



## Original research

# Dietary intakes of professional Australian football league women's (AFLW) athletes during a preseason training week

Sarah L. Jenner<sup>a,b,\*</sup>, Brooke L. Devlin<sup>a</sup>, Adrienne K. Forsyth<sup>a</sup>, Regina Belski<sup>c</sup><sup>a</sup> La Trobe University, Department of Dietetics, Nutrition and Sport, Australia<sup>b</sup> Carlton Football Club, Australia<sup>c</sup> Swinburne University of Technology, School of Health Sciences, Australia

## ARTICLE INFO

## Article history:

Received 9 May 2019

Received in revised form 21 June 2019

Accepted 21 June 2019

Available online 27 June 2019

## Keywords:

Sports nutrition

Energy

Carbohydrate

Diet

## ABSTRACT

**Objectives:** In 2016 the Australian football league introduced the first women's league, integrating part-time female athletes into the professional sporting environment. This study aims to assess the dietary intakes of professional Australian football league women's (AFLW) athletes to highlight key focus areas for nutrition and additionally provide nutrition recommendations for dietitians working with these athletes.

**Design:** Cross-sectional study.

**Methods:** Dietary intake data was collected from 23 players from the same club competing in the Australian football league women's, during a preseason week. Dietary intakes were assessed using three day estimated food records.

**Results:** Majority of athletes did not meet recommendations for carbohydrate (96%, n = 22), iron (87%, n = 20) and calcium (61%, n = 14). In comparison, majority of athletes met protein (74%, n = 17) and fat (78%, n = 18) recommendations. No significant difference was found in energy intake on main training, light training and recovery days ( $p > 0.05$ ). Energy and carbohydrate intakes reported by AFLW athletes ( $1884 \pm 457$  kcal day<sup>-1</sup> and  $2.7 \pm 0.7$  g kg<sup>-1</sup> day<sup>-1</sup>) were consistent with values reported in previous studies that included professional female athletes.

**Conclusions:** This research highlights that further exploration of the factors that influence dietary intake is required to support athletes to meet energy and carbohydrate recommendations required for desired training and performance outcomes.

© 2019 Published by Elsevier Ltd on behalf of Sports Medicine Australia.

## Practical implications

- This study provides baseline dietary intake data which may assist dietitians and scientists working with AFLW teams when prioritising nutrition needs.
- This study highlights that greater availability of nutrition support is required in the AFLW team environment to support individual athletes to attain dietary intakes that meet their recovery and performance needs.
- Sports dietitians should work collaboratively with high performance teams (i.e. sports scientists) to tailor dietary advice to the training loads and performance outcomes.

## 1. Introduction

In 2016, the Australian football league women's (AFLW) was established. Since its introduction, the league has grown from eight to ten teams, representing athletes from across Australia. The AFLW competition is made up of seven home and away games. Many of these athletes will continue to play Australian football (AF) in semi-professional state competitions across Australia on completion of the AFLW competition season.<sup>1</sup> Because of this, athletes competing in the AFLW will have minimal offseason time between these two leagues and therefore special consideration must be undertaken when assessing their nutrition needs. In addition, the intermittent and unique nature of AF games and training will require dietitians to tailor dietary planning to meet individual athlete needs. The physical demands of AFLW training and match play are different to the men's Australian football league (AFL). In particular, the AFL consists of a training year that is divided into; pre (4 months) and competition seasons (6 months).<sup>2</sup> The competition season consists of 23 games (i.e.  $4 \times 25$ –30 min quarters), with additional finals.

\* Corresponding author.

E-mail address: [s.jenner@latrobe.edu.au](mailto:s.jenner@latrobe.edu.au) (S.L. Jenner).

On a match day, AFL athletes on average can cover anywhere from 9.5 to 17 km of total distance per game.<sup>3</sup> In comparison the AFLW has shortened pre- and competition seasons (i.e. 3 months and 2 months, respectively) and overall game times (i.e. 4 × 15 min quarters), with additionally reduced total distance of match-play (i.e. range 4998–6255 m).<sup>1</sup> Differences in training loads, means energy demands differ between the AFL and AFLW, therefore dietary advice must be tailored according to the athletes' needs.

