

University of Wollongong

Research Online

Faculty of Science, Medicine and Health -
Papers: part A

Faculty of Science, Medicine and Health

1-1-2015

Changes in food choice patterns in a weight loss intervention

Sara J. Grafenauer

University of Wollongong, sarag@uow.edu.au

Linda C. Tapsell

University of Wollongong, ltapsell@uow.edu.au

Eleanor Beck

University of Wollongong, eleanor@uow.edu.au

Marijka Batterham

University of Wollongong, marijka@uow.edu.au

Follow this and additional works at: <https://ro.uow.edu.au/smhpapers>



Part of the [Medicine and Health Sciences Commons](#), and the [Social and Behavioral Sciences Commons](#)

Recommended Citation

Grafenauer, Sara J.; Tapsell, Linda C.; Beck, Eleanor; and Batterham, Marijka, "Changes in food choice patterns in a weight loss intervention" (2015). *Faculty of Science, Medicine and Health - Papers: part A*. 2722.

<https://ro.uow.edu.au/smhpapers/2722>

Research Online is the open access institutional repository for the University of Wollongong. For further information contact the UOW Library: research-pubs@uow.edu.au

Changes in food choice patterns in a weight loss intervention

Abstract

Aim Analyses of changes in food choice patterns made during weight loss may be informative for practice. In this research, food categorisation may be critical. The aim of the present study was to identify key changes in food choice patterns in weight loss trials. **Methods** Changes in dietary patterns between baseline and three months were analysed for 231 participants from two weight loss trials in terms of grams of food, kilojoules and the number of food serves consumed. Two food categorisation systems were applied using six more traditional food groups and 17 newly defined food categories considering national food guidance systems, and specific criteria, including the scientific evidence on the relationships between consumption of specific foods and health outcomes associated with weight management. **Results** After three months, there was no significant change in the total weight of food consumed, yet mean energy intakes decreased by more than 3000 kJ. Where six categories were applied, all groups except milk and milk alternatives were altered by the diet prescription. However, with 17 categories, subtle changes were more clearly demonstrated. For example, the 17 categories showed increased intake of low-fat dairy foods and decreased intake of fatty meats, non-wholegrain (refined) cereals specifically, and non-core foods and drinks more broadly. **Conclusions** Changes in food choice patterns can be identified during weight loss trials. Applying a greater number of categories in the analysis enables a greater identification of changes in choice of key foods reflecting actual dietary change.

Disciplines

Medicine and Health Sciences | Social and Behavioral Sciences

Publication Details

Grafenauer, S. J., Tapsell, L. C., Beck, E. J. & Batterham, M. J. (2015). Changes in food choice patterns in a weight loss intervention. *Nutrition and Dietetics*, 72 (4), 309-315.

Changes in food choice patterns in a weight loss intervention

Sara J. Grafenauer^a, APD, MSc (Nutrition & Dietetics); PhD candidate

Linda C. Tapsell^a, FDAA, PhD

Eleanor J. Beck^a, Adv APD, PhD

Marijka J. Batterham^b, Adv APD, PhD

^aSmart Foods Centre, School of Health Sciences, University of Wollongong, Northfields
Avenue, Wollongong, 2522 NSW, Australia

^bSchool of Mathematics and Applied Statistics, University of Wollongong, Northfields
Avenue, Wollongong, 2522 NSW, Australia

Corresponding author: Sara Grafenauer sara@nourishnutrition.com.au

Ph: 61 408 238 138

Fax: 61 2 4221 4844

Abstract

Aim: Analyses of changes in food choice patterns made during weight loss may be informative for practice. In this research, food categorisation may be critical. The aim of this study was to identify key changes in food choice patterns in weight-loss trials.

Methods: Changes in dietary patterns between baseline and 3-months were analysed for 231 participants from two weight-loss trials in terms of grams of food, kilojoules and the number of food serves consumed. Two food categorisation systems were applied using 6 more traditional food groups and 17 newly defined food categories considering national food guidance systems, and specific criteria, including the scientific evidence on the relationships between consumption of specific foods and health outcomes associated with weight management.

Results: After 3-months there was no significant change in the total weight of food consumed, yet mean energy intakes decreased by more than 3000kJ. Where 6 categories were applied, all groups except milk and milk alternatives were altered by the diet prescription. However, with 17 categories, subtle changes were more clearly demonstrated. For example, the 17 categories showed increased intake of low fat dairy foods, and decreased intake of fatty meats, non-whole grain (refined) cereals specifically, and non-core foods and drinks more broadly.

Conclusions: Changes in food choice patterns can be identified during weight loss trials. Applying a greater number of categories in the analysis enables a greater identification of changes in choice of key foods reflecting actual dietary change.

