



Ecological Validation and Practical Challenges of Conducting Dietary Analysis in Athletic Individuals Using a Novel Remote Food Photography Method Mobile Phone Application

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Abstract

Purpose Dietary analysis is an important part of the sports nutrition practitioners' role, however the ability to accurately collect and analyze dietary intake data is questionable. The remote food photography method (RFPM) has been proposed as a low-burden and potentially valid approach to collecting and interpreting dietary intake data. Preliminary research suggests that this is valid in some athletic populations, however the ecological validation in real-life settings warrants further investigation.

Methods Twenty athletic individuals completed simultaneous three-day RFPM diaries and weighed food diaries for the analysis of energy, protein, carbohydrate, and fat. Participants were required to provide details alongside provided photographs that did not include food weights to allow for the estimation of nutrient intake from minimally invasive photographs and descriptions.

Results RFPM demonstrated non-significant random and systematic error against the weighed food diary for energy, protein, carbohydrate, and fat at -20.0 ± 455.5 kcal, -2.9 ± 34.6 g, -12.4 ± 49.3 g and 2.3 ± 26.8 g, respectively. Coefficient of variation suggest acceptable agreement between RFPM and weighed food diary for energy and poor agreement for protein, carbohydrate, and fat. Considerable variability is observed in the individual calculated values, with the least and greatest difference being 0% and -83.0% , respectively.

Conclusion The results indicate that the RFPM may be an ecologically valid tool for the collection and analysis of dietary intake data on a group level; on an individual basis, data and subsequent recommendations based on this method must be applied with caution.

Keywords Dietary analysis · Remote food photography method · Practical validation · Practical challenges

Introduction

Athletic individuals have unique nutritional demands as consideration must be made not only for maintaining health and nutrient sufficiency, but also to ensure tissue repair, facilitate

adaptation and enhance performance [20]. Whilst recreational athletes can meet requirements for health and training by following national healthy eating guidelines [8], care must still be taken to ensure adequate energy and nutrient consumption. Ensuring athletic individuals follow appropriate dietary patterns to support health, performance and recovery is a crucial role for sports nutrition practitioners; depending on the training volume and level of competition, specific needs may need to be adhered to surrounding training [18]. As such, monitoring of dietary intake in a non-invasive and accurate manner is essential.

Numerous prospective and retrospective methods of dietary analysis are utilised for athletic individuals in sports nutrition research, including weighed and estimated food diaries, dietary recalls, and food frequency questionnaires [6]. Retrospective methods such as the food frequency

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questionnaire, dietary recall and diet history are prone to under-reporting due to participant memory [3]. Prospective methods are also prone to under-reporting due to the burden imposed on the individual; weighing individual food items and writing them down may result in an individual altering food intake to reduce burden or simply neglecting to log [3]. Practitioner variability in the interpretation and delivery of such methods can lead to considerable differences in the final nutrient data output [5].

The methods above are utilised frequently in both practice and sports nutrition research [9, 14], however the applicability in a free-living situation is questionable. For example, an athlete provided with a weighed food diary who eats out at restaurants frequently may not be able to provide accurate information for the determination of nutrient intake of which the remote food photography method (RFPM) has sought to address. Individuals are required to provide images of the food and beverages consumed via various methods such as wearable body cameras [15] or smartphone photographs [7]. When images are provided alongside descriptions of the meals, practitioners may be able to better identify dietary trends and intakes of those in their care. Energy intake measured via the smartphone RFPM was under-reported against doubly labelled water in some [13, 16] but not all [12] validation trials.

As the RFPM only requires access to a camera-embedded smartphone, the user is faced with less burden. Whilst such technologies may be more accessible to the individual whose diet is being monitored [17], the analysis of food images requires the practitioner to estimate portion sizes and/or ingredients in the meal unless weights and household measures are included. Like traditional methods of dietary intake monitoring [5]), such interpretations can be variable amongst practitioners independent of level of experience [19] and may be further influenced by variability in dietary intake, intentional or unintentional under-reporting and reporting fatigue [3].