Consuming a dietary intake that supports the metabolic and energy demands of professional sport is important for the development, recovery and performance of athletes. The Australian Guide to Healthy Eating (AGHE) promotes the inclusion of a variety of food groups to promote and support overall health and wellbeing. For the general female population, adequate intakes of food groups such as dairy and alternatives will help to meet calcium needs and therefore support bone health and the prevention of bone related diseases.<sup>4</sup> For females competing in professional sport, additional focus on energy, macronutrient (i.e. carbohydrate, protein and fat) and micronutrient intakes (i.e. folate, calcium and iron) will be important for fuelling, recovery and overall performance in training and competition.<sup>5</sup> In addition, the timing and distribution of macronutrients throughout a training week will further optimise training, performance outcomes and body composition and will additionally support immune function for the maintenance of good health.<sup>5,6</sup> Research has found that female athletes are more vulnerable to nutrition-related issues including micronutrient deficiencies (i.e. vitamin D, iron and folate), reduced bone mineral density, eating disorders and body image and weight management issues.<sup>7</sup> Furthermore, research undertaken in a variety of team sports including Australian football, volleyball, soccer, softball and basketball has found that females competing in these sports, often do not meet recommended intakes of energy, carbohydrate and protein based on their training loads and are at increased risk of micronutrient deficiencies such as iron, due to increased iron losses through menstruation and exercise-induced mechanisms particularly in endurance based sports.<sup>8–10</sup> In particular, recent research by Condo et al. explored the dietary intakes of female Australian football athletes competing in the state level Victorian football league (VFL) during a preseason and found that athletes had inadequate intake of carbohydrate, iron and calcium.<sup>8</sup> The importance of nutrition support and individualised dietary planning in the national level AFLW is further supported with the understanding of dietary deficiencies experienced by other female athletes in previous research.<sup>8–10</sup>

Due to the recent establishment of the AFLW competition, very little is known about the lifestyle characteristics including the habitual dietary intakes of these athletes. Currently, the majority of AFLW athletes train as part-time athletes, with many working and/or studying throughout a training week. As a result, athletes' ability to access dietetic services is limited, which may pose unique challenges when providing optimal nutrition advice. Research has found that nutrition interventions implemented by dietitians have improved nutrition knowledge and positively influenced dietary intake of total energy, macronutrients (i.e. carbohydrate and protein) and micronutrients among professional female athletes.<sup>10–12</sup> Therefore, understanding the nutrition behaviours and habitual eating habits of AFLW athletes, is essential for the development and implementation of effective nutrition education programs.

The aim of this research was to investigate the dietary intake of AFLW athletes and compare intakes to general population health recommendations including: AGHE and Nutrient Reference Values (NRV) and sport nutrition recommendations supported by the International Society of Sports Nutrition (ISSN) and sports nutrition research.<sup>4,6,13</sup> The secondary purpose of this study was to highlight potential areas for improvement which can be targeted by dietitians working with these athletes. The hypothesis of this study was

that the dietary intakes in particular; carbohydrate, calcium and iron would not align with nutrition recommendations, as has been found by research undertaken in female Australian football athletes competing at the state level.<sup>6,8,14</sup> Additionally, authors hypothesised that athletes' dietary intakes would not follow a periodised approach or common diet-exercise strategies to manipulate fuel availability such as 'Fuel for the work required'.<sup>6,15,16</sup>

## 2. Methods

Twenty-three professional AF athletes were recruited from one club competing in the Australian football league women's (AFLW) by the researcher (SJ). This study collected dietary intake data at the start of the 2017 preseason (second year of play), at which point athletes professional careers were relatively new and prior access to dietetic services and advice regarding performance nutrition was minimal. All athletes provided consent to participate in the study and research was approved by the Human Research Ethics Committee at La Trobe University (S17-025).

