**Dietary intake and nutritional adequacy among adults with suspected food intolerance before their initial appointment at the RPAH Allergy Unit**

Amanda Neubauer
SID:430081154

Allergy Unit
Department of Clinical Immunology
Royal Prince Alfred Hospital
9-11 Layton Street, Camperdown, NSW

Supervisors

Dr Velencia Soutter, MB, BS, FRACP (Paed) - Paediatrician
Dr Robert H Loblay, MB, BS, FRACP, PhD - Director
Dr Anne R Swain, Dip Nutr Diet, PhD - Chief Dietitian
Brooke McKinnon, BSc (Nutr Diet) (Hons) - Dietitian
Carling Chan, BSc (Hons) MND - Dietitian
Kirsty Le Ray, BSc (Hons) Nutr., BAppSc (ExSS) - Dietitian
Wendy Stuart-Smith, MND PhD Candidate - USYD Lecturer

The research presented in this report was conducted by the candidate under the guidance of the supervisors above. I Amanda Neubauer (the candidate) contributed to assessment form design and the development of recruitment and data collection protocols. I also recruited participants, and collected and entered data with assistance from Natalya Lukomskyj; and independently undertook data analysis.

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**Declaration**

1. I, ***Amanda Neubauer***, hereby declare than no work presented in this report has been submitted to any other University or Institution for a higher degree and that to the best of my knowledge contains no materials written or published by another person, except where due reference is made in text.
2. The studies described in this report were approved by the Ethics Review Committee (RPAH Zone) of the Sydney Local Health District, and all subjects gave informed consent before participating.

Signature

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Dated on 6 June, 2014

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**Authors**
[1]Ms Amanda Neubauer
[1]Ms Natalya Lukomskyj
[2]Ms Kristy-Lee Raso
[3]Dr Anne Swain
[3]Ms Brooke McKinnon
[3]Ms Carling Chan
[3]Ms Kirsty Le Ray
[3]Dr Robert Loblay

**Author affiliations**
[1]Discipline of Nutrition and Dietetics, School of Molecular Bioscience, Faculty of Science, University of Sydney, Sydney, Australia
[2]Discipline of Nutrition and Dietetics, School of Medicine, Faculty of Science, Medicine and Health, University of Wollongong, Wollongong, New South Wales, Australia
[3]Department of Clinical Immunology, Allergy Unit, Royal Prince Alfred Hospital, Camperdown, New South Wales, Australia

The aim of this study was to assess dietary intake and nutritional adequacy among adult patients with suspected food intolerance before their initial appointment at the Royal Prince Alfred Hospital (RPAH) Allergy Unit.

All new adult RPAH Allergy Unit patients were contacted via telephone before their initial appointment and assessed as eligible study participants based on suspected food intolerance. Four-day weighed food records were used to collect dietary intakes of participants. For analysis, data was combined with RPAH Allergy Unit patient data collected in 2013. Dietary intake was assessed by allocating all foods and drinks consumed to a food group, and comparing the number of serves consumed from each group to the Australian Guide to Healthy Eating recommendations. Nutritional adequacy was assessed using nutritional analysis software FoodWorks, by comparing nutrient intakes with Australian and New Zealand Nutrient Reference Values.

A total of 64 patient food records were analysed. Most patients had consumed protein at an amount recommended, but fat was above and carbohydrate was below recommendations. The Recommended Dietary Intake values for vitamin A and iron, and the Estimated Adequate Requirement values for folate, calcium and iodine were not met by most patients. On average, only 58% of the recommended core food serves were consumed, with discretionary foods commonly over-consumed.

Prior to their initial appointment at the RPAH Allergy Unit, most patients had over consumed fat and under consumed carbohydrate; most appeared to have inadequate intakes of calcium, folate and iodine, and may not have met their vitamin A and iron requirements. Core foods were generally displaced with a high discretionary intake.