The aim of the present study was to evaluate the relative validity of analysing energy and macronutrient intake using the RFPM via a free smartphone application in athletic individuals in a free-living environment.

Methods

Participants

Twenty-eight participants expressed interest in taking part in the study. Individuals were recruited if they self-identified as ‘athletic individuals’, defined as engaging in a sport or physical activity ≥ 3 days per week. Individuals expressing interest were invited to a session outlining the requirements

of the study, and to sign informed consent forms if they wished to participate and agreed their data being published. Ethical approval for the study was obtained from the University of Waikato Human Research Ethics Committee (HREC(Health)2020#87).

Study design

Participants were required to log their dietary intake across three days using both a weighed food diary and the RFPM. Initially, participants attended an informed consent session to discuss the requirements of the study. During this session, the lead researcher demonstrated how to record their dietary intake using both methods to ensure appropriate analysis of the information could occur. Participants were advised to log the same items using both methods but to avoid including the weight of foods in the photo logs. If common household measures such as cups or spoons were used, this was deemed acceptable as they would be more practically accessible in a free-living situation than food scales.

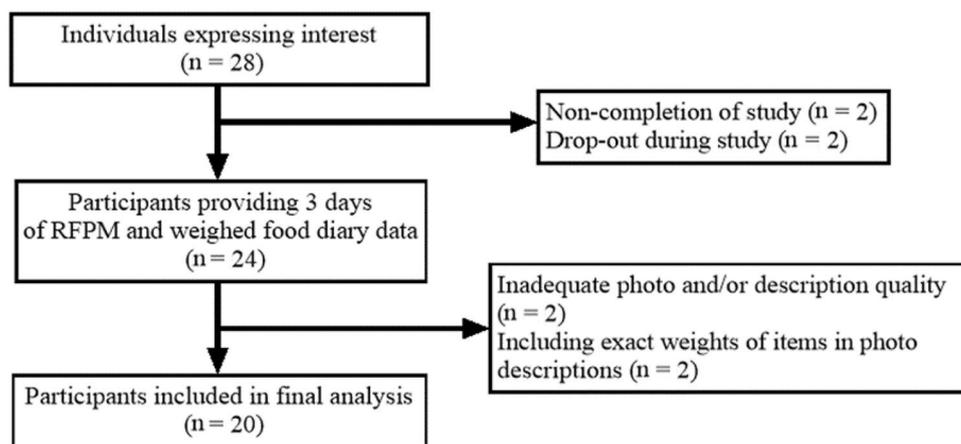
Materials

For the weighed food diaries, participants were provided with household digital scales (Kmart, Melbourne, AU) sensitive to one gram and the capacity to measure fluid volume. A generic template food diary was provided as a hard copy to participants, with additional instructions included to assist with appropriate logging of food and beverage items.

The RFPM was implemented via a smartphone application (MealLogger, Wellness Foundry, Ashburn, VA). MealLogger was chosen as it allows users to upload photographs with descriptions to assist with the identification and analysis of foods or items. Additionally, the application has been identified as a preferred method to traditional dietary analysis methods in athletes [17]. The photographs were uploaded via the application in real-time allowing for the lead researcher to enquire about inadequate photos, however, unclear photos due to complex meals or inadequate descriptions were not enquired about to test the practical validity of the tool. Participants were required to take a clear photo of the entire food item or meal before and after consumption to account for leftovers. Photographs were to be taken from between a 90° and 45° to allow for the judgement of depth of the food. Participants were asked to place either a hand, pen or cutlery next to the food item as a size marker.

Analysis of both the written food diaries and RFPM was conducted using FoodWorks 10 (Version 10.0.4266, Xyris Software, Australia) as it contains a comprehensive database of food items in both Australia and New Zealand. If a food item was not present in FoodWorks, energy and macronutrient information was collected from food labels or the company website. The photographs and diaries were

Fig. 1 Flow of participants. RFPM Remote Food Photography Method



analyzed by the lead researcher, a graduate registrant of the Sport and Exercise Nutrition Register. Analysis of the photographs occurred as they were returned to the lead researcher. Written diaries were returned without names or identifying information attached and were analyzed as a group to ensure blinding of the researcher.

