Electronic food records among middle-aged and older people: A comparison of self-reported and dietitian-assisted information.

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Aim

Nutrition-based applications (“apps”) offer enormous research potential, however evidence of their use and acceptability among older adults is limited. We compared self-reported and dietitian-adjusted dietary intake records among adults 55-75 years using the *Research Food Diary* (RFD) app.

Methods

Participants were recruited from the 45 and Up Study and completed a 3-day food record using the RFD. A follow-up dietetic phone interview was performed to confirm the electronic dietary data. Independent of these interviews, a set of adjustments based on dietetic skills, nutritional database knowledge, food composition and dietary assessment was established to resolve probable reporting errors. The “adjusted” and “dietitian-assisted” records were compared to self-reported records for nutrient intakes and serves of The Five Food Groups using one-way repeated measures analysis of variance.

Results

Sixty-two participants were recruited, with 48 using the RFD app which included eight records without any identified errors. Reporting errors contained in the raw self-reported records included: food items with missing/improbable quantities or insufficient descriptions to allow automatic coding. After removal of unusable records, 44 records

were analysed. Differences were found between the self-reported and adjusted records for protein, calcium, vitamin B₁₂, zinc and dairy food serves (all $P < 0.001$; differences up to 8%). No significant differences were found between the adjusted and dietitian-assisted measures.

Conclusions

Similarities between adjusted and dietitian-assisted records suggest carefully applied dietetic assumptions are likely to improve accuracy of self-reported intake data where dietitian interviews are not possible. We provide four key recommendations to guide this process.

Keywords: Mobile applications, Nutrition assessment, Smartphone, Diet Record

Introduction

The popularity of smartphone and tablet devices, and innovation in dietary intake assessment, has resulted in the evolution of conventional methods.¹⁻⁴ Approximately 89% of surveyed Australians owned a smartphone in 2018,⁵ with smart phones used by 91% of internet connected households.⁶ Recording electronically, such as via phone apps, can reduce both participant and researcher burden allowing timelier approaches through automatic and standardised coding.^{4, 7-9}

Three smartphone dietary recording apps (electronic Dietary Intake Assessment (e-DIA), Easy Diet Diary and FoodNow) have been validated for the Australian setting, but all

have been in younger adults¹⁰⁻¹³ or pregnant women.¹⁴ The e-DIA app validated in university students found no differences between 24-hr recalls for mean intakes of energy, nutrients¹¹ or food groups.¹⁰ The Easy Diet diary app compared 24-hr recalls in participants (mean age 31 years) and found a mean difference of 268 kJ/d between methods with similar misreporting.¹² The FoodNow meal app was validated against temperature monitoring with high correlations between estimated energy intake and measured energy expenditure.¹³

There is little research in older adults, where computer-literacy and acceptability of new methods may be lower. One study, assessed app use in Spanish adults (mean age 52 years) and found significant correlations with energy and macronutrient intakes compared to a food frequency questionnaire.¹⁵ With Australia's ageing population¹⁶ it is important that technology-based methods are cost-effective, user friendly and appropriate to improve accuracy of research data to inform guidelines and public health policy. To our knowledge, there is no published data of food record apps use among middle-aged and older adults in Australia.

The aims of this study were to a) explore the data quality from self-reported food diaries in adults using the validated RFD app b) assess differences when dietetic data cleaning skills and a follow-up dietetic interview were undertaken.

Methods

This study was part of a validation study¹⁷ for the '*Maintain Your Brain*' (MYB) randomised controlled trial.¹⁸ Participants were recruited from the Sax Institute's 45 and Up Study, a cohort study of 267,153 participants based in NSW, Australia recruited from the Department of Human Services (DHS) enrolment database.¹⁹ Email invitations were sent by The Sax Institute to a random sample (n=603); 175 participants elected to participate; 93 participants were eligible. Inclusion criteria were participants aged 55-75 years at baseline, English-literate, without neurological disease, living within 30 km of the research clinic and with iPad or iPhone access. Participants were excluded if they had serious psychiatric or unstable medical conditions. Ethical approval was granted by the University of New South Wales Human Research Ethics Committee (#16252) and NSW Population and Health Services Ethics Committee (#2016/03/636); conduct for the 45 and Up Study was approved by University of New South Wales Human Research Ethics Committee (HREC 05035/HREC 10186).

The RFD app is the research equivalent to the Easy Diet Diary app developed by Xyris Software Pty Ltd²⁰ (Supplementary figures 2-3), validated against two 24-hr recalls providing valid nutrient group level estimates.¹² The app enables recording of foods consumed by searching the food database or scanning food label barcodes. It uses the AUSNUT2011-13 database, Food Standards Australia New Zealand, and AusFoods2015 and AusBrands2015, consumer friendly description databases mapping to AUSNUT2011-13.