**Contact Email:** aneu3704@uni.sydney.edu.au

**Dietary intake and nutritional adequacy among adults with suspected food intolerance before their initial appointment at the RPAH Allergy Unit**

**Authors:**

Amanda Neubauer, BHSc, MND Research student, University of Sydney
Natalya Lukomskyj, BAppSc, MND Research student, University of Sydney
Kristy-Lee Raso, BSc, MND Research student, University of Wollongong
Dr Robert H Loblay, PhD, Director, RPAH Allergy Unit
Dr Anne R Swain, PhD, APD, chief dietitian, RPAH Allergy Unit
Brooke McKinnon, BSc (Nutr Diet) (Hons), APD, dietitian, RPAH Allergy Unit
Carling Chan, MND, APD, research dietitian, RPAH Allergy Unit
Kirsty Le Ray, BSc (Hons) Nutr., APD, research dietitian, RPAH Allergy Unit

**Authorship:**

Amanda Neubauer was the primary author involved in recruitment, data collection, entry and analysis, and writing the manuscript. Natalya Lukomskyj and Kristy-Lee Raso contributed to recruitment, data collection and data entry. Dr Robert Loblay, Dr Anne Swain, Brooke McKinnon, Carling Chan and Kirsty Le Ray were responsible for the study design and supervision.

**Project location**

Royal Prince Alfred Hospital, Allergy Unit, Camperdown, NSW

**Correspondence**

A. Neubauer, Royal Prince Alfred Hospital, Allergy Unit, 9-11 Layton Street, Camperdown 2050. Email: aneu3704@uni.sydney.edu.au

**Abstract**

**Aim:** The aim of this study was to assess dietary intake and nutritional adequacy among adult patients with suspected food intolerance before their initial appointment at the Royal Prince Alfred Hospital (RPAH) Allergy Unit.

**Methods:** All new adult RPAH Allergy Unit patients were contacted via telephone before their initial appointment and assessed as eligible study participants based on suspected food intolerance. Four-day weighed food records were used to collect dietary intakes of participants. For analysis, data was combined with RPAH Allergy Unit patient data collected in 2013. Dietary intake was assessed by allocating all foods and drinks consumed to a food group, and comparing the number of serves consumed from each group to the Australian Guide to Healthy Eating recommendations. Nutritional adequacy was assessed using nutritional analysis software FoodWorks, by comparing nutrient intakes with Australian and New Zealand Nutrient Reference Values.

**Results:** A total of 64 patient food records were analysed. Most patients had consumed protein at an amount recommended, but fat was above and carbohydrate was below recommendations. The Recommended Dietary Intake values for vitamin A and iron, and the Estimated Adequate Requirement values for folate, calcium and iodine were not met by most patients. On average, only 58% of the recommended core food serves were consumed, with discretionary foods commonly over-consumed.

**Conclusion:** Prior to their initial appointment at the RPAH Allergy Unit, most patients had over consumed fat and under consumed carbohydrate; most appeared to have inadequate intakes of calcium, folate and iodine, and may not have met their vitamin A and iron requirements. Core foods were generally displaced with a high discretionary intake.

**Key words:** food hypersensitivity, nutritional adequacy, dietary intake

## Introduction

Food intolerance is a reproducible adverse reaction to a food or food chemical that has no immunological mechanism.[1] Food chemicals, which are found in a wide range of common foods, can be naturally occurring (e.g. salicylates, amines, glutamate) or added during food processing (e.g. preservatives and colours). Wheat, milk and soy can also be problematic for sensitive people.[2] Food intolerance can affect any system of the body, commonly the skin, gastrointestinal and respiratory tracts, and the central nervous system. Reactions can range from mild to severe and can be episodic, recurrent or chronic.[1,3,4] While prevalence is difficult to measure, up to 25 percent of the Australian population believe they have a food intolerance.[5]

While currently there is no accurate clinical diagnostic test for food intolerance,[6] the Royal Prince Alfred Hospital (RPAH) Elimination Diet and challenge protocol has been used in Australia for over 30 years as a diagnostic process. Strict compliance with this diet results in a low consumption of salicylates, amines and glutamates, and the elimination of added flavour enhancers, preservatives and colours.[7] The Elimination Diet is to be followed for two to six weeks, and seeks to determine whether an individual's symptoms subside. If appropriate, a systematic challenge with food chemicals is undertaken to identify intolerances. Following this, a tailored diet is prescribed and liberalisation can be recommended accordingly.[1]

The degree of dietary restriction required when following the RPAH Elimination Diet raises concerns that nutritional adequacy may be compromised. In particular, concerns may be raised because many fruits, vegetables, nuts, seeds and some seafood and cheeses are restricted. Nutritional adequacy is of even greater concern for people who require the exclusion of staple foods such as wheat, milk and

soy.[3,8] To help meet nutritional needs, patients are advised to follow the Australian Guide to Healthy Eating (AGHE) and consume a variety of foods available on the diet.