Dietary intake was recorded for three days using an estimated food record via the mobile application Easy Diet Diary (Xyris Software, Australia, 2011) which was used to reduce participant burden and logistically fit within the constraints of this research project (i.e. cost effective and ease of access). Assessing dietary intake over three days was considered appropriate, as access to these athletes was limited. This approach has been previously used to assess dietary intakes of female athletes in other research.<sup>8,10</sup> The three-day food record observed a normal preseason training week which included one main training session (one skills session 60–80 min), a light training session (one weights session 30–40 min) and one recovery day (where no activity was recorded). Athletes were provided with written and verbal instructions by the researcher on how to complete an estimated food record (i.e. record usual intake, use appropriate portion measures where possible etc.) using the mobile application. Food records estimated intakes of food, fluid and supplements (i.e. whey protein). Food records were analysed using a food composition software program (Foodworks Version 8, Xyris, Queensland). Mean daily energy intake was reported as a group average and was not compared against recommendations due that energy intakes will depend on the size and activity level of the athlete. Macronutrient intake was assessed against recommendations advocated by the ISSN and specific sports nutrition research (Table 1).<sup>6,13</sup> Food groups and micronutrient intake (i.e. calcium and iron) were compared against AGHE and Nutrient Reference Values (NRV) (i.e. Recommended Dietary Intakes (RDI)).<sup>4,14</sup> Under-reporting of energy intake was explored using the Goldberg threshold; where a ratio of reported energy intake and basal metabolic rate (BMR) was calculated against a cut off limit of 1.11 based on females with medium physical activity levels.<sup>17</sup>

Statistical analysis was conducted using IBM SPSS Statistics for Windows version 24.0 (IBM Corp, Armonk, New York, USA, 2013). Statistical significance was set at  $p < 0.05$ . Normality of dietary intake data was assessed using a Shapiro Wilk test to ensure data was normally distributed. Dietary intake data was presented descriptively as means, standard deviations ( $\pm$ ) and percentage of athletes that met macronutrient and micronutrient recommendations (%). One-way repeated measures ANOVA was conducted to compare dietary intakes on different training days (main, light and recovery).

## 3. Results

Twenty-three AFLW athletes ( $25 \pm 4$  years,  $67 \pm 8$  kg,  $169 \pm 7$  cm) took part in the study, which was a response rate of 82%. Athletes had competed for on average  $9.1 \pm 6.0$  years in AF

**Table 1**  
Dietary intake data collected from 3-day food records; group means for total energy (kcal day<sup>-1</sup> and kcal kg<sup>-1</sup> day<sup>-1</sup>), macronutrients (g day<sup>-1</sup> and g kg<sup>-1</sup> day<sup>-1</sup>), micronutrients (mg day<sup>-1</sup>) and fibre (g day<sup>-1</sup>).

	Recommendation	Group average	Percent of athletes meeting recommendations % (n)
Energy intake (kcal day <sup>-1</sup> )		1884 ± 457	
kcal kg <sup>-1</sup> day <sup>-1</sup>	*	28.0 ± 7.1	*
Carbohydrate intake (g day <sup>-1</sup> )		178.0 ± 44.1	
g kg <sup>-1</sup> day <sup>-1</sup>	(5–8 g kg <sup>-1</sup> day <sup>-1</sup> ) <sup>6</sup>	2.7 ± 0.7	4% (n = 1)
Protein intake (g day <sup>-1</sup> )		107.0 ± 33.2	
g kg <sup>-1</sup> day <sup>-1</sup>	(1.2–2.0 g kg <sup>-1</sup> day <sup>-1</sup> ) <sup>6,13</sup>	1.6 ± 0.5	74% (n = 17)
Fat intake (g day <sup>-1</sup> )		72.7 ± 23.3	
% TEI	(30% TEI) <sup>6</sup>	34.0 ± 6.0	78% (n = 18)
Calcium (mg day <sup>-1</sup> )		852.0 ± 288.0	
Iron (mg day <sup>-1</sup> )	(1000 mg day <sup>-1</sup> ) <sup>14</sup>	12.1 ± 3.5	39% (n = 9)
Fibre (g day <sup>-1</sup> )	(18 mg day <sup>-1</sup> ) <sup>14</sup> (30 g day <sup>-1</sup> ) <sup>14</sup>	25.2 ± 8.3	13% (n = 3) 30% (n = 7)

Note: \*given recommended energy intake depends on the size and activity level of an athlete, energy is reported only as a group average, %TEI = Percentage of total energy intake, Recommendations used include; International Society of Sports Nutrition (Kerksick et al.),<sup>6</sup> International Society of Sports Nutrition (Jäger et al.),<sup>13</sup> National Reference Values (National Health and Medical Research Council).<sup>14</sup>

**Table 2**  
Dietary intake data collected from 3-day food records; group means for food groups as per Australian Guide to Healthy Eating guidelines (AGHE).