Statistical Analysis

Statistical analyses were conducted on Statistical Packages for Social Sciences (SPSS version 28.0.1.0, IBM Corporation, Chicago, Illinois, USA) and GraphPad Prism (GraphPad Software Inc version 9.2.0, San Diego, CA, USA). Descriptive data are displayed as mean \pm SD. Significance was set at $P < 0.05$. Data were grouped into the average of days logged for each participant. Normality testing were conducted using Shapiro-Wilk tests; all data were normally distributed. The strength of the relationship and proportional bias of energy and macronutrient intake were assessed via Pearson correlations between the mean of both measures with the residuals and absolute residuals of the measures, respectively. Bland-Altman analysis was conducted to measure and visualize the systematic bias between RFPM and weighed food diaries. Mean % difference at both group and individual level and coefficient of variation (CV) were calculated to measure the level of agreement between RFPM and weighed food diaries. CV thresholds were interpreted using thresholds described by Stables et al. [19]: $< 2\%$ (excellent), $< 5\%$ (good), $< 10\%$ (acceptable), $> 10\%$ (poor), and $> 20\%$ (very poor).

Results

Participants

Of the 28 individuals expressing interest, 20 were included in the final analysis (33.0 ± 9.3 years, 173.6 ± 9.8 cm,

76.0 ± 15.0 kg, 30% female). Eighteen participants engaged in recreational resistance and/or endurance training, whilst two engaged in competitive amateur activities (football and cricket). Nineteen participants completed three days of logging that were of an acceptable quality for analysis, with one participant completing two days that were of acceptable quality for analysis. Three participants (15%) had prior experience with using weighed food diaries for monitoring dietary intake. The flow of participants is presented in Fig. 1.

Validation

A strong positive significant relationship between RFPM and weighed food diary was observed for energy ($r = 0.74$, $P < 0.001$), protein ($r = 0.73$, $P < 0.001$), carbohydrate ($r = 0.80$, $P < 0.001$) and fat ($r = 0.66$, $P = 0.001$). Assessment of proportional bias indicated a weak non-significant relationship between RFPM and weighed food diary for energy ($r = 0.43$, $P = 0.062$) and protein ($r = 0.42$, $P = 0.063$); a significant moderate relationship for carbohydrate ($r = 0.58$, $P = 0.007$) and fat ($r = 0.59$, $P = 0.007$) indicates greater heteroscedasticity. Bland-Altman plots for visualisation of the agreement between RFPM and weighed food diaries are presented in Figs. 2, 3, 4 and 5. Systematic and random error were not significantly different for energy (-20.0 ± 455.5 kcal), protein (-2.9 ± 34.6 g), carbohydrate (-12.4 ± 49.3 g) or fat (2.3 ± 26.8 g).

Individual values for analysed nutrients and mean % difference are presented in Table 1. CV suggest acceptable agreement between RFPM and weighed food diary for energy (CV = 9.9%) and poor agreement for protein (CV = 13.1%), carbohydrate (CV = 10.0%) and fat (CV = 14.6%). Mean % difference of the grouped data is acceptable (Table 1), however considerable variability is observed in the individual calculated values, with the least and greatest difference being 0% and -83.0% , respectively.