Participants were given a detailed instruction manual to download the app and record food intake over 3 days (including one weekend day, within one week). Instructions included how to: enter items, add new foods and create new recipes, with supporting screenshots, video links and general tips relating to logging of intake. Participants then emailed their raw self-reported RFDs to the research dietitian, which were imported into FoodWorks Professional analysis software (version 8.0.3553, Xyris Software Pty Ltd, Australia). The dietitian telephoned each participant within 24–48 hours to query unusual quantities and confirm completeness using a checklist for potentially forgotten foods, based on principles from the ASA24 Automated Self-Administered 24-hour Dietary Assessment Tool.^{17, 21-23} This information was added to the participant's raw RFD producing a new dietitian-assisted version of their RFD. Hence, the dietitian-assisted records are the only records with omitted foods added. Brief qualitative questions regarding recording of intake and usability of the app were gathered.

All raw self-reported RFDs were manually and independently assessed for errors by a second researcher blinded to the dietitian-assisted RFD. Data cleaning procedures for the raw self-reported RFD were applied including removing food items with missing quantities, or food items unable to be coded automatically due to incomplete descriptions. This process generated the self-reported RFD. No further additions, assumptions or edits were made to these records to ensure records were representative of intake entered by participants and automatically coded for, without further researcher input. As such, these self-reported records are not strictly raw data.

All reporting errors occurring within raw self-reported RFD were categorised (Table 1). These included failure to enter complete details for food items; missing or implausible quantities; discrepancies between food weight and nutritional values for ‘new foods’ created by participants or from scanned items; and when recipes required conversion from grams to percent of total recipe consumed.²⁴ Further data cleaning was applied to raw RFDs that included recipes. Lack of compatibility between some participant entered recipes stored in the app and analysis of recipes within FoodWorks meant these recipes required manual re-entering into a recipe format within FoodWorks.

1.

Participants with implausible energy intakes were identified based on reported daily energy intake (kJ) $SD \pm 1.0$.²⁵ A Goldberg cut-off of 0.9 was used to identify low-energy reporters and a sensitivity analysis undertaken for macro- and micro-nutrients including and excluding low energy reporters. The following records for each participant were then available:

1. raw self-reported RFD,
2. self-reported RFD (outliers excluded, minimally cleaned, no adjustments)
3. adjusted RFD (reporting errors resolved after dietetic data cleaning)
4. dietitian-assisted RFD (record updated after participant interview with research dietitian)

One-way repeated measure analysis of variance (ANOVA) and Bonferroni post hoc tests were used to compare nutrient intakes, serves of Five Food Groups and discretionary foods/nutrients available in FoodWorks²⁰ between the three RFDs (“self-reported” RFD, “adjusted” RFD and “dietitian-assisted” RFD) but not the raw self-reported RFD.

Statistical Package for the Social Science (SPSS) software (version 24 2016, International Business Machines (IBM) Corporation, New York) was used to conduct the analyses.

This study was reported in a manner that is compliant with the Guidelines for Reporting Reliability and Agreement Studies (GRRAS).²⁶

Results

Sixty-two participants completed the 3-day food record (Supplementary Figure).

Fourteen participants declined to use the RFD app, opting to complete their food records using pen and paper and were excluded. Hence 48 participants (33 females, 15 males, mean age 64 ($\pm$ 5.5) years) were included. Sixteen of these 48 participants did not record their food intake in “real time” but used written notes to assist logging onto the app or recalled meals at the end of the day.

Eight of 48 (17%) participants submitted RFDs without any identified errors and that allowed automatic coding i.e. no incomplete, incorrect values or recipe errors (Table 1).

Most frequent errors were reported for discretionary foods (n=32), followed by vegetables (n=22), grains (n=19), milk (n=16), fruit (n=9) and meat (n=8). Day 1 had more errors (n=45), compared to the second (n=29) and third days diary (n=32). Four RFDs were identified as over-reporters with extreme estimated energy intakes of 48,728kJ, 44,137kJ, 49,004kJ and 119,846kJ reflecting implausible quantities of foods, such as 300 takeaway coffees, 120 pieces of fruit, 250 cups of fresh fruit and 4000% of a roast lamb recipe. Forty-four participant RFDs were then available for final analysis and comparison after excluding these 4 over-reporters. Table 2 describes the estimated macro- and micronutrients from the three RFD types (self-reported, adjusted and dietitian-assisted).

