22)
Pull-Up (kg)	105.8 (13.6)	103.9 (10.4)	95.1 (9.1)	0.14	0.15 (-0.87-1.16)	0.88 (-0.22-1.88)	0.90 (-0.35-2.01)
Bench Press (kg·kg <sup>-1</sup> )	1.06 (0.16)§	0.99 (0.22)	0.91 (0.12)†	0.27	0.38 (-0.66-1.38)	1.02 (-0.10-2.03)	0.45 (-0.73-1.56)
Back Squat (kg·kg <sup>-1</sup> )	1.21 (0.2)	1.38 (0.25)§	1.06 (0.14)‡	0.04	-0.78 (-1.78-0.31)	0.83 (-0.26-1.83)	1.58 (0.18-2.73)
Pull-Up (kg·kg <sup>-1</sup> )	1.14 (0.07)	1.2 (0.16)	1.17 (0.05)	0.53	-0.54 (-1.54-0.52)	-0.47 (-1.47-0.58)	0.25 (-0.90-1.37)
Total Weight (kg)	315.3 (42.0)§	301.7 (36.6)	260.2 (30.8)†	0.01	0.34 (-0.70-1.34)	1.44 (0.24-2.47)	1.23 (-0.09-2.35)
Time Trial (sec)	637.8 (38.3)	669.7 (58.5)	661.0 (25.7)	0.31	-0.69 (-1.68-0.39)	-0.68 (-1.67-0.40)	0.19 (-0.96-1.31)

CMJ = counter movement jump

† significantly different to League

‡ significantly different to DL

§ significantly different to U18