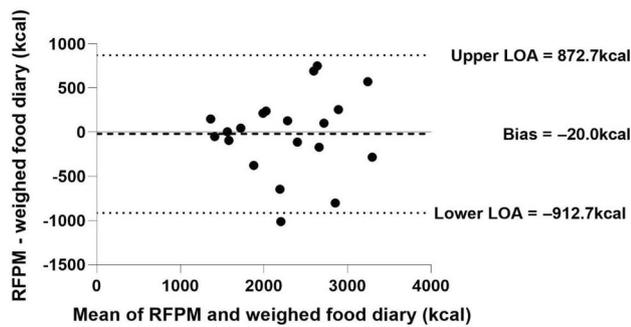


Fig. 2 Bland–Altman plot for energy intake calculated using RFPM and weighed food diary. *RFPM* Remote Food Photography Method, *LOA* limits of agreement

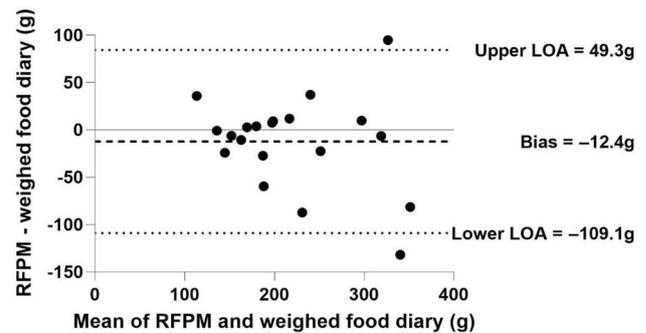


Fig. 4 Bland–Altman plot for carbohydrate intake calculated using RFPM and weighed food diary. *RFPM* Remote Food Photography Method, *LOA* limits of agreement

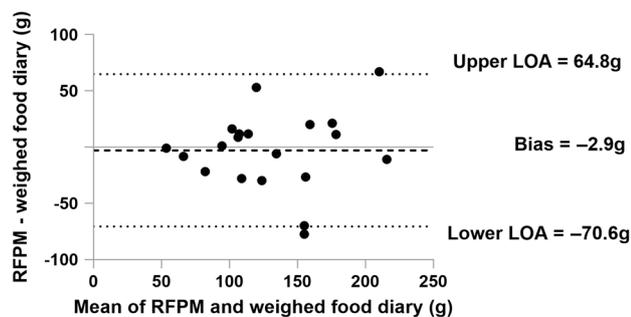


Fig. 3 Bland–Altman plot for protein intake calculated using RFPM and weighed food diary. *RFPM* Remote Food Photography Method, *LOA* limits of agreement

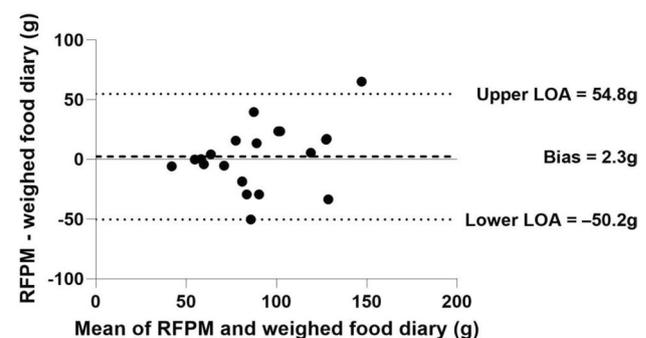


Fig. 5 Bland–Altman plot for fat intake calculated using RFPM and weighed food diary. *RFPM* Remote Food Photography Method, *LOA* limits of agreement

Discussion

The purpose of the present study was to examine the ecological validity of the RFPM to measure energy and macronutrient intake in free-living athletic individuals against a weighed food diary. Upon initial interpretation, agreement represented by low levels of bias warrants the practical use of the RFPM for the measurement of energy and macronutrients at a group level; however proportional bias, large limits of agreement and poor *CV* ($> 10\%$) indicates that macronutrient values are not valid on an individual level and caution should be applied when interpreting results. Furthermore, observation of individual mean % difference between RFPM and weighed food diaries for energy and macronutrient intake suggest under-estimation and over-estimation in individuals.