The mean energy intake of the self-reported RFD was non-significantly lower, compared to the adjusted or dietitian-assisted RFD. Estimated protein intake was 8% lower ($p<0.001$) and saturated fat 6-7.5% lower ($p<0.01$) in the self-reported RFD compared to the adjusted and dietitian-assisted RFD. No differences were found between the adjusted and dietitian-assisted RFDs. Other macronutrients were similar across the three record types.

Ten micronutrients were lower in self-reported RFDs compared to the adjusted and dietitian-assisted RFDs ($p<0.05$) (Table 2). There were no significant differences between the adjusted and dietitian-assisted RFDs for micronutrient intake.

After additional removal of two (0.05%) low energy reporters (Supplementary table), two nutrients (calcium and iron) were no longer different between the raw and adjusted or dietitian assisted data. All other nutrients remained significant. There were no differences between the adjusted and dietitian assisted versions of the RFDs.

Mean daily serves of the Five Food Groups (Figure 1) were similar for fruits and vegetables across all RFD. Significant differences were found for grains and cereals, meats and alternatives and dairy foods ($P<0.05$), with self-reported estimates lower compared to adjusted and/or dietitian-assisted records.

For discretionary foods (Table 3), an overall difference was found for refined grains and added sugars between the three diaries, however, post hoc tests found only added sugar was lower in self-reported compared to adjusted RFD ($P=0.008$), with self-reported added sugars estimates half a teaspoon lower than adjusted RFD estimates.

Table 4 shows study recommendations for using app data.

Discussion

To our knowledge, this is the first study to explore the use of an Australian-based commercial app to collect self-reported dietary data in older Australian adults and although not a validation study, provides insight into common reporting errors. Only eight out of 62 participants submitted a complete RFD that allowed automatic coding.

Day one recordings had the highest number of reporting errors. We found similar mean daily macronutrient estimates between the three versions of RFD (self-reported, adjusted and dietitian-assisted) except for protein and saturated fat. Larger differences were found for micronutrient intakes. Estimates of serves were similar for fruits and vegetables, but lower for other food groups in the self-reported compared to the adjusted and/or dietitian-assisted RFD. The only discretionary food different between the three types of RFD was added sugar, which was lower in the self-reported versus the adjusted but not different to the dietitian-assisted RFD. No significant differences were found between the adjusted and dietitian-assisted RFD for nutrients or food groups. These results suggest that recording intake via an app, when combined with careful dietetic data cleaning procedures using app and food intake knowledge and training as well as appropriate population data, can potentially provide dietary data comparable to that from dietitian-assisted electronic food records. These data-cleaning procedures require skilled application and are labour intensive but raw self-reported data from apps should not be used as the sole basis of determining dietary intake.

Once dietetic data cleaning was applied, similarities in the reported nutrients (energy and most macronutrients) from the three versions of the RFD suggest the app may be useful for monitoring diet at a group level. Recording using the Tap & Track app²⁷ found energy and macronutrients were comparable to a dietitian-coded diet record and suitable for group intake estimates. The My Meal Mate app, was found suitable for estimating group means for carbohydrate, fat and protein.²⁸ Validity studies examining mobile apps

to assess dietary intake found the apps comparable to conventional methods, although wide limits of agreement were reported^{8, 11, 27, 28} indicating large variability in intakes when recording electronically. Our results of mean intakes of raw self-reported RFD (n=48) are similar, with extremely large standard deviations suggesting that self-reported app dietary data, without adequate dietetic cleaning are unsuitable for individual, or even group level, dietary intake estimates.

Other studies show underestimation of intake. A US study found five apps all underestimated between one and six nutrients.²⁹ Studies assessing MyFitnessPal showed underestimation with increasing intake, except for carbohydrates and lipids³⁰ and underestimation of all macronutrients, including energy with 18% of food items omitted, especially energy-dense, nutrient-poor foods.²¹ Consistent with this, we found estimates of protein and saturated fat were lower in the self-reported compared to both the adjusted and dietitian-assisted RFDs. Differences in nutrient estimates may be due to the accuracy of food records generally, with omission of energy-dense and nutrient-poor foods²¹ as well as participant's ability to accurately estimate portion sizes.^{21, 27} Portion estimation is a limitation of self-reported records, with mixed dishes particularly difficult to estimate.³¹ Participants generally report discretionary foods in smaller portions or less frequently,²¹ whilst fruits and vegetables may be overestimated^{22, 32} due to social desirability.^{11, 33} We found two participants classified as low energy reporters but when these participants were excluded there was little change in results.