Key words: Dietary assessment methodology; Dietary pattern; Food; Food intake;

Weight reduction

Introduction

There are suggestions in the nutrition research literature that food intake patterns, rather than nutrient intakes, are preferable for assessing diet-health relationships,¹⁻³ yet there are few studies testing health outcomes at an intervention level using this approach.⁴ Focusing only on the macronutrient proportions of the diet may be less important than once thought⁵ since it is recognised that foods, and therefore diets, are more complex than the sum of the parts.⁶ Analyses based on the categorisation of foods may expose links between food choice patterns and health outcomes.⁷ In turn, this may reveal information relevant for translation to the clinical setting.⁶ Few studies have tracked food pattern changes in relation to weight-loss⁸ in sufficient detail to be useful for direct translation to practice.

The literature often refers to 5 'core' food groups and an additional group of non-core foods and drinks (including sugar, fats/oils and discretionary food and drink choices).^{9,10} This framework of 6-food groups may be suitable as a communication tool and food guidance system at the population-level, but it may not be specific enough, to capture the complexity of food intake patterns at an individual level. More categories may be required to differentiate between foods chosen and may need to be tailored to the disease state.¹¹ Dietary advice is given in terms of food choice and so food-level analysis can be directly translated to practice.

In previous analyses of data from weight loss intervention trials we demonstrated that subjects with poor baseline dietary patterns lost more weight ($P < 0.05$) than those who started with dietary patterns more closely aligned with desirable eating patterns.¹²

While we were able to identify the foods predominantly chosen by these subjects at baseline, we needed to know more about the actual changes they made during the course of the trial. The aim of the current study therefore was to identify changes in food choice patterns during these weight-loss trials.

Methods

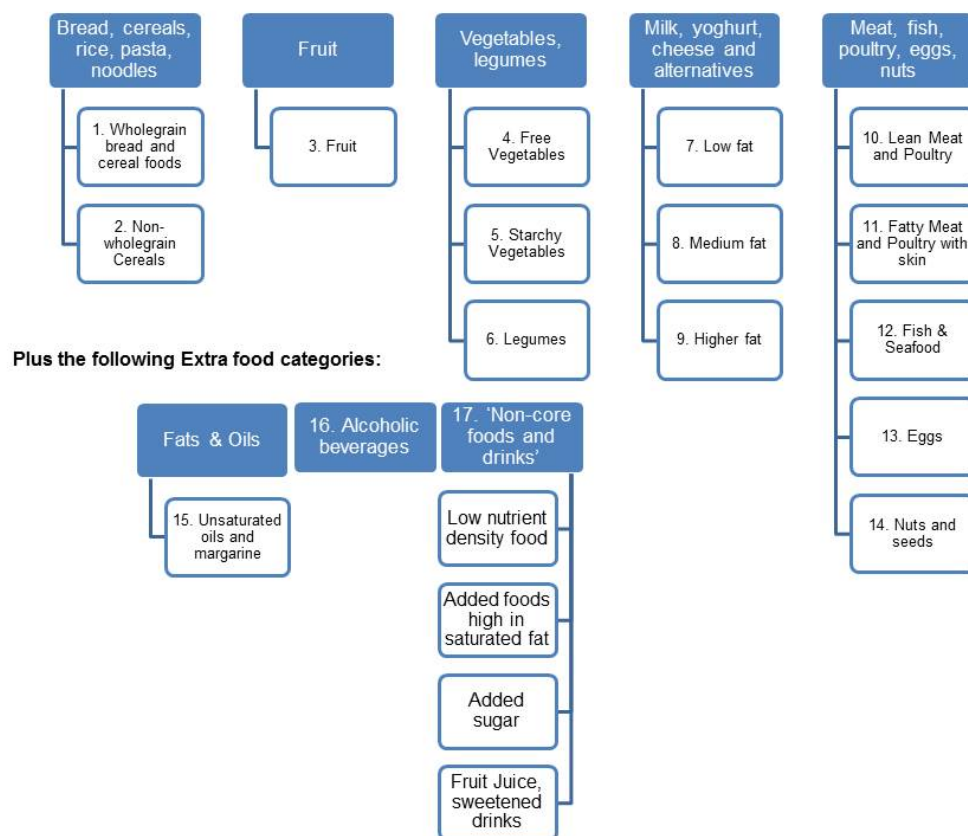
Participant diet history records were drawn from two registered clinical weight-loss trials^{13,14} (ACTRN 12608000425392 and 12610000784011) for secondary analysis. The trials utilised were 12-month dietary interventions in healthy, overweight to obese adults, recruited from the local area using newspaper advertisements. The designs were similar, where intervention and control groups received energy restricted (-2MJ) dietary advice based on food groups from the Australian Guide to Healthy Eating. In both cases, differences between the control and intervention diets from each trial used in this analysis related to a single food group (only the amounts of vegetables¹⁴ or fish¹³ were altered with the intervention), but the type of foods in the overall dietary patterns were similar. Data for the analyses reported here refer to the changes achieved after the completion of the 3-month intensive phase. Each trial was approved by the University of Wollongong Human Research Ethics Committee (HE07/323 and HE10/192) and all participants provided written informed consent. Participants in both trials were blinded to the intervention. Dietary education involved the use of a food-based diet prescription for both the control and intervention groups with the same energy restriction for weight reduction described previously.¹² For each trial, Accredited Practising Dietitians interviewed participants who were asked to report their usual intake of foods and beverages beginning with the first meal of the day and