A strong positive relationship was observed for energy and macronutrient intake, however proportional bias analysis, observation of the individual datapoints, mean % difference and visualisation of Bland-Altman plots suggests considerable inter-individual variability in the estimation of nutrient intake. Such a finding is interesting as Pearson

correlation should demonstrate the strength of the relationship at the individual level [11], which occurs when corrected for absolute residuals to assess proportional bias. The energy and macronutrient intake demonstrates larger differences at greater intakes, which have also been reported when using the adapted 24-hour recall method for energy and macronutrient intake [1], protein intake [21], and food frequency questionnaire for antioxidant intake [4]. A possible explanation for this finding could be that as greater food and beverage intakes are analysed, the potential for errors in the analysis increases. Practitioners must consider these differences as athletes are likely to require elevated energy requirements and thus, food intake due to training and competition volume and intensity [20].

Individual agreement between RFPM and weighed food diary was acceptable for energy but poor for macronutrient intake as interpreted by *CV* values. Similar to the studies demonstrating proportional bias between dietary assessment methods in athletes [2, 4, 21], agreement was deemed weaker than overall group validity. Such an observation in the present data was expected due to the considerable

Table 1 Individual participant's estimated energy and macronutrient intake between RFPM and weighed food diary with % difference between methods

Participant	Energy (kcal)				Protein (g)				Carbohydrate (g)				Fat (g)			
	RFPM	WFD	$\Delta\%$	CV	RFPM	WFD	$\Delta\%$	CV	RFPM	WFD	$\Delta\%$	CV	RFPM	WFD	$\Delta\%$	CV
1	1437	1289	10.3	7.7	95.0	94.0	1.1	0.7	131.3	95.7	27.2	22.2	54.7	55.0	-0.6	0.4
2	1533	1627	-6.1	4.2	71.3	93.0	-30.4	18.6	170.7	168.0	1.6	1.1	58.3	58.3	0.0	0.0
3	2143	1906	11.1	8.3	146.3	93.3	36.2	31.3	222.7	211.0	5.2	3.8	68.3	73.7	-7.8	5.3
4	3155	3438	-9.0	6.1	142.7	169.3	-18.7	12.1	310.7	392.3	-26.3	16.4	136.3	119.3	12.5	9.4
5	3015	2263	24.9	20.1	243.7	176.7	27.5	22.5	258.7	221.7	14.3	10.9	107.3	67.7	37.0	32.1
6	1696	2709	-59.7	32.5	116.3	193.7	-66.5	35.3	158.3	218.0	-37.7	22.4	60.7	111.0	-83.0	41.5
7	1746	1700	2.6	1.9	113.0	101.3	10.4	7.7	149.0	155.3	-4.3	2.9	65.7	61.7	6.1	4.4
8	2344	2458	-4.8	3.3	131.5	137.5	-4.6	3.2	173.5	201.0	-15.9	10.4	112.0	145.5	-29.9	18.4
9	1566	1561	0.3	0.2	62.0	70.3	-13.4	8.9	132.7	157.0	-18.3	11.9	85.3	69.7	18.4	14.3
10	2576	2747	-6.6	4.5	184.0	172.7	6.1	4.5	302.0	292.3	3.2	2.3	69.0	98.3	-42.5	24.8
11	1869	2514	-34.6	20.8	95.0	123.0	-29.5	18.2	187.3	274.7	-46.6	26.7	71.7	90.3	-26.0	16.3
12	1387	1438	-3.7	2.5	53.0	54.0	-1.9	1.3	201.0	193.7	3.6	2.6	39.0	45.0	-15.4	10.1
13	3528	2956	16.2	12.5	210.3	221.3	-5.2	3.6	374.0	279.3	25.3	20.5	112.7	89.3	20.7	16.3
14	2942	2249	23.6	18.9	186.3	165.0	11.4	8.6	135.3	136.3	-0.7	0.5	179.7	114.7	36.2	31.2
15	2095	1882	10.2	7.6	110.0	93.7	14.8	11.3	203.0	194.0	4.4	3.2	95.7	82.3	13.9	10.6
16	3020	2765	8.4	6.2	169.3	149.3	11.8	8.9	315.7	322.3	-2.1	1.5	113.7	90.3	20.5	16.2
17	2455	3255	-32.6	19.8	109.0	138.7	-27.2	17.0	274.3	406.3	-48.1	27.4	75.7	105.0	-38.8	23.0
18	1690	2068	-22.3	14.2	120.0	190.0	-58.3	31.9	157.7	168.3	-6.8	4.6	57.7	62.0	-7.5	5.1
19	2768	2668	3.6	2.6	110.7	102.0	7.8	5.8	240.0	262.7	-9.4	6.4	135.7	119.3	12.0	9.1
20	2346	2219	5.4	3.9	119.7	108.0	9.7	7.3	181.7	178.0	2.0	1.4	121.7	116.3	4.4	3.2
Mean	2266	2286	-3.1	9.9	129.5	132.3	-5.9	12.9	214.0	226.4	-6.5	10.0	91.0	88.7	-3.5	14.6
SD	648	604	20.8	8.5	49.1	45.9	26.3	10.4	70.8	81.8	20.7	9.3	35.5	27.0	29.3	14.1