Mean daily intakes of 10 of 17 micronutrients were lower in the self-reported RFD compared to the adjusted and/or dietitian-assisted RFD. The e-DIA app also underestimated seven of 14 micronutrients¹¹ and a web-based food record⁹ found under-reporting of 21 from 22 micronutrients on day one, and 18 of 22 on day two, suggesting increased proficiency with use, however still underestimation of micronutrient intake.⁹ This underestimation is likely due to the increased variety of foods captured in an interviewer led dietary recall.^{9, 11}

Previous validation of the RFD app found poor agreement with two 24-hr recalls for added sugars, with increasing values as sugar intake rose.¹² We found added sugars estimates were lower in self-reported compared to adjusted records. Other studies have similarly found electronic records underestimate sugar intake.^{9, 11} However, there were no significant differences between the adjusted and the dietitian-assisted RFD.

The reporting of food groups was determined by the Xyris software system, and does not fully reflect Australian Dietary Guidelines food groups.³⁴ In the Xyris system, composite foods are divided into constituent ingredients and assigned to 'groups'.²⁰ This restricted the analysis of discretionary foods, which were expressed as oil equivalents, solid fat equivalents, added sugars and alcohol. As both oil equivalents and solid fat equivalents included ingredients and nutrients naturally occurring in the Five Food Groups' (such as nuts, seeds, seafood, dairy, meat, poultry, eggs) we only examined discretionary food intake for refined grains, added sugars and alcohol intake. As there are no analytical

methods to distinguish between sugar added to foods by manufacturers and sugars inherent in foods,³⁵ all determinations of added sugars are estimates only. Therefore, reporting these food components as a representation of discretionary food intake does not truly reflect actual intake and requires further examination.

The feasibility of the RFD app for research and clinical use shows promise, once dietetic data cleaning assumptions or dietitian follow-up is provided. This app has been validated against 24-hr recalls among participants with an average age of 31 years.¹² In our older participants, only eight of 62 participants submitted a complete RFD, and the first recording day had the highest number of errors. Providing a trial period or discarding the first day's record may reduce reporting errors. Validation in older age groups is needed since smartphone ownership and technological literacy may be lower than younger populations. Participant usability of the RFD app found that one in five participants preferred recording their intake using conventional pen and paper, and one third still recorded using pen and paper before entering food items into the app at a later time.

Our findings led to the development of recommendations for participants, researchers and software designers (Table 4). Integration of these features into app software and study designs may improve the precision of participants recording.

Dietitians regularly use apps³⁶ which may enhance dietetic nutrition care.³⁷ Education and training are required to increase self-efficacy³⁸ and for effective implementation.^{36, 39}

Being aware of likely app recording errors and applying data cleaning approaches outlined in this study may improve the plausibility and usability of data.

Limitations

This study was not a validation study. Other limitations include the inherent bias associated with self-reported dietary assessments. Both random and systematic measurement errors reduce accuracy of 'usual' intake²⁷ and data should be interpreted with caution.^{8, 28} Sixteen of 48 participants completed written food diaries and subsequent app recording, and the accuracy of reported intakes may be limited by potential recall bias depending on the accuracy of their written records. The small sample size may have attenuated true similarities and differences between the three versions of RFD. This study was performed among well-educated older Australians using the Australian RFD app including Australian databases, hence findings are not generalizable. Discrepancies in AusBrands databases used by the app and the analytical software required additional coding when RFDs were imported into the professional software and reduced the capacity for the app to accurately capture dietary intake of participants without additional dietetic evaluation and input.

Conclusion

The use of apps within dietetic research and clinical care offers enormous potential. However, ongoing investigation into the sources of error that may bias results is essential to improve the accuracy and validity of self-reported approaches. This study

demonstrated that careful dietetic data cleaning assumptions are paramount to nutritional research. We have provided four key recommendations to guide this process, however, specific dietetic knowledge and training will be required. Based on our findings, raw data from app technology should not be used to determine dietary intake without further data cleaning or dietetic review. The study also showed that it is important to integrate the key attributes offered by electronic dietary methodology with preferences of the target population. Further research, validation studies and development of mobile apps for an older demographic are required to facilitate nutrition research into healthy ageing.

Authorship

VF designed the study with assistance from FO, SR, MFS and RL. RL, SR, VF and FO performed data analysis and interpretation and were the main contributors to drafting and editing the manuscript with assistance from MFS. MFS, YN, KD, assisted with recruitment of participants and data collection. All authors, except RL, provided input into the design of the larger study of which this is a part. All authors approved the final manuscript. The manuscript has not been published elsewhere.

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Ethical approval was granted by the University of New South Wales Human Research Ethics Committee (#16252) and NSW Population and Health Services Ethics Committee (#2016/03/636); conduct for the 45 and Up Study was approved by University of New South Wales Human Research Ethics Committee (HREC 05035/HREC 10186).