indicating variations within a four week period. An estimated 4-day food record was completed prior to the diet history interview which assisted participants with recall of the types and amounts of consumed food. In addition, household measures and food models were used for estimation of portion size. A food frequency questionnaire targeting the consumption of specific foods was used as a cross-check of items omitted from the history. The diet history data was then analysed using a computerised food and nutrient database, Foodworks™ Professional (Xyris, Brisbane, Australia, Version 6, 2009) to reflect a weekly pattern of intake at baseline and 3-months. Anthropometric measurements from each trial, including body weight, height, estimated body fat percentage (Tanita® TBF-662) and waist circumference were utilised for this analysis.

A set of 6-food groups was identified by referring to national food guidance systems for adults.^{15,16} A second set of 17 food categories (Figure 1) of interest in the clinical context was derived through a qualitative assessment of a number of factors including (i) biological categories of foods, such as forms of plants (to establish core categories such as fruit, or nuts and seeds),¹⁷ (ii) relative nutrient composition and energy density (to distinguish within category, such as low fat milk versus cheese in the milk and milk alternatives), (iii) degree of manufacturing (to distinguish between whole grain and non-whole grain cereals),¹⁷ (iv) culinary use (to differentiate on the basis of modes of consumption such as oils used in frying and dressings),¹⁰ and (v) the presence of scientific evidence on the relationships between consumption of specific foods and health outcomes associated with weight management (to further differentiate between foods such as fatty, processed meats).¹⁸ The resulting food categories were similar to those in previous published research¹² including observational research.¹⁸

Food and drink serve sizes were calculated with reference to a clinical practice ready reckoner.¹⁹ Reference values included a 30g serve for whole grain foods, non-whole grain (refined) cereal foods, meat, fish, eggs, nuts and higher fat dairy foods (cheese), 150mL per serve for low and medium fat dairy foods, 150g for fruit, 75g for vegetables, 5g for unsaturated oils and margarine ('virtually trans-fat free'), 400kJ for alcoholic beverages and 600kJ for non-core foods and drinks. The same food serve size was utilised in the analyses involving both the 6-food groups and the 17 food categories and these were also converted to serves used in the AGHE¹⁵ to allow for comparison and to assist the clinician in interpreting the data.

Figure 1. Schematic of proposed new classification based on the Traditional food groups.



Each food and beverage item from the diet history records collected at baseline and 3-months were tabulated by food group using both the 6-food group system and the 17 food categories. The primary outcome measure of the overall analysis was change in food group consumption (median food weight in grams, median energy intake in kilojoules, and mean number of serves). These were compared to changes in energy and nutrient intakes.

The compatibility of combining the two trial databases has been assessed and reported previously.¹² In summary, independent t-tests revealed no baseline differences in terms of age of participants, per cent fat or carbohydrate intake yet the difference in per cent protein ($P=0.006$) and reported energy intake ($P=0.006$) was significant. There was no difference in the weight lost by three months ($P=0.639$) and a Chi square analysis found no difference in gender between the two trials. The commonalities between the primary trials allowed data to be combined and allowed data from males and females to be analysed together.

A Linear Mixed Model with post hoc Bonferroni correction was used to assess change in total energy intake, selected nutrients (dietary protein, dietary fat, carbohydrate) and the weight of food between baseline and 3-months. All food category data was checked for normality using Shapiro-Wilks and the median and interquartile range (IQR) were presented for each food category system in grams and kilojoules in addition to mean serves. The individual results from the analysis using the 17 food categories should not be expected to add to the composite value obtained from the analysis using the 6-food groups. This is because there were differences in the form of categorisation

(e.g. alcoholic beverages alone or combined with non-core foods and drinks), and median values were reported. Adjustment for multiple comparisons was conducted using the method of Benjamini and Hochberg using *p.adjust* in R Studio version 0.97.388 (c) 2009-2012 R Studio, Inc.²⁰ All analyses used SPSS Statistics Software (version 19.0.0 IBM Corporation Armonk, NY).

Results

At the 3-month time point, there was a significant reduction in mean energy intake of >3000kJ (9449±2998kJ versus 6348±1400kJ; $P<0.001$) yet there was no significant difference in consumed food weight (1581±455g versus 1594±429g; $P=0.069$) (Table 1). The reduction in energy intake was confirmed by a concomitant weight loss of >5% (-4.6±3.1kg; $P<0.001$). There were no gender differences in reported energy or nutrient intakes.