RFPM Remote Food Photography Method, WFD weighed food diary, Δ difference, CV coefficient of variation, SD standard deviation

variability in individual differences in nutrient intake between methods; the difference in fat intake was 0% for one individual and -89% for another, whilst overall mean % difference for fat intake was -3.5%. This highlights potential issues with presenting only mean values in both applied sport and exercise research and practical settings; large inter-individual variability may negatively influence the interpretation of results and thus the quality of information and service provided based on said values.

Whilst the results of the present validation study indicate the RFPM may be a valid tool for analysing energy and macronutrient intake on a population level in athletic individuals, several limitations have been identified. The current analysis was conducted in athletic individuals, and therefore the results may not be translated to trained competitive athletes. On a population level the RFPM may be a valid tool for analysing nutrient intake, such as within a team or group, however the individual data indicates RFPM is prone to both under-estimating and over-estimating energy and macronutrient intake when compared to a weighed food diary. As such, practitioners delivering specific nutrition advice and recommendations based on monitoring of dietary intake using RFPM must remain

cautious. Combining elements of both a weighed food diary and RFPM may be beneficial to reduce measurement errors. Additionally, we were unable to detect true reporting bias as both methods are self-reported. Accessibility, acceptability, and cost mean the application of additional biomarker methods such as DLW is often unfeasible and thus, the data collected using self-reported dietary analysis methods may not reflect true nutrient intake.

A major limitation in the analysis of dietary intake is the presence of inter-individual variability between practitioners during the food diary analysis process. In the present study, a single trained sports nutritionist interpreted both the RFPM and weighed food diaries. Previous studies have identified variability between practitioners when coding both weighed food diaries [5] and food photographs [19] provided by athletes.

Future research should aim to assess the validity of practical dietary analysis methods such as the RFPM against biological markers such as DLW. Furthermore, validity should be assessed in trained athletic populations and the degree to which individual data influences population data in teams and groups of variable sizes and disciplines quantified to further ensure ecological validity of dietary analysis methods.

Conclusion

The present study demonstrated that the RFPM using a mobile phone application to record both photographs and descriptions of food, meals and beverages is a valid tool for analysing energy and macronutrient intake in athletic individuals at the group level. For individuals, considerable variability is apparent and therefore, it may not be appropriate for practitioners to prescribe detailed recommendations and feedback based on the data collected from such tools.

Practical recommendations

Several observations were made during data collection which may explain the variability between RFPM and weighed food diary measurements in some participants. These observations should be considered by both practitioners and researchers when seeking to collect and interpret dietary analysis data.