	Recommendations	Group average	Percent of athletes meeting AGHE recommendations % (n)
Fruit intake			
Serves/day	2 serves per day	1.6 ± 1.0	35% (n = 8)
Vegetable intake			
Serves/day	5 serves per day	4.1 ± 2.1	35% (n = 8)
Milk and alternatives*			
Serves/day	2.5 serves per day	1.7 ± 0.8	13% (n = 3)
Grain (cereal) food intake			
Serves/day	6 serves per day	4.8 ± 1.8	26% (n = 6)
Lean meat and alternatives			
Serves/day	2.5 serves per day	3.2 ± 1.2	61% (n = 14)

Note: all food group serves as per AGHE recommendations<sup>4</sup>, \* as per the AGHE 'Milk alternatives are those foods that contain the same amount of calcium as a serve of milk, yoghurt and cheese i.e. 100 g almonds, 60 g sardines canned in water, ½ cup (100 g) canned pink salmon and 100 g firm tofu'.<sup>4</sup>

and 2.1 ± 1.1 years in the AFLW. Table 1 provides detail on the dietary intake of AFLW athletes collected from 3 day estimated food records. The majority of athletes did not meet current recommended intakes for carbohydrate (96%, n = 22), iron (87%, n = 20) and calcium (61%, n = 14) (Table 1). The majority of athletes met protein and fat recommendations (Table 1).<sup>6,13,14</sup> When food group intake was assessed using AGHE guidelines for general healthy (non-athletic) populations, athletes met the recommended serves for the lean meat and poultry group only (Table 2).<sup>4</sup> Thirty percent (n = 7) of athletes were classified as under-reporters, as athletes' EI:BR ratio fell below the Goldberg cut-off limit of 1.11 for a plausible intake.

No significant differences in energy intake were found between main training, light training and recovery days (Table 3,  $p > 0.31$ ). There were no significant differences found in carbohydrate intake on main training day and recovery days or light training and recovery days (Table 3,  $p > 0.05$ ). Mean protein intakes were in line with recommendations across training days of 1.2–2.0 g kg<sup>-1</sup> day<sup>-1</sup>.<sup>6</sup> There were no significant differences for protein and fat intake between main training, light training and recovery days ( $p > 0.43$  and  $p > 0.19$ , respectively).

#### 4. Discussion

The aim of this research was to assess the dietary intake of professional AFLW athletes over three days in a pre-season training week. The main findings were (1) dietary intakes did not align with nutrition recommendations for carbohydrate, iron and calcium (2) the majority of athletes met sports nutrition recommendations for protein and fat and (3) there were no significant differences in total daily dietary intakes for main training, light training and recovery days. These results support the hypothesis that dietary

intakes would not meet nutrition recommendations for carbohydrate, iron and calcium.<sup>6,14</sup> Furthermore, these results highlight that intakes would not align with diet-exercise strategies such as macronutrient periodisation and fuel availability (i.e. 'Fuel for the work required').<sup>16</sup>

The average energy intake of this group of AFLW athletes was 1884 ± 457 kcal day<sup>-1</sup> (7875 ± 1910 kJ day<sup>-1</sup>). Energy intake reported by athletes in this study (Table 1) is consistent with values reported by female athletes competing in a variety of individual and team sports including Australian football, basketball, softball, volleyball, middle distance running, dance and soccer (i.e. 1600–2500 kcal day<sup>-1</sup>).<sup>8–10</sup> Low energy intake which is defined by the American College of Sports Medicine (ACSM) as intakes <1800 k–2000 kcal day<sup>-1</sup>, is highlighted as a nutritional concern when working with female athletes.<sup>5</sup> It is important athletes meet energy requirements based on their training loads to promote fueling, recovery and to support overall health. Chronic low energy intakes can increase the risk of injury and illness, the likelihood of macro- and micronutrient deficiencies and hormone and/or menstrual disturbances.<sup>5</sup> It is important to also take into consideration the existence under-reporting when assessing dietary records. Using the Goldberg equation, seven (30%) of the AFLW athletes were classified as 'under-reporters', however within this study reasons for under-reporting was not explored.<sup>17</sup> Research by Valliant et al. found when assessing the dietary intakes of female volleyball athletes, that weight loss and misconceptions about calorie needs, contributed to under-reporting of intake.<sup>10</sup> Therefore a desire to decrease body fat percentage (BF%) or lose total mass, may result in under-reporting.<sup>5</sup> At the time of data collection, body composition (i.e. Dual energy X-ray Absorptiometry (DXA), skinfolds) was not being assessed, hence there was no immediate pressure for these athletes to meet a body composition goal.<sup>2</sup> To prevent underfu-

**Table 3**

Dietary intake data collected from 3-day food records; group means for total energy (kcal), carbohydrate (g), protein (g) and fat (g) on main training, light training and recovery days.