Table 1 Changes in body composition, energy and nutrient intakes between Baseline and 3-months (mean ±SD)

| | Baseline (n=231) | 3-months (n=195) | P value |
|--------------------------|---------------------|---------------------|---------|
| Body weight (kg) | 86.9±12.0 | 82.0±11.7 | <0.001 |
| BMI (kg/m ²) | 30.7±3.2 | 28.9±3.0 | <0.001 |
| Body fat (%) | 38.9±6.8 | 37.0±7.2 | <0.001 |
| Waist circumference (cm) | 101.7±10.9 | 96.4±9.8 | <0.001 |
| Energy (kJ) | 9449±2998 | 6348±1400 | <0.001 |
| Protein (g) | 104.0±31.4 | 84.5±19.3 | <0.001 |
| Fat (g) | 87.2±36.3 | 44.4±15.2 | <0.001 |
| Carbohydrate (g) | 233.9±77.0 | 170.0±40.2 | <0.001 |
| Food weight (g) | 1581±455 | 1594±429 | 0.069 |

Paired T-test 95%CI; Diet history analysis using FoodWorks[®] Professional 2009, version 6, Xyris software, Brisbane, Australia; Food weight calculation excludes liquids.

At baseline, and using the 6-food group system, all participants were consuming within the suggested guideline amounts of breads and cereals (6.7 serves) and milk and milk

alternatives (3.3 serves), but inadequate fruit (1.3 serves) and vegetables (4.3 serves) and excessive meat and meat alternatives (8.2 serves equivalent to 246g) and excessive non-core foods and drinks (5.4 serves or ~3000kJ). By 3-months there were significant changes in consumption from all of the traditional food groups except milk and milk alternatives ($P=0.113$). However, the change in (median) kilojoules was only significant for milk and milk alternatives ($P=0.016$) (Table 2). The consumption of fruit and vegetables increased significantly by 3-months (expressed as serves, $P=0.007$ and $P<0.001$ respectively) but fruit consumption remained lower than the national food guide target of 2 serves per day, whereas vegetable consumption exceeded the target. Consumption of breads and cereals ($P<0.001$), meat and meat alternatives ($P<0.001$) and non-core foods and drinks ($P<0.001$) decreased significantly. However the latter two groups remained above suggested national target intakes.

The same analysis using the 17 food categories revealed significant changes in 14 of the 17 food categories (Table 2). Vegetable consumption increased as a result of increased consumption of 'free' vegetables ($P<0.001$) and legumes ($P<0.001$) but not starchy vegetables ($P=0.924$). Participants reported consuming more non-whole grain (refined) cereal foods than whole grain varieties, however by 3-months this was reversed due to a decrease in non-whole grain varieties ($P<0.001$). In order to assess the protein-rich foods category (meat and meat alternatives) in comparison to the national food guide,¹⁵ the per-week consumption was calculated. The mean consumption emerged as 4 serves of lean meat, 1.5 serves for fatty meat, and 1.4 serves for fish and seafood, slightly exceeding the recommendation in the national food guide.¹⁵ This analysis showed a two thirds reduction in fatty meat consumption

Table 2 Changes in food contributions to diet at baseline and 3 months using traditional 6 food groups and 17 derived food categories.