Limited research has analysed nutritional adequacy among adult RPAH Allergy Unit patients during the Elimination Diet and challenge protocol (Chiu A, 1997, & Soutar J, 1996, unpublished data) Further, little research has been done to assess the nutritional adequacy of patients' 'usual' diets before starting the RPAH Elimination Diet. This is important to understand as some patients already restrict foods for symptom management prior to their initial appointments. In 1997, Chiu (1997, unpublished data) reported that adult RPAH Allergy Unit patients (n=5) on the most liberal form of the RPAH Elimination Diet improved micronutrient intakes except for vitamin A. The interpretation of the results in that study is limited however by its small sample size.

This study will provide a greater understanding of diet quality and nutritional adequacy among adults with suspected food intolerances before their initial appointment at the RPAH Allergy Unit. This research is part of a larger study that commenced in 2013 and will run over a number of years. It will assess the nutritional adequacy and impact of the RPAH Elimination Diet and its effect on symptom control and quality of life.

## Methods

This prospective, observational study was approved by the Ethics Review Committee (RPAH Zone) of the Sydney Local Health District and conforms to the provisions of the Declaration of Helsinki. Recruitment, data collection and data entry were undertaken by student research dietitians. For analysis, data was combined with RPAH

Allergy Unit patient data collected in 2013 by Dynan & McGirr (2013, unpublished data).

Participants were recruited between March and May 2014. All new RPAH Allergy Unit adult patients (i.e. above 18 years of age) were contacted via telephone one to two weeks prior to their initial appointment. A telephone script and standard selection criteria were used to identify participant suitability and interest. Patients were assessed as eligible on the basis of suspected food intolerance, as identified by their symptoms (urticaria, angioedema, irritable bowel, headaches, migraines, muscle aches, other food reactions, and symptoms suspected to be food related). Patients were excluded if they had previously seen a dietitian for the RPAH Elimination Diet and had modified their dietary intake accordingly. Eligible patients were issued an information pack including a food record template and instructions. Patients were asked to complete a four-day weighed food record prior to their appointment, either via hard copy or the free iPhone application named Australian Calorie Counter - Easy Diet Diary (Xyris software, Brisbane, Australia).

Participation consent was confirmed verbally at the initial appointment, and supported by provision of the patients' completed food records. Participants were categorised as either 'Elimination Diet' or 'non Elimination Diet' patients according to whether they were referred to a dietitian for the RPAH Elimination Diet. While waiting for their appointment, patients completed an adult RPAH Allergy Unit assessment form, which was used to collect relevant medical and dietetic information, including dietary restrictions. Where possible, all completed food records and assessment forms were checked for missing or unclear data and patients were asked to confirm the information. Elimination Diet patients had their height and weight measurements taken using electronic floor scales and stadiometer.

Patient energy and nutrient intake estimates were calculated from the four-day weighed food records using FoodWorks (Professional Version 7, Xyris software, Brisbane, Australia). AUSNUT 2007, NUTTAB 2010, AUSFOODS 2012, and AUSBRANDS 2012 databases were used. Nutritional analysis was completed by comparing total energy intake with the Estimated Energy Requirement (EER) (calculated by FoodWorks), and comparing macro and micro-nutrient intakes with the Australian and New Zealand Nutrient Reference Values (National Health and Medical Research Centre).[9] The percentage of total energy intake from protein, carbohydrate and fat were compared to the Acceptable Macronutrient Distribution Range (AMDR) for each. The Estimated Average Requirement (EAR) and Recommended Dietary Intake (RDI) values of each nutrient (where available) were compared to the intake estimate to assess risk of inadequate intake. As an EAR does not exist for dietary fibre, sodium or potassium, due to insufficient data, an Adequate Intake (AI) is used. Despite this, the AI value cannot be used to identify probable inadequate nutrient intakes; instead the Upper Level (UL) of intake was used to identify risk of adverse health effects.