Conflicts of Interest

HB sits on the Advisory Board for Nutricia Australia. KD is a recipient of extra virgin olive oil supplied in kind by Cobram Estate Pty Ltd. No other authors declare any conflict of interest. Xyris Software (Australia) Pty Ltd was not involved in the study design, data analysis, interpretation or writing of this manuscript.

REFERENCES

- 1 Eldridge AL, Piernas C, Illner AK, *et al.* Evaluation of New Technology-Based Tools for Dietary Intake Assessment-An ILSI Europe Dietary Intake and Exposure Task Force Evaluation. *Nutrients*. 2018; **11**.
- 2 Amoutzopoulos B, Steer T, Roberts C, *et al.* Traditional methods v. new technologies - dilemmas for dietary assessment in large-scale nutrition surveys and studies: a report following an international panel discussion at the 9th International Conference on Diet and Activity Methods (ICDAM9), Brisbane, 3 September 2015. *Journal of nutritional science*. 2018; **7**: e11.
- 3 Archundia Herrera MC, Chan CB. Narrative Review of New Methods for Assessing Food and Energy Intake. *Nutrients*. 2018; **10**.
- 4 Cade JE. Measuring diet in the 21st century: use of new technologies. *The Proceedings of the Nutrition Society*. 2017; **76**: 276-82.
- 5 Deloitte Australia. Mobile Consumer Survey. 2018. (Also available from: <https://www2.deloitte.com/au/mobile-consumer-survey>, accessed 01/10/2019 2019).
- 6 Australian Bureau of Statistics. Household Use of Information Technology, Australia, 2016-17. 2018.
- 7 Rollo ME, Williams RL, Burrows T, Kirkpatrick SI, Bucher T, Collins CE. What Are They Really Eating? A Review on New Approaches to Dietary Intake Assessment and Validation. *Curr Nutr Rep*. 2016; **5**: 307-14.
- 8 Sharp DB, Allman-Farinelli M. Feasibility and validity of mobile phones to assess dietary intake. *Nutrition (Burbank, Los Angeles County, Calif)*. 2014; **30**: 1257-66.
- 9 Timon CM, Astell AJ, Hwang F, *et al.* The validation of a computer-based food record for older adults: the Novel Assessment of Nutrition and Ageing (NANA) method. *The British journal of nutrition*. 2015; **113**: 654-64.
- 10 Rangan AM, Tieleman L, Louie JC, *et al.* Electronic Dietary Intake Assessment (e-DIA): relative validity of a mobile phone application to measure intake of food groups. *The British journal of nutrition*. 2016; **115**: 2219-26.
- 11 Rangan AM, O'Connor S, Giannelli V, *et al.* Electronic Dietary Intake Assessment (e-DIA): Comparison of a Mobile Phone Digital Entry App for Dietary Data Collection With 24-Hour Dietary Recalls. *JMIR mHealth and uHealth*. 2015; **3**: e98-e98.
- 12 Ambrosini GL, Hurworth M, Giglia R, Trapp G, Strauss P. Feasibility of a commercial smartphone application for dietary assessment in epidemiological research and comparison with 24-h dietary recalls. *Nutrition journal*. 2018; **17**: 5.
- 13 Pendergast FJ, Ridgers ND, Worsley A, McNaughton SA. Evaluation of a smartphone food diary application using objectively measured energy expenditure. *International Journal of Behavioral Nutrition and Physical Activity*. 2017; **14**: 30.
- 14 Ashman AM, Collins CE, Brown LJ, Rae KM, Rollo ME. Validation of a Smartphone Image-Based Dietary Assessment Method for Pregnant Women. *Nutrients*. 2017; **9**.