	Recommendation	Main training	Light training	Recovery day	p Value
Energy intake	*	1913 ± 470	1832 ± 560	1764 ± 477	0.312
kcal day <sup>-1</sup>		28.8 ± 7.3	27.6 ± 9.1	26.6 ± 7.5	
kcal kg <sup>-1</sup>					
Carbohydrate intake	(3–8 g kg <sup>-1</sup> day <sup>-1</sup> ) <sup>6</sup>	(5 g kg <sup>-1</sup> day <sup>-1</sup> ) <sup>6</sup>	(4 g kg <sup>-1</sup> day <sup>-1</sup> ) <sup>6</sup>	(3 g kg <sup>-1</sup> day <sup>-1</sup> ) <sup>6</sup>	0.052
g day <sup>-1</sup>		196 ± 60.0	150 ± 46.4	169 ± 61.0	
g kg <sup>-1</sup>		3.0 ± 0.9	2.3 ± 0.7	2.6 ± 1.0	
% met recommendation		4% (n = 1)	0% (n = 0)	48% (n = 11)	
Protein intake	(1.2–2.0 g kg <sup>-1</sup> day <sup>-1</sup> ) <sup>6,13</sup>	(1.2 g kg <sup>-1</sup> day <sup>-1</sup> ) <sup>6,13</sup>	(1.2 g kg <sup>-1</sup> day <sup>-1</sup> ) <sup>6,13</sup>	(1.2 g kg <sup>-1</sup> day <sup>-1</sup> ) <sup>6,13</sup>	0.43
g day <sup>-1</sup>		108.9 ± 36.2	101.1 ± 42.5	113.3 ± 42.1	
g kg <sup>-1</sup>		1.63 ± 0.5	1.51 ± 0.60	1.70 ± 0.60	
% met recommendation		83% (n = 19)	74% (n = 17)	(87% (n = 20))	
Fat intake	(30% TEI) <sup>6</sup>	(30% TEI) <sup>6</sup>	(30% TEI) <sup>6</sup>	(30% TEI) <sup>6</sup>	0.19
g day <sup>-1</sup>		66.7 ± 23.0	67.10 ± 28.5	68.5 ± 25.5	
%TEI		30.8 ± 7.4	32.5 ± 9.2	34.0 ± 10.0	
% met recommendation		65% (n = 15)	57% (n = 13)	65% (n = 15)	

Note: \*given recommended energy intake depends on the size and activity level of an athlete, energy is reported only as a group average, no significant differences detected in dietary intakes between training sessions ( $p > 0.05$ ), %TEI = total percentage of intake, recommendations used include; International Society of Sports Nutrition (Kerksick et al.)<sup>6</sup>, International Society of Sports Nutrition (Jäger et al.)<sup>13</sup>

elling throughout a training week, energy availability should be estimated using measures of energy expenditure (i.e. collection of Global positioning system (GPS) data) and lean mass (i.e. DXA). There is a great opportunity for future research, to explore dietary intake data alongside energy availability, as GPS and body composition data, are now routinely collected by many AFLW high performance teams. Furthermore, a knowledge of athletes' training loads and body composition can allow dietitians to match dietary intakes to training loads, to enhance performance outcomes.