Dietary intake was assessed by using Microsoft Excel to code all foods and drinks consumed; attributing them to one of the core food groups (vegetables, fruit, grains and cereals, meat and alternatives or dairy and alternatives), the unsaturated oils and spreads group or the discretionary food group, as per the AGHE.[10] The number of serves of each food group consumed by each patient was compared to the AGHE serving recommendations, accounting for their age and gender. Serves were calculated according to the AGHE suggested serve sizes. However, only one serve (125mL) of fruit juice per day was coded as fruit, with any additional volume coded as discretionary. Any unsaturated oils and spreads consumed in excess of the allowance

were also coded as discretionary. Legumes were coded separately so they could be allocated to the meat and alternatives and/or vegetable groups depending on which had the lowest consumption by the patient. If a similar number of servings of both of these food groups had been consumed, the total portion of legumes was split equally among the two food groups. The AGHE was followed for coding where possible and clinical dietitians were consulted when uncertainty arose. Coding decisions, particularly for discretionary items, were based on clinical judgement, considering whether there was high sodium (>480mg), fat (>10% total energy), or added sugar (>20% total energy) per serve. Mixed dishes were broken up into ingredients for coding unless they were discretionary dishes (e.g. takeaway meals). When a recipe was not provided by the patient for ingredients and their proportions, a standard dish was created from recipes sourced by the researchers.

**Results**

Among the 203 patients called prior to their initial appointment, 155 were contactable, and 74 were assessed as eligible and sent information packs. At the initial appointment, 50 patients agreed to be in the study, however only 26 food records and 25 RPAH Allergy Unit assessment forms were completed. A total of 64 patient food records (n=39 Elimination Diet, n=25 non Elimination Diet) were used in the analysis after combining the 2013 data. Assessment forms were not completed by patients in 2013. Due to small sample sizes of the Elimination Diet and non Elimination Diet groups, significant statistical comparisons were unable to be made. Therefore, the dietary and nutritional results reported are from all 64 patients.

Only 8 patients (13%) met their daily EER, with most patients (59%) having consumed between 80-90%. Figure 1a shows the proportion of patients who consumed

the macronutrients below, within and above their AMDRs. Protein, total fat and carbohydrate contributed an average of 20%, 35% and 38% total daily energy respectively. Most patients (67%) consumed more than 10% total energy from saturated fat, with an average intake of 11%. Nearly all patients (97%) met their RDI for protein. Just over a third (39%) met the AI for fibre. The majority of patients (67%) consumed more than 20% of their total energy from discretionary foods, with an average intake of 32% (range 0-59%). Figure 1b shows the contribution made by discretionary foods to total energy and macronutrients. Discretionary foods contributed an average of 33% total fat, 41% saturated fat, 33% carbohydrate, 19% fibre and 17% protein to the diet, and contributed to 38% EAR for protein and 15% AI for fibre.

On average, patients met only 56% of their micronutrient RDI and AI values. Most patients met their RDI for all micronutrients except vitamin A, iron, calcium, folate and iodine. While most patients met the EAR for vitamin A and iron, this was not the case for folate, calcium and iodine. Figure 1c shows the proportion of patients meeting their EARs and RDIs for the assessed micronutrients. Half the patients met their AI for potassium and a third exceeded their UL for sodium (range 101-217% UL) (data not shown). Discretionary foods contributed approximately 19% of micronutrient intake, ranging from 11% for vitamin C to 23% for both thiamin and riboflavin. Discretionary foods contributed to 16% iodine, 19% folate, 20% vitamin A, and 21% calcium and iron. Figure 1d shows the percentage of micronutrient EARs met from discretionary foods. This food group also contributed to 18% AI for potassium and 36% UL for sodium (data not shown).