- Limited participants included fine details when recording their dietary intake. Important details were often missed, such as not including whether oil was used for cooking, not being descriptive about the cut and/or leanness of meat and not including the type of milk used [10]. In the FoodWorks software used to analyze dietary intake in the present study, meat has different options (rump steak, trimmed, semi trimmed or not trimmed) which can confound the nutrient analysis if details are not included (SI1). Whilst it did not negatively influence the validity analysis, this would be detrimental for practitioners or researchers aiming to accurately understand an individuals' dietary intake or eating patterns.
- Variability in the details added to the description indicates that whilst the use of food photographs may reduce burden for some individuals, following-up with those who do not provide adequate complementary details may increase the burden and increase non-compliance (SI3).
- Individuals not including brands in the description alongside photographs or when completing food diaries may confound the true nutrient intake as the nutrient content of items can be variable between brands. Furthermore, the interpretation of a 'serving' in dietary analysis software may be different to that of a brand. This can be problematic as the nutrient content information may be variable.
- Athletes may eat out at restaurants and cafes, may visit establishments where accurate logging of food intake

is impractical, such as when visiting the cinema, and are likely to purchase pre-made food items (wraps and sandwiches) that cannot be adequately logged without disassembly. Using either weighed food diaries or food photographs can be impractical in these situations. Furthermore, when meals are prepared at home, care must be taken to present the food or meals such that analysis can occur if the individuals' dietary intake is being monitored (SI4).

- As above, situations where individuals eat out may be impractical for taking clear photographs. This may also apply to other scenarios, such as during the preparation of complex meals whereby the volume of individual items cannot be accurately estimated as they are hidden, such as meat and vegetables in a curry or stir-fry.
- Many foods may not be present in the dietary analysis database and appropriate nutrition information may be absent online. In such situations, estimation of the nutrient content is likely warranted but threatens the accuracy of the information provided. Additionally, food purchased from a takeaway, such as a curry, presents a multi-faceted problem as this may not be present in food databases and is a complex meal resulting in difficulty determining the contents of the meal.
- The presentation of food can result in imprecise interpretation of the nutrient content. If the meal is presented in a bowl or as stir-fry it can be difficult to determine the amounts of individual ingredients using photos if a detailed description is not added (SI2).
- Individuals may not prepare food for themselves. This is common in young athletes who still live with parents or caregivers who purchase and prepare the foods and meals consumed by the athlete. This may confound dietary analysis as inadequate presentation of the foods and/or meals, others preparing meals for multiple people or others misremembering or not considering the portion sizes, cooking methods and other fine details of the food preparation process can influence the information the athlete ultimately provides the practitioner.
- Similarly, athletes may be in a situation where they are cooking for family or friends. This would likely make logging impractical, particularly if a complex meal is being prepared and requires multiple photographs.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s42978-022-00213-w>.

Author Contributions CR, SS and NG contributed to the study conception and design. Material preparation and data collection were performed by CR. Data analysis were performed by CR and BB. The first draft of the manuscript was written by CR and all authors commented on the manuscript prior to completion. All authors read and approved the final manuscript.

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Data Availability The datasets generated and/or analysed during the current study are available at: [10.24339/66b623b4-8b01-4698-ba06-7324dcfad73e](https://doi.org/10.24339/66b623b4-8b01-4698-ba06-7324dcfad73e).

Declarations

Conflict of Interest The authors have no relevant financial or non-financial interests to disclose.