Carbohydrates are an essential macronutrient for fuel and recovery. Due to the intermittent, yet aerobic nature of AF the replenishment and storage of muscle glycogen is essential for optimal performance. Although modified in intensity and duration of game play, in comparison to the Australian football league, AFLW athletes still require a level of carbohydrate manipulation during a training week. From the observed data, athletes did not meet carbohydrate recommendations for low intensity training sessions (3–5 g kg<sup>-1</sup> day<sup>-1</sup>), in comparison athletes met recommended intakes of protein (1.2–2.0 g kg<sup>-1</sup> day<sup>-1</sup>) and fat (30% of total energy intake).<sup>6,13</sup> Mean carbohydrate intakes (Table 1) fell below values reported in endurance and non endurance female athletes (4.6–5.7 g kg<sup>-1</sup> day<sup>-1</sup>).<sup>18</sup> In addition, when intakes were compared against AGHE recommended serves; athletes did not meet serves for carbohydrate-containing food groups including Grain (cereal) foods, Fruit, Vegetables and Milk and alternatives (Table 2). Low carbohydrate intakes are consistent with previous research undertaken in female team sport athletes competing in a variety of team sports including; volleyball, soccer, softball and basketball.<sup>9,10,19</sup> In particular, research by Devlin et al., Jenner et al., Condo et al., reported that male and female AF athletes had carbohydrate intakes that either met the lower range or did not meet sports nutrition recommendations (range: 2.8–4.5 g kg<sup>-1</sup> day<sup>-1</sup>).<sup>2,8,20</sup> Factors such as the existence of body composition goals and the large variation in training loads during a training week were reported to have influenced male AF athletes carbohydrate intake.<sup>2,20,21</sup> Future research should further explore the potential barriers AFLW athletes face when trying to meet carbohydrate recommendations, to provide a greater understanding for professionals working with these athletes.

The majority of athletes reported intakes that met the protein recommendations of 1.2–2.0 g kg<sup>-1</sup> day<sup>-1</sup> and AGHE serves of meat and alternatives (Tables 1 and 2).<sup>6,13</sup> Protein intake was consis-

tent with research undertaken with female athletes competing in AF (1.5 ± 0.5 g kg<sup>-1</sup> day<sup>-1</sup>), ice-hockey (1.4 ± 0.1 g kg<sup>-1</sup> day<sup>-1</sup>) and soccer (1.4 ± 0.3 g kg<sup>-1</sup> day<sup>-1</sup>).<sup>8,19,22</sup> There was a macronutrient imbalance observed when assessing dietary intakes, finding that 74% (n = 17) of athletes met protein recommendations, in comparison to 4% (n = 1) meeting carbohydrate recommendations. It may be suggested that due to limited nutrition education and/or dietetic intervention, these athletes may be vulnerable to unreliable sources of nutrition advice and information. In particular, the presence of media attention surrounding low-carbohydrate and high-protein diets<sup>23</sup> Research in athletes suggests there is a weak to moderate positive association between NK and dietary intake.<sup>23–25</sup> Professional and semi-professional male and female AF athletes have been found to have poor nutrition knowledge, with many of these athletes also reporting intakes that do not align with sports nutrition recommendations.<sup>2,8,20</sup> Future research exploring the influence of nutrition knowledge on AFLW athletes' dietary habits is required to provide a greater understanding of the gaps in nutrition knowledge and enable the prioritisation of nutrition education according to athletes' needs.

Micronutrients, in particular iron and calcium, play an important role in many aspects of female athletes' performance. Low primary mineral intakes are frequently reported by researchers working with female athletes including iron, zinc, calcium and magnesium.<sup>8,19,26</sup> In particular, research by Nepocatyč et al. found that female basketball and soccer athletes consumed dietary intakes that did not meet dietary reference intakes for iron, magnesium, calcium, vitamin E and potassium at the beginning and end of a competitive season.<sup>26</sup> This study found that athletes' intakes did not meet the RDIs for calcium and iron (Table 1).<sup>14</sup> Similarly, athletes did not meet AGHE serves for milk and alternatives (Table 2). Other research has explored common reasons for low intakes of microminerals in female athletes, suggesting that it may be a result of low energy intakes (i.e. energy restriction) and/or dietary preferences such as vegetarianism.<sup>5</sup> However research by Heaney et al. has suggested that a longer collection period (i.e. >3 days) is required when assessing micronutrient adequacy in athletes, therefore more research is required to assess the micronutrient intake status of AFLW athletes.<sup>27</sup>