| Food Group and portion size | Median (IQR) weight (g) | | | | Median (IQR) kilojoules (kJ) | | | | Mean Serves | | | |
|---|-------------------------|---------------------|------------|-----------------------------|------------------------------|---------------------|------------|----------------|---------------------|---------------------|------------|----------------|
| | Baseline (n=231) | 3-months (n=195) | p value | p adj value [†] | Baseline (n=231) | 3-months (n=195) | p value | p adj value | Baseline (n=231) | 3-months (n=195) | p value | p adj value |
| 1. Breads and Cereals (30g) | 181(140-244) | 140(99-193) | <0.001 | <0.001 | 1709(1349-2169) | 1339(994-1734) | <0.001 | <0.001 | 6.7 | 5.2 | <0.001 | <0.001 |
| 2. Fruit (150g) | 165 (89-257) | 224 (157-280) | 0.006 | 0.007 | 407 (234-675) | 541 (392-699) | 0.006 | 0.007 | 1.3 | 1.5 | 0.006 | 0.007 |
| 3. Vegetables (75g) | 296(201-413) | 458(340-576) | <0.001 | <0.001 | 559(354-825) | 806(587-1036) | <0.001 | <0.001 | 4.3 | 6.3 | <0.001 | <0.001 |
| 4. Milk and Milk alternatives (150ml) | 341(189-555) | 394(262-553) | 0.488 | 0.488 | 944(564-1364) | 896(655-1190) | 0.014 | 0.016 | 3.3 | 3 | 0.107 | 0.113 |
| 5. Meat and Meat alternatives (30g) | 227(176-301) | 164(130-203) | <0.001 | <0.001 | 1930(1459-2617) | 1315(1035-1693) | <0.001 | <0.001 | 8.2 | 5.9 | <0.001 | <0.001 |
| 6. Non-Core Foods and drinks (600kJ) | 437(289-800) | 165(84-323) | <0.001 | <0.001 | 2818(1985-3988) | 1007(577-1520) | <0.001 | <0.001 | 5.4 | 1.9 | <0.001 | <0.001 |
| 1. Wholegrain foods (30g) | 79 (45-119) | 81 (52-112) | 0.401 | 0.445 | 947 (512-1410) | 937 (654-1223) | 0.254 | 0.294 | 3.1 | 2.9 | 0.401 | 0.445 |
| 2. Non-wholegrain cereals (30g) | 94 (55-150) | 50 (25-88) | <0.001 | <0.001 | 684 (387-1078) | 350 (162-634) | <0.001 | <0.001 | 3.7 | 2.3 | <0.001 | <0.001 |
| 3. Fruit (150g) | 165 (89-257) | 224 (157-280) | 0.006 | 0.007 | 407 (234-675) | 541 (392-699) | 0.011 | 0.013 | 1.3 | 1.5 | 0.006 | 0.007 |
| 4. Free vegetables (75g) | 213 (145-325) | 360 (256-464) | <0.001 | <0.001 | 268 (183-435) | 465 (282-615) | <0.001 | <0.001 | 3.2 | 4.9 | <0.001 | <0.001 |
| 5. Starchy vegetables (75g) | 53(26-87) | 58 (31-90) | 0.924 | 0.924 | 192 (91-328) | 189 (101-314) | 0.241 | 0.286 | 0.9 | 0.9 | 0.924 | 0.924 |
| 6. Legumes (75g) | 0(0-24) | 26 (0-57) | <0.001 | <0.001 | 0 (0-92) | 90 (0-207) | <0.001 | <0.001 | 0.2 | 0.5 | <0.001 | <0.001 |
| 7. Low fat dairy foods:<3.5% fat (150ml) | 216 (83-438) | 359 (229-515) | <0.001 | <0.001 | 479 (168-834) | 720 (474-984) | <0.001 | <0.001 | 1.9 | 2.6 | <0.001 | <0.001 |
| 8. Medium fat dairy foods:3.5-10% fat (150ml) | 0 (0-103) | 0 (0-6) | <0.001 | <0.001 | 0 (0-271) | 0 (0-24) | <0.001 | <0.001 | 0.7 | 0.2 | <0.001 | <0.001 |
| 9. High fat dairy foods: >10% fat (30g) | 14 (6-25) | 3 (0-9) | <0.001 | <0.001 | 220 (84-364) | 48 (0-120) | <0.001 | <0.001 | 0.7 | 0.2 | <0.001 | <0.001 |
| 10. Lean Meat and poultry (30g) | 105 (70-148) | 83 (63-122) | 0.001 | 0.001 | 686 (458-1042) | 562 (424-841) | <0.001 | <0.001 | 4 | 3.3 | 0.001 | 0.001 |
| 11. Fatty meat (30g) | 33 (10-62) | 8 (0-23) | <0.001 | <0.001 | 299 (76-566) | 70 (0-207) | <0.001 | <0.001 | 1.5 | 0.5 | <0.001 | <0.001 |
| 12. Fish and seafood (30g) | 35 (14-58) | 34 (20-54) | 0.782 | 0.814 | 231 (90-411) | 225 (129-387) | 0.726 | 0.788 | 1.4 | 1.4 | 0.782 | 0.814 |
| 13. Eggs (1 egg) | 13 (5-21) | 10 (5-14) | <0.001 | <0.001 | 84 (31-154) | 62 (31-94) | <0.001 | <0.001 | 0.5 | 0.4 | <0.001 | <0.001 |
| 14. Nuts (and seeds) (30g) | 13 (2-28) | 6 (2-14) | <0.001 | <0.001 | 308 (54-697) | 161 (41-366) | <0.001 | <0.001 | 0.7 | 0.3 | <0.001 | <0.001 |
| 15. Unsaturated oils and margarine (5g) | 11 (2-27) | 5 (1-13) | <0.001 | <0.001 | 202 (51-474) | 134 (30-337) | <0.001 | <0.001 | 4.2 | 2 | <0.001 | <0.001 |
| 16. Alcoholic beverages (400kJ) | 84 (4-235) | 49 (0-149) | <0.001 | <0.001 | 185 (21-563) | 110 (0-296) | <0.001 | <0.001 | 1 | 0.6 | <0.001 | <0.001 |
| 17.Non-Core foods and drinks (600kJ) | 290 (148-509) | 84 (35-166) | <0.001 | <0.001 | 2096 (1334-3105) | 573 (285-984) | <0.001 | <0.001 | 4.2 | 1.2 | <0.001 | <0.001 |

ACTRN 12608000425392 and 12610000784011. [†] P values adjusted for multiple comparisons within each analysis (6 food groups and 17 food categories) using the method of Benjamini and Hochberg. Benjamini, Y., and Hochberg, Y. (1995). Controlling the false discovery rate: a practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society Series B*, **57**, 289–300. Note: the median figures for the 17 groups should not be expected to add to the composite figure of the 5-food groups.