- 15 Recio-Rodriguez JI, Rodriguez-Martin C, Gonzalez-Sanchez J, *et al.* EVIDENT Smartphone App, a New Method for the Dietary Record: Comparison With a Food Frequency Questionnaire. *JMIR mHealth and uHealth*. 2019; **7**: e11463.
- 16 Australian Bureau of Statistics. Australian Demographic Statistics. Canberra, Australia. 2016.
- 17 Radd-Vagenas S, Fiatarone Singh MA, Daniel K, *et al.* Validity of the Mediterranean Diet and Culinary Index (MediCul) for Online Assessment of Adherence to the 'Traditional' Diet and Aspects of Cuisine in Older Adults. *Nutrients*. 2018; **10**.
- 18 Heffernan M, Andrews G, Fiatarone Singh MA, *et al.* Maintain Your Brain: Protocol of a 3-Year Randomized Controlled Trial of a Personalized Multi-Modal Digital Health Intervention to Prevent Cognitive Decline Among Community Dwelling 55 to 77 Year Olds. *J Alzheimers Dis*. 2018.
- 19 45 and Up Study C, Banks E, Redman S, *et al.* Cohort profile: the 45 and up study. *International J Epidemiol*. 2008; **37**: 941-47.
- 20 Xyris Software Pty Ltd. Introduction to Dietary Analysis with FoodWorks 8. 2015.
- 21 Chen J, Berkman W, Bardouh M, Ng CYK, Allman-Farinelli M. The use of a food logging app in the naturalistic setting fails to provide accurate measurements of nutrients and poses usability challenges. *Nutrition (Burbank, Los Angeles County, Calif)*. 2019; **57**: 208-16.
- 22 Gemming L, Ni Mhurchu C. Dietary under-reporting: what foods and which meals are typically under-reported? *European journal of clinical nutrition*. 2015; **70**: 640-1.
- 23 National Institutes of Health NCI. Automated Self-Administered 24-hour (ASA24) Dietary Assessment Tool. (Also available from: <https://epi.grants.cancer.gov/asa24/respondent/methodology.html> accessed 2 August 2017).
- 24 Zheng M, Wu JH, Louie JC, *et al.* Typical food portion sizes consumed by Australian adults: results from the 2011-12 Australian National Nutrition and Physical Activity Survey. *Sci Rep*. 2016; **6**: 19596.
- 25 McCrory MA, McCrory MA, Hajduk CL, Roberts SB. Procedures for screening out inaccurate reports of dietary energy intake. *Public health nutrition*. 2002; **5**: 873-82.
- 26 Kottner J, Audigé L, Brorson S, *et al.* Guidelines for reporting reliability and agreement studies (GRRAS) were proposed. *J Clin Epidemiol*. 2011; **64**: 96-106
- 27 Raatz SK, Scheett AJ, Johnson LK, Jahns L. Validity of electronic diet recording nutrient estimates compared to dietitian analysis of diet records: randomized controlled trial. *J Med Internet Res*. 2015; **17**: e21.
- 28 Carter MC, Burley VJ, Nykjaer C, Cade JE. Adherence to a smartphone application for weight loss compared to website and paper diary: pilot randomized controlled trial. *J Med Internet Res*. 2013; **15**: e32.

- 29 Griffiths C, Harnack L, Pereira MA. Assessment of the accuracy of nutrient calculations of five popular nutrition tracking applications. *Public health nutrition*. 2018; **21**: 1495-502.
- 30 Teixeira V, Voci SM, Mendes-Netto RS, da Silva DG. The relative validity of a food record using the smartphone application MyFitnessPal. *Nutrition & dietetics: the journal of the Dietitians Association of Australia*. 2018; **75**: 219-25.
- 31 Kirkpatrick SI, Subar AF, Douglass D, *et al*. Performance of the Automated Self-Administered 24-hour Recall relative to a measure of true intakes and to an interviewer-administered 24-h recall. *The American journal of clinical nutrition*. 2014; **100**: 233-40.
- 32 Lafay L, Mennen L, Basdevant A, *et al*. Does energy intake underreporting involve all kinds of food or only specific food items? Results from the Fleurbaix Laventie Ville Sante (FLVS) study. *International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity*. 2000; **24**: 1500-6.
- 33 Miller TM, Abdel-Maksoud MF, Crane LA, Marcus AC, Byers TE. Effects of social approval bias on self-reported fruit and vegetable consumption: a randomized controlled trial. *Nutrition journal*. 2008; **7**: 18.
- 34 National Health and Medical Research Council. Australian Dietary Guidelines. *Eat for Health*. Canberra: National Health and Medical Research Council, 2013.
- 35 Food Standards Australia New Zealand. Determining the amount of added sugars and free sugars in foods listed in the AUSNUT 2011-13 dataset (Also available from: <http://www.foodstandards.gov.au/science/monitoringnutrients/ausnut/foodnutrient/Pages/Determining-the-amount-of-added-sugars-and-free-sugars-in-foods-listed-in-the-AUSNUT-201113-dataset.aspx> accessed).
- 36 Chen J, Lieffers J, Bauman A, Hanning R, Allman-Farinelli M. The use of smartphone health apps and other mobile health (mHealth) technologies in dietetic practice: a three country study. *Journal of human nutrition and dietetics : the official journal of the British Dietetic Association*. 2017; **30**: 439-52.
- 37 Chen J, Gemming L, Hanning R, Allman-Farinelli M. Smartphone apps and the nutrition care process: Current perspectives and future considerations. *Patient education and counseling*. 2018; **101**: 750-57.
- 38 Chen J, Allman-Farinelli M. Impact of Training and Integration of Apps Into Dietetic Practice on Dietitians' Self-Efficacy With Using Mobile Health Apps and Patient Satisfaction. *JMIR mHealth and uHealth*. 2019; **7**: e12349.
- 39 Lieffers JR, Vance VA, Hanning RM. Use of mobile device applications in Canadian dietetic practice. *Canadian journal of dietetic practice and research : a publication of Dietitians of Canada = Revue canadienne de la pratique et de la recherche en dietetique : une publication des Dietetistes du Canada*. 2014; **75**: 41-7.