In order to support training adaptations and performance, dietary intakes should be tailored to the energy needs of athletes and incorporate proper timing of macronutrients throughout a train-

ing week.<sup>6</sup> When dietary intakes were compared over three days (i.e. main training, light training and recovery days) no significant differences or evidence of energy and macronutrient periodisation was found (Table 3,  $p > 0.05$ ). Our results are consistent with findings from a recent systematic review by Noll et al. which highlighted that adolescent athletes did not adjust their nutrient intake to the demands of differing training sessions and loads.<sup>28</sup> The International Society of Sports Nutrition has highlighted that maintaining a diet that matches the demands of training can decrease the risk of various adverse outcomes including loss of muscle mass, decreased bone mineral density, illness and injury and hormonal fluctuations.<sup>6</sup> Therefore, in order to support athletes optimising training outcomes, sports dietitians should work collaboratively with high performance teams (i.e. sports scientists) when tailoring nutrition advice to meet energy and macronutrient demands.<sup>29</sup> In particular, advice given to athletes regarding carbohydrate intake, should follow the strategy 'Fuelling for the work required' whereby carbohydrate availability is adjusted according to training and performance outputs.<sup>16</sup>

While this study aims to provide the first insight into the dietary intake of professional AFLW athletes, when collecting data on these athletes several limitations must be acknowledged. Firstly, this study only reports the intakes of one professional AFLW team ( $n = 23$ ), therefore this data may not be reflective of the demographics and characteristics of all athletes competing in this sport. Furthermore, the cross-sectional data collection method used, although deemed the most appropriate method with this group, may not provide the level of detail required to assess adequacy of intake. Future research may aim to use a longitudinal method to assess dietary intake and provide a greater insight into the habitual intake of AFLW athletes over the pre and competition seasons.

Studies suggest that females are more likely to underreport, when compared to males, therefore when evaluating the dietary intakes of female athletes the presence of under-reporting was considered.<sup>30</sup> Although 30% of athletes were considered 'under reporters' using the Goldberg equation, inadequate dietary intake observed does align with other published research undertaken with female athletes.<sup>8,9,26</sup> Due that athletes were time poor the decision to use a three day estimated food record using the application Easy Diet Diary (Xyris Software, Australia, 2011) was determined by researchers as the most practical method to collect dietary intake data to promote completion. To improve the quality of dietary assessment in female populations, the inclusion of a variety of methods including food frequency questionnaires and diet histories undertaken with dietitians, may be used in combination with food records, as a supplementary tool to minimise recording errors.<sup>27</sup>

## 5. Conclusion

This was the first study to assess the dietary intakes of professional AFLW athletes and found that the majority of athletes did not meet dietary recommendations for carbohydrate, iron and calcium.<sup>6,14</sup> Currently, due to limited available studies in AFLW and the small sample size of the cohort included, conclusions should be viewed with caution. However, this study may have specific application in the Australian female sport context and highlights the broader need to investigate the factors that affect dietary intake, to support athletes in meeting dietary recommendations required for desired training and performance outcomes.

## Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## Acknowledgements

The authors would like to thank the AFLW club for their participation in the study. The study was designed by SJ and RB. SJ collected and analysed the data. AF and RB assisted with the data interpretation. All authors assisted with manuscript revision and approved the final manuscript. The authors declare no conflicts of interest.