Figure 2a shows the proportion of patients meeting their percentage of recommended food group serves. The average percentage of recommended vegetables, fruit, and grains and cereals consumed was 73%, 58% and 53% respectively. The

average percentage of recommended dairy and alternatives, and meat and alternatives consumed was 46% and 108% respectively. The unsaturated oils and spreads allowance was consumed at an average of 33%. The allowance for discretionary foods was consumed at an average of 178%. Only 13 patients (20%) did not exceed their discretionary limit. The allowance of unsaturated oils and spreads was exceeded by 6 patients (9%), of which the excess amount was added to their discretionary intake. Only 3 patients consumed fruit juice in excess of the 125ml daily allowance, which was also contributed to their discretionary intake.

Core food group consumption did not show a clear relationship with micronutrient intake. Some patients met above 50% RDI for calcium without consuming any of the dairy food group (see Figure 2b). This trend was similar for other poorly consumed micronutrients including folate and vegetables, folate and grains and cereals, iodine and grains and cereals, and iodine and meat and vegetables.

Of the 25 patients who completed the RPAH Allergy Unit assessment form, 13 (20%) reported having dietary restrictions prior to their initial appointment. Gluten, wheat, lactose and milk were being avoided by 5, 7, 7 and 10 patients respectively.

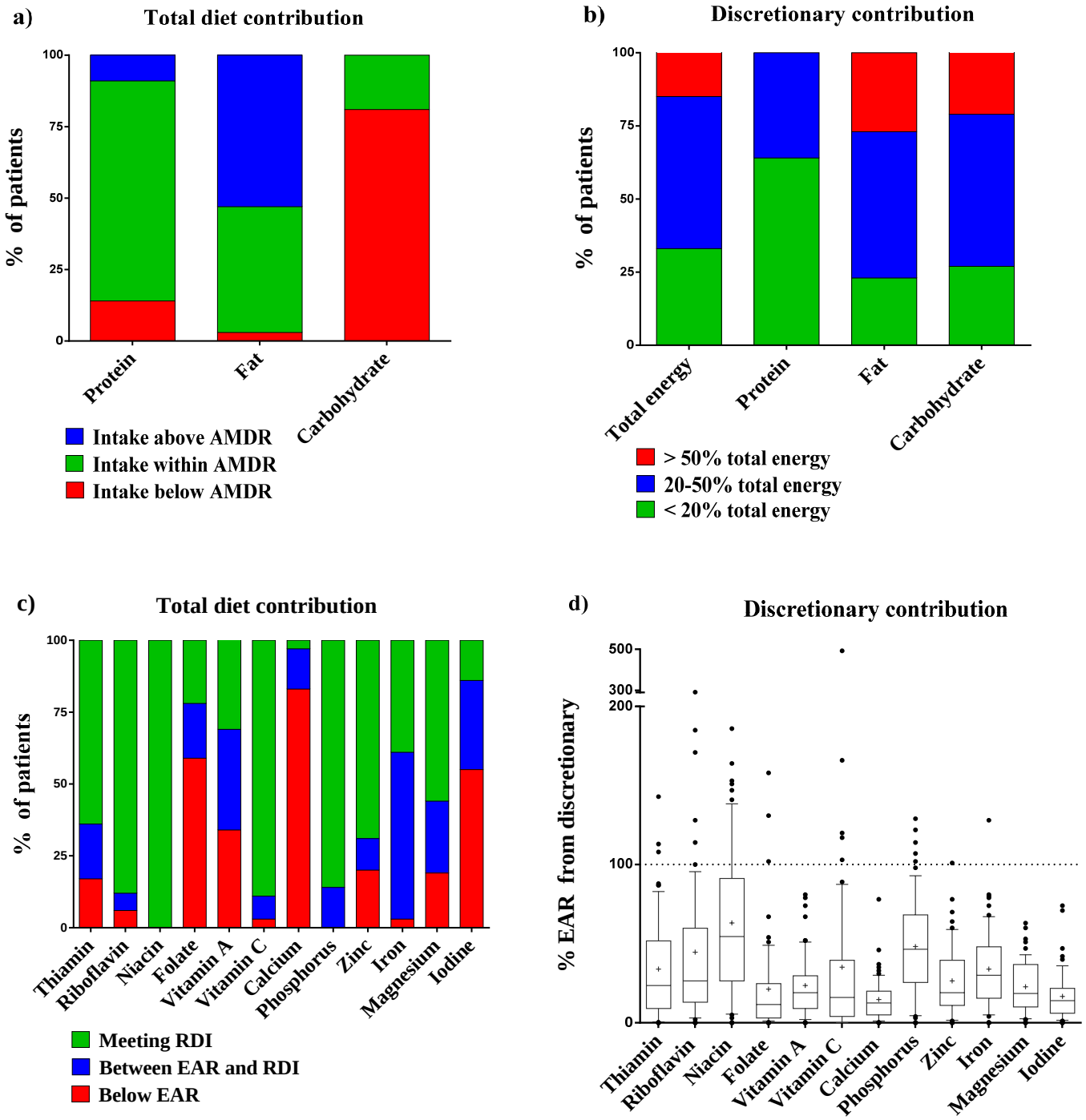


**Figure 1** Total patients n=64 (a) macronutrient intake from the total diet; (b) energy and macronutrient intake from discretionary foods; (c) micronutrient intake from the total diet; (d) contribution to micronutrient EARs from discretionary foods. Box showing median and interquartile range. Whiskers showing 10-90 percentiles, outliers shown by • and mean shown by +.

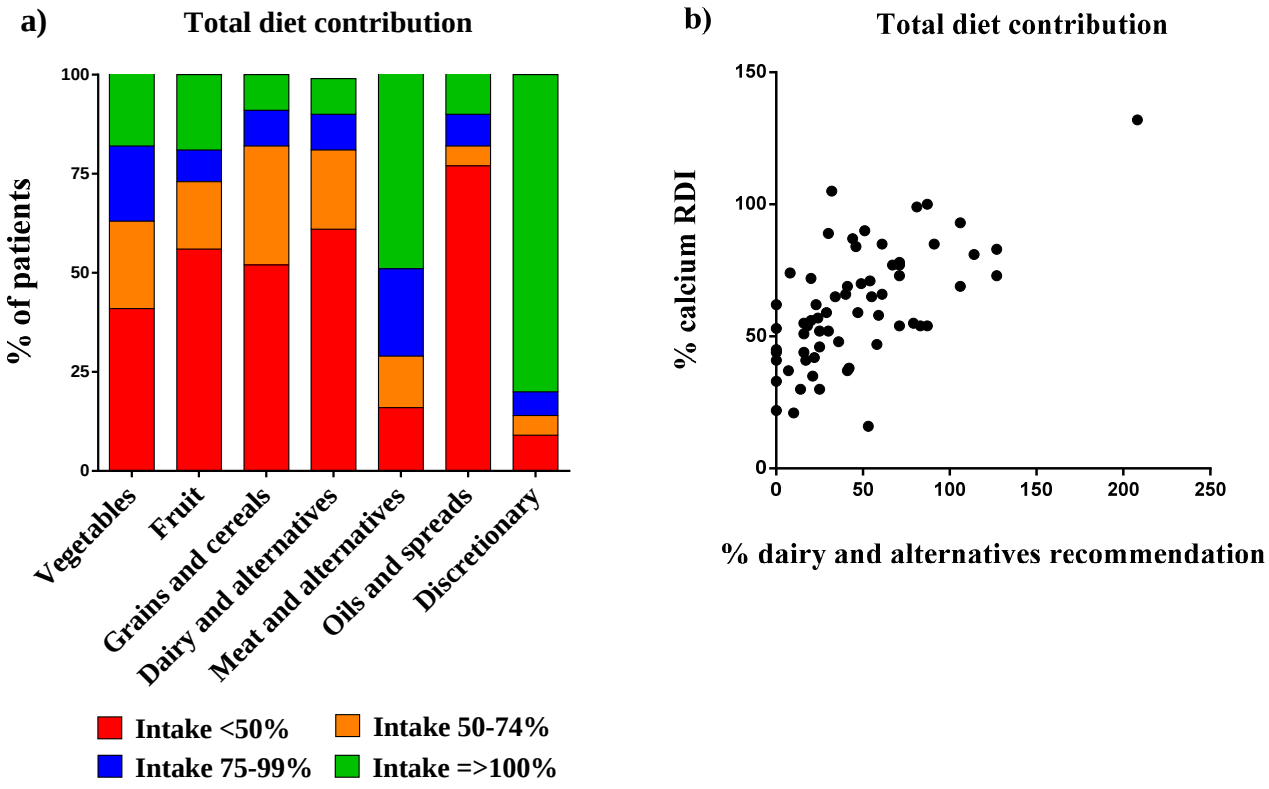


**Figure 2** Total patients n=64 (a) percentage of recommended food group serves consumed; (b) % RDI for calcium versus % dairy recommendation consumed.