($P<0.001$). Other protein sources such as eggs (0.5 serves/day), nuts and seeds (0.7 serves/day), were apparently consumed in smaller daily amounts, contributing to energy and nutritional intakes over the week. Reported consumption of dairy food emerged as 1.9 serves of low fat products and 0.7 serves for each medium and higher fat dairy products. By 3-months, consumption of low fat dairy products increased ($P<0.001$) as both medium fat dairy ($P<0.001$) and higher fat dairy ($P<0.001$) decreased. The analysis showed 4.2 serves ($>2000\text{kJ}$) consumed from non-core foods and drinks, one portion from alcoholic beverages and 4.2 serves of unsaturated oils and margarine. By 3-months, consumption of alcoholic beverages and non-core foods and drinks reduced to less than 1 serve/day ($P<0.001$) and 1.2 serves/day ($P<0.001$) respectively.

Using food weight and energy intake (raw data), the changes in food choice patterns resulted in large reductions in energy intakes from non-core foods and drinks (a 73% reduction in energy intake and 71% decrease in food weight) and an increase in energy intake from vegetables (63% increase in energy and 69% increase by weight).

Discussion

This analysis showed that detailed food category changes can be used in the analyses of dietary data from weight loss trials. Using a greater number of food categories enabled more specific food changes to be identified that are informative for practice and mirror dietary energy and nutrient changes. These included the change to proportionally more whole grain foods and less refined cereal foods, an increase in 'free' vegetables and legumes, a shift to more low fat varieties of dairy foods and

changes in meat consumption, particularly less fatty meats. Each of these changes yielded a reduction in energy intake though the most dramatic change over time was the large reduction in non-core foods and drinks. These foods and drinks were depicted separately from alcohol and the preferred sources of unsaturated fats in the detailed analysis, and assisted in a more accurate depiction of dietary change using food categories.

Food guidance systems that target populations have generally tended to be simplified for communication purposes and use a small number food groups. This may not be the best model for food-level clinical research, because other aspects of foods and food categories may need to be considered. For example, to categorise dairy foods in a single group based on protein and calcium content does not clearly articulate the wide variation in the macronutrients within a diverse group of foods and beverages which includes cheese and skim milk. Some research suggests further separation of food categories such as extending free vegetables into three categories - cruciferous, green leafy and dark-yellow,¹¹ however this depends on the purpose and the outcome measures. In practice, dietitians may categorise foods using particular short-cut methods, such as categorising cheese, eggs, legumes or nuts with meat. However, these protein-rich foods have a diverse culinary usage, and a divergent fat profile, suggesting they should be categorised separately. The important issue for our research was to account for subtle differences in foods, such that effects could be discerned in terms of outcome measures.

Using only 6-food groups limited the description of the types of specific foods that changed over the length of the intervention. Whereas the energy and nutrient changes were shown to be significant within the dataset, the use of 17 food categories captured the actual dietary changes in terms of more discrete food types and the magnitude of those changes in the context of the whole diet. For example, the number of serves of milk and milk alternatives did not appear to change using 6-food groups, but applying more categories demonstrated that low fat dairy food consumption replaced medium and higher fat dairy food choices. Furthermore, the reported consumption of protein-rich foods (meat etc.) decreased, yet the more detailed analysis showed that within that group, the consumption of fish and seafood remained stable, slightly exceeding guideline targets,^{15,16} while consumption of fatty meats decreased. The quality of food choices in that category therefore improved, and the changes in consumption were important for decreasing the overall energy intake while maintaining the weight of food consumed.

To closely examine changes in food choice patterns, food categories need to be carefully considered. In the study reported here, a number of criteria were used to define food categories, and these were similar to those used in a recent observational study¹⁸ that identified specific food choices that appear significant in weight management. In that analysis, weight-gain was linked with consumption of potatoes, processed and unprocessed meat and food categorised in the present study as non-core foods and drinks.¹⁸ The authors suggested that these findings may be effectively employed in the advice setting since the dietary changes accounted for substantial difference in weight

gain. Our analysis confirms this position in a dietary trial setting, providing further support for targeting certain foods and drinks in weight-loss advice.