NDI_12606_Figure 1 Five Food Groups.tiff

Table 2: Macro- and micro-nutrient intake derived from the self-reported, adjusted and dietitian-assisted food records, n=44, mean $\pm$ SD

Nutrient	Self -reported	Adjusted	Dietitian-assisted
Macronutrients			
Energy (kJ)	8350.6 $\pm$ 2437.4	8819.0 $\pm$ 2291.5	8788.9 $\pm$ 2141.4
Protein (g)	87.9 $\pm$ 21.1*** ^c	95.3 $\pm$ 20.9*** ^c	95.6 $\pm$ 18.2*** ^c
Total fat (g)	77.5 $\pm$ 28.3	83.2 $\pm$ 30.7	85.3 $\pm$ 29.5
- Saturated Fat (g)	27.0 $\pm$ 10.9** ^c	28.7 $\pm$ 11.1** ^c	29.2 $\pm$ 11.6** ^c
- Monounsaturated (g)	31.0 $\pm$ 12.5	33.2 $\pm$ 13.6	34.5 $\pm$ 13.4
- Polyunsaturated (g)	12.4 $\pm$ 6.4	14.0 $\pm$ 7.9	14.1 $\pm$ 7.3
Carbohydrate (g)	191.5 $\pm$ 90.0	199.4 $\pm$ 63.3	193.6 $\pm$ 61.9
- Dietary Fibre (g)	29.8 $\pm$ 14.5	30.9 $\pm$ 10.6	30.4 $\pm$ 9.4
Micronutrients			
Calcium (mg)	938.7 $\pm$ 392.9*** ^c	1018.9 $\pm$ 384.9*** ^c	1029.9 $\pm$ 394.7*** ^c
Folate [†] (μ g)	541.2 $\pm$ 196.6** ^b	575.0 $\pm$ 173.8	594.9 $\pm$ 172.6** ^b
Iron (mg)	11.7 $\pm$ 3.6* ^b	12.7 $\pm$ 3.8	12.6 $\pm$ 3.5* ^b
Magnesium (mg)	421.4 $\pm$ 124.8	458.6 $\pm$ 158.3	456.7 $\pm$ 159.0
Niacin [†] (mg)	40.3 $\pm$ 11.0 ** ^c	43.5 $\pm$ 11.6** ^c	44.0 $\pm$ 10.7** ^c
Phosphorous (mg)	1524.0 $\pm$ 367.6** ^c	1671.9 $\pm$ 404.5** ^c	1681.8 $\pm$ 375.3** ^c
Potassium (mg)	3721.5 $\pm$ 1644.3	3860.1 $\pm$ 1285.8	3888.2 $\pm$ 1250.7
Riboflavin (mg)	1.9 $\pm$ 0.7 ** ^c	2.1 $\pm$ 0.7** ^c	2.1 $\pm$ 0.8** ^c
Sodium (mg)	2077.6 $\pm$ 1574.4** ^a	2223.7 $\pm$ 1510.6** ^a	2119.9 $\pm$ 699.5
Thiamin (mg)	1.3 $\pm$ 0.4** ^b	1.4 $\pm$ 0.5	1.4 $\pm$ 0.5** ^b
Vitamin C (mg)	145.0 $\pm$ 153.1	141.5 $\pm$ 119.5	140.8 $\pm$ 118.2
Vitamin E (mg)	14.5 $\pm$ 6.8	15.4 $\pm$ 7.7	15.9 $\pm$ 7.7
Vitamin A [†] (μ g)	1329.0 $\pm$ 1286.4	1374.9 $\pm$ 1254.8	1242.0 $\pm$ 822.4
Vitamin B6 (mg)	1.9 $\pm$ 1.3	1.8 $\pm$ 0.7	1.8 $\pm$ 0.6
Vitamin B12 (μ g)	4.6 $\pm$ 2.43 2.4*** ^c	4.9 $\pm$ 2.4*** ^c	4.9 $\pm$ 2.3*** ^c
Zinc (mg)	10.8 $\pm$ 3.2*** ^c	11.8 $\pm$ 3.2*** ^c	11.8 $\pm$ 3.2*** ^c
Caffeine (mg)	210.7 $\pm$ 171.3	223.4 $\pm$ 183.5	238.6 $\pm$ 186.6

Self-reported: outliers excluded, minimally cleaned, no adjustments

Adjusted: reporting errors resolved after data cleaning (Table 1)

Dietitian-assisted: record updated after participant interview with research dietitian

Statistically significantly repeated measure ANOVA: * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

Bonferroni post hoc tests statistically significant: ^a Self-reported vs Adjusted (only), ^b Self-reported vs Dietitian-assisted (only), ^c Self-reported vs adjusted & dietitian-assisted (both).