## Discussion

This dietary and nutritional analysis of adult RPAH Allergy Unit patients shows that compared to the AGHE, most did not consume an adequate intake of core foods prior to their initial appointment. On average, only 58% of the total recommended number of core food serves was consumed. Meat and alternatives had the greatest consumption, with half the patients meeting their recommendation. Vegetables were the next greatest consumed (19% meeting their recommendation), followed by grains and cereals (9%), fruit (19%), then dairy and alternatives (9%). Most patients also did not exceed their maximum amount of unsaturated oils and spreads, however, additional intakes of this food group is likely to be consumed in discretionary meals. The 2007-08 National

Health Survey reported that less than 10% of Australian adults consumed enough vegetables, and about half consumed enough fruit.[11] In comparison, our study patients consumed more vegetables but less fruit. The 1995 National Nutrition Survey (NNS) reported that 21% of Australian adults met the recommendations for grains and cereals.[12] This is a much higher proportion compared to our study group. Additionally, the recommended number of serves for grain and cereals in 1995 was 7 and the current recommendation is 4-6 (depending on age and gender). The NNS also reported that approximately 66% of Australians aged 12 years and over consumed less than 3 serves of dairy per day,[13] which is at least 75% of the current recommendations, depending on age and gender. Because half of our study patients consumed less than 75% of their recommended serves, they had consumed less than the national average.

Most of the study patients (80%) consumed more discretionary serves than their recommended allowance. Many patients (67%) also consumed more than 20% of their total daily energy from discretionary foods (average of 32%), which is above the maximum acceptable limit outlined in the AGHE.[10] This is consistent with the average Australian adult consuming 36% of their total energy intake from discretionary foods, as reported from the NNS.[14]

Most patients consumed protein within the AMDR. It was common however, that fat intake was higher and carbohydrate intake was lower than recommended. Saturated fat intake was also greater than the 10% total energy limit for most patients (67%). The NNS showed that most Australians above 16 years consumed the macronutrients within the AMDRs.[15] Specifically, carbohydrate provided 45–50%, fats provided 32–33% and protein provided 16–18% of total energy. Additionally, saturated fat contributed 12–14%. In this study, most patients consumed similar amounts of

protein and saturated fat, but less carbohydrate and more total fat than the general Australian population.

The RDIs for thiamin, riboflavin, vitamin C, phosphorous, zinc and magnesium, were met by the majority of patients (75% average). All patients met their RDI for niacin. Most patients were therefore likely to have consumed adequate amounts of these nutrients. Half the patients met the AI for potassium, and therefore have a high probability of adequacy. Most patients (82% average) did not meet the RDI for vitamin A and iron but did meet the EAR, suggesting that likelihood of adequacy is between 50-97% and that intake probably needs to improve. However, most patients (67% average) consumed folate, calcium and iodine below the EAR, and are therefore at risk of inadequate intakes of these nutrients. In contrast, the NNS found that the majority of Australian adults met the EARs of all the micronutrients except calcium.

The dietary restrictions of wheat, gluten, milk and lactose reported by some patients may have contributed to the generally low intakes of carbohydrate, grains and cereals, and dairy and alternatives. Carbohydrate intake was likely further affected by the low consumption of vegetables and fruit. Additionally, a high consumption of discretionary foods can displace core foods in the diet, and thus compromise the intake of a range of micronutrients. Specifically, high discretionary intake is associated with lower intakes of dietary fibre, vitamin A, folate, iron and calcium, and higher intakes of saturated fat,[16,17] which was generally reflected in our study population. However, this study found that some patients did meet adequate micronutrient intakes without meeting core food group recommendations. It is notable that some patients consumed more that 50% of their RDI for calcium without consuming any dairy and alternatives. This is because discretionary foods contributed an average of 19% to total micronutrient intake. Despite discretionary foods often being energy-dense, and high in

sugar, fat or salt, they are not necessarily low in nutrients, especially if they are fortified. Discretionary foods including protein bars, mocha and chai lattes, pad thai, caramel slice, laksa and cheesecake provided significant amounts of calcium for some patients; chai latte, ice cream sundae and smoked salmon provided significant amounts of iodine; and vegemite, muesli bars, noodlebox take away meals and pizza provided significant amounts of folate. Therefore a limitation of using the AGHE and food groups to assess dietary intake is that diet quality is not always a good indicator of nutritional intake.