This analysis of food choice patterns aligns well with new research indicating that focusing on the macronutrient proportions of the diet may be less important than once thought in predicting change in weight or waist circumference.⁵ Seeking solutions at a food-level has been called a “top-down” approach,²¹ and may present new ideas of where to look for biologically active compounds in whole foods consumed within whole diets,⁶ not explained by analysis of nutrient composition alone. There is also some indication in the literature that the consumption of whole foods versus processed foods may be dealt with differently by the body,²² and in this analysis, there was a decrease in consumption of breads and cereals which was shown to be the result of choosing less non-whole grain (refined) cereals, a positive dietary change, only identified through the use of 17 food categories.

The inclusion of non-core foods and drinks (or discretionary choices) in recent food guides^{4,10} reflects the diverse range of food choices made at an individual level. However, this category of foods and drinks varies significantly in nutrient profile. In this analysis using the 17 food categories, we found that 28.8% of baseline dietary energy came from non-core foods and drinks, compared with 35% from the latest Australian Health Survey²³. Both analyses exceed the maximum recommended limit of 20% energy for healthy populations.²⁴ Separating out categories of beverages enabled by the more detailed analysis was also of value. For example we showed consumption

of alcoholic beverages was within guideline amounts for healthy populations²⁵ at baseline, and decreased within the trials.

We also noted that foods linked with desirable effects on health outcomes in observational research,¹⁸ such as fruit, vegetables, legumes and low fat milk and milk alternatives, were reported as consumed in less than recommended amounts at baseline and improved by 3-months without an increase in total food weight. Researchers have suggested that individuals consume a constant weight of food rather than a constant amount of energy.^{26,27} Therefore, by substituting lower energy dense foods for higher energy dense foods maybe a more important and effective strategy in weight-loss than is recognised.²⁸ In the analysis conducted, there was a reduction (by weight) in non-core foods and drinks and a corresponding increase in vegetables consumed in the 3-month timeframe, a result confirming the value of the detailed food-level analysis for research informing practice. Increasing the focus on food-level research has been suggested in previous studies.^{5,29} Analyses of dietary patterns provide details closer to the actual foods consumed, and allows for further insights for weight reduction advice that build on previous findings using cluster analysis of dietary patterns at baseline.¹²

There were limitations to our analysis. Firstly, individual diet history records were used in the primary studies in order to quantify more individual food items, and discern as accurately as possible the change in food consumption that may impact on weight-loss outcomes.¹² This method of dietary data collection reflects clinical practice and is known to provide accurate estimates of habitual intake³⁰⁻³⁴ though misreporting is

always possible.³⁵ Secondly, the decisions regarding food classification were justified in terms of biological characteristics, nutrient composition and energy density, degree of manufacturing, and were based on the assessment of available literature for weight management. However, this system of classification may change depending on the research purpose.¹¹

Distinct changes in food choice patterns were able to be detected using food groups in the analysis of these weight loss interventions. Because individual foods were identified, this is useful for translating research to practice, but using a greater number of categories in the analysis was more informative in highlighting key foods associated with dietary change. Analyses of shifts in consumption of the 17 food categories provided indications of where shifts occurred, and highlighted improvements in dietary quality during the interventions. Consuming the same amount of food (by weight) while achieving a decreased energy intake was a significant finding. The decreased consumption of non-core foods and drinks was matched by an almost equal increase in vegetables, and this knowledge could be applied in the practice setting. Although there are a number of ways in which foods can be categorised, this analysis used food categories relevant to weight management. Analysis of dietary patterns using detailed food groups within the context of dietary intervention trials may open up new opportunities for investigating relationships between dietary intake and health outcomes in a range of therapeutic areas. This in turn, would inform food-based advice for direct translation to practice.

Funding

This project was supported by an Australian Postgraduate Award and the trials from which the data was made available for this analysis were funded by the National Health and Medical Research Council and Horticulture Australia Ltd (ACTRN 12608000425392 and 12610000784011). The funding bodies had no role in the design, analysis or writing of this manuscript.

Conflicts of Interest

The authors of this paper, titled '*Changes in food choice patterns in a weight loss intervention.*' do not have any conflicts of interest to declare.

Authorship

SG was responsible for conceptualising the study, data analysis and the initial and final drafts of the manuscript. LT and EB collaborated on the writing of the manuscripts and MB provided guidance regarding statistical analysis. All authors read and approved the final manuscript.