No statistical significances found between 'Adjusted' and 'Dietitian-assisted' records using Bonferroni post hoc tests.

[†] Including dietary nutrient equivalents. SD, standard deviation

Table 3: Key discretionary food/nutrient intakes for self-reported, adjusted and dietitian-assisted Research Food Research Food Diary (RFD) (mean $\pm$ SD)

Discretionary Food	Self-reported (n=44)	Adjusted (n=44)	Dietitian-assisted (n=44)
Refined grains (serves) [†]	2.7 $\pm$ 1.8*	2.8 $\pm$ 1.8*	2.6 $\pm$ 1.6*
Added sugars (tsp)	5.8 $\pm$ 6.4** ^a	6.3 $\pm$ 6.6** ^a	6.0 $\pm$ 5.8
Alcohol (standard drinks)	1.7 $\pm$ 1.5	1.7 $\pm$ 1.6	1.7 $\pm$ 1.5

[†] Food groups and serves as defined by the Australian Dietary Guidelines 2013,

Self-Reported: outliers excluded, minimally cleaned, no adjustments

Adjusted: reporting errors resolved after data cleaning

Dietitian-assisted: record updated after participant interview with research dietitian

Statistically significantly repeated measure ANOVA: * *P* for trend <0.05, ** *P*<0.01

Bonferroni post hoc tests statistically significant: ^a Self-reported vs Adjusted (only).

SD, standard deviation.

Table 1: Type and frequency of reporting errors and procedures for adjustments

Reporting Error % of total [€]	Data Cleaning Adjustments ^Δ
Missing quantities 37%	<ol style="list-style-type: none"> 1. Consumption habits, if evident (i.e., same quantity of food item recorded by participant on more than one occasion throughout record). 2. National median daily intake values, based on age and gender (using National Nutrition and Physical Activity Survey 2011-12 data). If food item recorded multiple times throughout a single day use national median portion values.¹
Missing/incomplete nutrient profiles 42%	<ol style="list-style-type: none"> 3. Select most suitable alternative available in database provided by analysis software. Code for item using as much relevant detail as possible (e.g., an alternative brand to listed product), before selecting a generic option.
Insufficient detail 22%	<ol style="list-style-type: none"> 4. Previous consumption habits, if evident (i.e., same food item recorded by participant on more than one occasion throughout record). 5. Code for most generic option available, using detail already provided (and coded for) from participant. Assume minimum detail e.g., no added fat unless otherwise specified by participant. 6. If multiple options available from database, using detail already provided by participant, take an average of all relevant options.
Implausible quantities 4%	<ol style="list-style-type: none"> 7. Convert to relevant unit of measure (e.g., grams instead of number of items), if logical. 8. Decrease quantity by a factor of 10, if logical e.g. 3000mL to 300mL. 9. Treat for missing quantity.
Reporting errors † 7%	<ol style="list-style-type: none"> 10. Convert amount consumed (grams) to percent of recipe consumed.

[€] A total of 255 reporting errors were found

^Δ Data cleaning was undertaken based on a hierarchy of procedures: if recording error unable to be resolved by first step, proceed to next, and so on. If all steps non-applicable to code for reporting error, remove entry from RFD and log changes

¹ Zheng et al. (24)

† Recipe errors included those requiring data cleaning or adjustments in order to generate a nutritional analysis from FoodWorks or related to software-errors or new foods not recognised by FoodWorks.

Table 4: Recommendations

- (i) Incorporation of warning notifications or error codes; to allow and encourage participants to self-check entries with missing or excessively large quantities, and for food items requiring more details.
- (ii) Familiarisation period; to allow participants time to practice navigating the app, entering new foods/recipes with greater specificity to the database options.
- (iii) Improved synchronicity between application software and professional analysis program (for example, the storage of recipe documents and composition databases used).
- (iv) Training in the application of dietetic data cleaning adjustments, using national survey data, as part of the data cleaning process to resolve reporting errors.

Minerva Access is the Institutional Repository of The University of Melbourne

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