It is important to note that energy intake strongly correlates with nutrient adequacy and food group intakes.[18] Considering most patients reported only consuming 80-90% of their EER, it is likely there was under-reporting, incorrect physical activity estimations, and/or incorrect anthropometric measurements reported by non Elimination Diet patients. While weighed food records are considered the gold standard for estimating the usual food intakes of individuals, under-reporting is common with all methods of dietary assessment.[19] In this study, some patients didn't follow the food recording instructions, failing to report all ingredients (including cooking oils and sandwich spreads), and misreported portion sizes. When recipes weren't provided, standard recipes had to be created for the food groups analysis, which meant estimating actual ingredients consumed. Also, some patients reported only weekday intake, while others reported for one or two weekend days. While this was sometimes unavoidable because of limited time between recruitment and their initial appointment, there is the potential for discretionary intakes on weekend days to misrepresent a patient's usual intake. Using the Easy Diet Diary iPhone application to record food intake provided additional limitations. While it was useful to reduce manual data entry time due to the ability to export food records into FoodWorks, recipes and physical activity details do

not get included in the export, and there is also no way of recording supplement intake. Patients therefore had to email these details separately. The application can also be time consuming to use and it appeared that some patients selected the first acceptable meal or ingredient option to add to their daily intake, rather than the most appropriate one. Accidental selection of incorrect measurements, such as pieces or cups rather than grams, also occurred occasionally. Unavoidable limitations of both the Easy Diet Diary application and FoodWorks was difficulty matching uncommon foods within the database, such as pickled mango, salac berry and taro cake. While all food records completed in 2014 were checked for errors and confirmed with patients at their appointments, uncertainties with food records completed in 2013 could not be followed-up.

To address respondent bias in this study, future data collection methods are encouraged to ensure food record instructions are clear. Confirming that participants understand the requirements before completing a food record may also be useful. The number of estimated rather than weighed food records completed should be recorded in order to help understand the degree of data accuracy. Also, more accurate physical activity data could be obtained from a questionnaire that requires reporting frequency, duration and intensity of planned exercise and incidental exercise, as well as the number of hours spent sitting per day.

The study's small sample size has limited the ability to generalise the results to the wider population of people with suspected food intolerance, including RPAH Allergy Unit patients. Further research would be useful to compare the dietary and nutrient intakes of Elimination Diet and non Elimination Diet patients, in addition to those who do and don't follow specific food restrictions. This knowledge would be valuable for dietitians to better understand the potential baseline nutritional status of

these patients. It would also be useful to assess the relationship between nutritional adequacy and individual characteristics of patients, including symptoms and triggers, shopping and kitchen skills, food preparation enjoyment and employment status. Associations between nutritional adequacy and diet variety could be further explored.

## Conclusion

This research identified that prior to their initial appointment at the RPAH Allergy Unit, most patients had over consumed total and saturated fat, and under consumed carbohydrate and total energy. Most patients appeared not to have consumed adequate intakes of calcium, folate and iodine, and many may not have met their vitamin A and iron requirements. A high discretionary intake contributed to a low consumption of all core food groups except meat and alternatives. However, diet quality was not a strong indicator of nutritional intake, and vice versa.

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## Conflict of interest

There is no conflict of interest to report.

## Authorship

Amanda Neubauer was the primary author involved in recruitment, data collection, entry and analysis, and writing the manuscript. Natalya Lukomskyj and Kristy-Lee Raso contributed to recruitment, data collection and data entry. Dr Robert Loblay, Dr Anne Swain, Brooke McKinnon, Carling Chan and Kirsty Le Ray were responsible for the study design and supervision.

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