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References

- Baker LB, Heaton LE, Nuccio RP, Stein KW. Dietitian-observed macronutrient intakes of young skill and team-sport athletes: adequacy of pre, during, and postexercise nutrition. *Int J Sport Nutr Exercise Metab.* 2014;24(2):166–76.
- Baker LB, Heaton LE, Stein KW, Nuccio RP, Jeukendrup AE. Validity and relative validity of a novel digital approach for 24-h dietary recall in athletes. *Nutr J.* 2014;13(1):41.
- Black AE. Dietary assessment for sports dietetics. *Nutr Bull.* 2001. <https://doi.org/10.1046/j.1467-3010.2001.00096.x>.
- Braakhuis AJ, Hopkins WG, Lowe TE, Rush EC. Development and validation of a food-frequency questionnaire to assess short-term antioxidant intake in athletes. *Int J Sport Nutr Exercise Metab.* 2011;21(2):105–12.
- Braakhuis AJ, Meredith K, Cox GR, Hopkins WG, Burke LM. Variability in estimation of self-reported dietary intake data from elite athletes resulting from coding by different sports dietitians. *Int J Sport Nutr Exercise Metab.* 2003;13(2):152–65.
- Capling L, Beck KL, Gifford JA, Slater G, Flood VM, O'Connor H. Validity of dietary assessment in athletes: a systematic review. *Nutrients.* 2017;9(12):1313.
- Costello N, Deighton K, Dyson J, Mckenna J, Jones B. Snap-N-Send: a valid and reliable method for assessing the energy intake of elite adolescent athletes. *Eur J Sport Sci.* 2017;17(8):1044–55.
- Desbrow B, Slater G, Cox GR. Sports nutrition for the recreational athlete. *Austr J Gen Pract.* 2020;49(1–2):17–22.
- Jenner SL, Buckley GL, Belski R, Devlin BL, Forsyth AK. 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.
- Ji Y, Plourde H, Bouzo V, Kilgour RD, Cohen TR. Validity and usability of a smartphone image-based dietary assessment app compared to 3-day food diaries in assessing dietary intake among Canadian adults: randomized controlled trial. *JMIR mHealth and uHealth.* 2020. <https://doi.org/10.2196/16953>.
- Lombard MJ, Steyn NP, Charlton KE, Senekal M. Application and interpretation of multiple statistical tests to evaluate validity of dietary intake assessment methods. *Nutr J.* 2015;14(1):40.
- Martin CK, Correa JB, Han H, Allen HR, Rood JC, Champagne CM, Gunturk BK, Bray GA. Validity of the remote food photography method (RFPM) for estimating energy and nutrient intake in near real-time. *Obesity.* 2012;20(4):891–9.
- Most J, Vallo PM, Altazan AD, Gilmore LA, Sutton EF, Cain LE, Burton JH, Martin CK, Redman LM. Food photography is not an accurate measure of energy intake in obese, pregnant women. *J Nutr.* 2018;148(4):658–63.
- Noll M, de Mendonça CR, de Souza Rosa LP, Silveira EA. Determinants of eating patterns and nutrient intake among adolescent athletes: a systematic review. *Nutr J.* 2017;16(1):46.
- O'Loughlin G, Cullen SJ, McGoldrick A, O'Connor S, Blain R, O'Malley S, Warrington GD. Using a wearable camera to increase the accuracy of dietary analysis. *Am J Preventive Med.* 2013;44(3):297–301.
- Rollo ME, Ash S, Lyons-Wall P, Russell AW. Evaluation of a mobile phone image-based dietary assessment method in adults with type 2 diabetes. *Nutrients.* 2015;7(6):4897–910.
- Simpson A, Gemming L, Baker D, Braakhuis A. Do image-assisted mobile applications improve dietary habits, knowledge, and behaviours in elite athletes? A pilot study. *Sports.* 2017;5(3):60.
- Spriet LL. Performance nutrition for athletes. *Sports Med.* 2019;49:1–2.
- Stables RG, Kasper AM, Andy Sparks S, Morton JP, Close GL. An assessment of the validity of the remote food photography method (termed snap-N-send) in experienced and inexperienced sport nutritionists. *Int J Sport Nutr Exercise Metab.* 2021;31(2):125–34.
- Thomas DT, Erdman KA, Burke LM. American College of Sports Medicine Joint position Statement. Nutrition and athletic performance. *Med Sci Sports Exerc.* 2016;48(3):543–68.
- Wardenaar FC, Steennis J, Ceelen IJM, Mensink M, Witkamp R, de Vries JHM. Validation of web-based, multiple 24-h recalls combined with nutritional supplement intake questionnaires against nitrogen excretions to determine protein intake in dutch elite athletes. *Br J Nutr.* 2015;114(12):2083–92.