## References

- Clarke AC, Ryan S, Couvalias G et al. Physical demands and technical performance in Australian football league women's (AFLW) competition match-play. *J Sci Med Sport* 2018; 21(7):748–752.
- Jenner SL, Trakman G, Coutts A et al. Dietary intake of professional Australian football athletes surrounding body composition assessment. *J Int Soc Sport Nutr* 2018; 15(1):43.
- Ritchie D, Hopkins WG, Buchheit M et al. Quantification of training and competition load across a season in an elite Australian Football Club. *Int J Sports Physiol Perform* 2016; 11(4):474.
- National Health and Medical Research Council. *Australian guide to healthy eating*, Canberra, NHMRC, 2013.
- Thomas D, Erdman K, Burke L. American college of sports medicine joint position statement. Nutrition and athletic performance. *Med Sci Sport Exerc* 2016; 48(3):543–568.
- Kerksick CM, Wilborn CD, Roberts MD et al. ISSN exercise & sports nutrition review update: research & recommendations. *J Int Soc Sport Nutr* 2018; 15(1):38.
- Escalante G. Nutritional considerations for female athletes. *SCJ* 2016; 38(2):57–63.
- Condo D, Lohman R, Kelly M et al. Nutritional intake, sports nutrition knowledge and energy availability in female Australian Rules Football Players. *Nutrients* 2019; 11(5):971.
- Hassapidou MN, Manstrantoni A. Dietary intakes of elite female athletes in Greece. *J Hum Nutr Diet* 2001; 14(5):391–396.
- Valliant M, Emplainscourt H, Wenzel R et al. Nutrition education by a registered dietitian improves dietary intake and nutrition knowledge of a NCAA female volleyball team. *Nutrients* 2012; 4(6):506–516.
- Wenzel KR, Valliant WM, Chang KY et al. Dietary assessment and education improves body composition and diet in NCAA female volleyball players. *Top Clin Nutr* 2012; 27(1):67–73.
- Anderson ED. The impact of feedback on dietary intake and body composition of college women volleyball players over a competitive season. *J Strength Cond Res* 2010; 24(8):2220–2226.
- Jäger R, Kerksick CM, Campbell BI et al. International society of sports nutrition position stand: protein and exercise. *J Int Soc Sport Nutr* 2017; 14(20):1–25.
- National Health and Medical Research Council. *Nutrient reference values for Australia and New Zealand including recommended dietary intakes*, Canberra, NHMRC, 2006.
- Burke L, Hawley J, Jeukendrup A et al. Toward a common understanding of diet–exercise strategies to manipulate fuel availability for training and competition preparation in endurance sport. *Int J Sport Nutr Exerc* 2018; 28(5):451–463.
- Impey SG, Hammond KM, Shepherd SO et al. Fuel for the work required: a practical approach to amalgamating train-low paradigms for endurance athletes. *Physiol Rep* 2016; 4(10):e12803.
- Black AE. The sensitivity and specificity of the Goldberg cut-off for EI:BMR for identifying diet reports of poor validity. *Eur J Clin Nutr* 2000; 54(5):395.
- Burke LM, Kiens B, Ivy JL. Carbohydrates and fat for training and recovery. *J Sport Sci* 2004; 22(1):15–30.
- Clark M, Reed DB, Crouse SF et al. Pre- and post-season dietary intake, body composition, and performance indices of NCAA division I female soccer players. *Int J Sport Nutr Exerc* 2003; 13(3):303.
- Devlin BL, Leveritt MD, Kingsley M et al. Dietary intake, body composition, and nutrition knowledge of Australian football and soccer players: implications for sports nutrition professionals in practice. *Int J Sport Nutr Exerc* 2016; 27(2):130–138.
- Bilsborough J, Greenway K, Livingston S et al. Changes in anthropometry, upper-body strength, and nutrient intake in professional Australian football players during a season. *Int J Sport Physiol* 2016; 11(3):290–300.
- Vermeulen T. *Seven day dietary intakes of female varsity ice hockey players*. Department of Human Health and Nutritional Sciences. Vol Masters of Science (MSc), Guelph, Ontario, Canada, The University of Guelph, 2017, 87.
- Spendlove J, Heaney S, Gifford J et al. Evaluation of general nutrition knowledge in elite Australian athletes. *Med Sci Sports Exerc* 2011; 43(5):501.
- Spronk I, Heaney SE, Prvan T et al. Relationship between general nutrition knowledge and dietary quality in elite athletes. *Int J Sport Nutr Exerc* 2015; 25(3):243.
- Heaney S, O'Connor H, Michael S et al. Nutrition knowledge in athletes: a systematic review. *Int J Sport Nutr Exerc* 2011; 21(3):248–261.
- Nepocatyč S, Balilionis G, O'Neal EK. Analysis of dietary intake and body composition of female athletes over a competitive season. *MJSSM* 2017; 6(2):57–65.
- Heaney S, O'Connor H, Gifford J et al. Comparison of strategies for assessing nutritional adequacy in elite female athletes' dietary intake. *Int J Sport Nutr Exerc* 2010; 20(3):245–256.

28. Noll M, Mendonça CR, de Souza Rosa LP. Determinants of eating patterns and nutrient intake among adolescent athletes: a systematic review. *Nutr J* 2017; 16(1):46.
29. Jenner SL, Buckley GL, Belski R et al. Dietary intakes of professional and semi-professional team sport athletes do not meet sport nutrition recommendations—a systematic literature review. *Nutrients* 2019; 11(5):1160.
30. García-Rovés P, García-Zapico P, Patterson A et al. Nutrient intake and food habits of soccer players: analyzing the correlates of eating practice. *Nutrients* 2014; 6(7):2697–2717.