References

1. Anderson AL, Harris TB, Tyllavsky FA, et al. Dietary Patterns and Survival of Older Adults. *J Am Diet Assoc* 2011;111:84-91.
2. Hu FB. Dietary pattern analysis: a new direction in nutritional epidemiology. *Curr Opin Lipidol* 2002;13:3-9.
3. Kant AK. Dietary patterns and health outcomes. *J Am Diet Assoc* 2004;104:615-35.
4. Dietary Guidelines Advisory Committee. Report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans. In: The Secretary of Agriculture and the Secretary of Health and Human Services, ed.: U.S. Department of Agriculture, Agricultural Research Service, Washington, DC.; 2010.
5. Fogelholm M, Anderssen S, Gunnarsdottir I, Lahti-Koski M. Dietary macronutrients and food consumption as determinants of long-term weight change in adult populations: a systematic literature review. *Food Nutr Res* 2012;56:1-45.
6. Jacobs DRJ, Tapsell LC, Temple NJ. Food synergy: the key to balancing the nutrition research effort. *Public Health Rev* 2011;33:507-29.
7. Jacobs DRJ, Gross MD, Tapsell LC. Food synergy: an operational concept for understanding nutrition. *Am J Clin Nutr* 2009;89:1S-6S.
8. Pachucki MA. Food Pattern analysis over time: unhealthful eating trajectories predict obesity. *Int J Obes* 2012;36:686-94.
9. Painter J, Rah JH, Lee YK. Comparison of international food guide pictorial representations. *J Am Diet Assoc* 2002;102:483-9.
10. National Health and Medical Research Council. The Australian Dietary Guidelines In: Department of Health and Aging, ed. Canberra: Commonwealth of Australia; 2013.
11. Nettleton JA, Schulze MB, Jiang R, Jenny NS, Burke GL, Jacobs DR. A priori-defined dietary patterns and markers of cardiovascular disease risk in the Multi-Ethnic Study of Atherosclerosis (MESA). *Am J Clin Nutr* 2008;88:185-94.
12. Grafenauer SJ, Tapsell LC, Beck EJ, Batterham MJ. Baseline dietary patterns are a significant consideration in correcting dietary exposure for weight loss. *Eur J Clin Nutr* 2013;67:330-6.
13. Tapsell L, Batterham M, Charlton K, et al. Foods, nutrients or whole diets: effects of targeting fish and LCn3PUFA consumption in a 12mo weight loss trial. *BMC*

Public Health 2013;13:1231 <http://www.biomedcentral.com/471-2458/13/1231>

Accessed 1 June 2014.

14. Tapsell LC, Batterham MJ, Thorne RL, O'Shea JE, Grafenauer SJ, Probst YC. Weight loss effects from vegetable intake: a 12-month randomised controlled trial. *Eur J Clin Nutr* 2014;68:778-85.
15. NHMRC. Australian Guide to Healthy Eating. In: Department of Health and Aging, ed. Canberra; 2013.
16. NHMRC. A modelling system to inform the revision to the Australian Guide to Healthy Eating. In: Commonwealth of Australia; 2013.
17. Scarborough P, Rayner M, Stockley L. Developing nutrient profile models: a systematic approach. *Public Health Nutr* 2007;10:330-6.
18. Mozaffarian D, Hao T, Rimm EB, Willett WC, Hu FB. Changes in Diet and Lifestyle and Long-Term Weight Gain in Women and Men. *N Engl J Med* 2011;364:2392-404.
19. Curtin University of Technology. Dietitians' Pocket Book. Perth, Western Australia: Dept. of Nutrition and Dietetics and Food Science, School of Public Health, Curtin University of Technology; 2002.
20. Benjamini Y, Hochberg Y. Controlling the False Discovery Rate: A Practical and Powerful Approach to Multiple Testing. *J R Stat Soc Ser B Stat Soc* 1995;57:289-300.
21. Jacobs DR, Steffen LM. Nutrients, food and dietary patterns as exposures in research: a framework for food synergy. *Am J Clin Nutr* 2003;78:508S-13S.
22. Barr SB, Wright JC. Postprandial energy expenditure in whole-food and processed-food meals: implications for daily energy expenditure. *Food Nutr Res* 2010;54:5144.
23. Australian Bureau of Statistics. Australian Health Survey: Nutrition First Results - Foods and Nutrients - Discretionary foods 2011-12 In: Commonwealth of Australia; 2014.
24. Rangan AM, Schindeler S, Hector DJ, Gill TP, Webb KL. Consumption of 'extra' foods by Australian adults: types, quantities and contribution to energy and nutrient intakes. *Eur J Clin Nutr* 2009;63:865-71.
25. National Health and Medical Research Council. Australian Guidelines to Reduce Health Risks from Drinking Alcohol. In. Canberra ACT; 2009.

26. Rolls BJ, Drewnowski A, Ledikwe JH. Changing the Energy Density of the Diet as a Strategy for Weight Management. *J Am Diet Assoc* 2005;105:S98-S103.
27. Lapointe A, Weisnagel SJ, Provencher V, et al. Comparison of a dietary intervention promoting high intakes of fruits and vegetables with a low-fat approach: long-term effects on dietary intakes, eating behaviours and body weight in postmenopausal women. *Br J Nutr* 2010;104:1080-90.
28. Pérez-Escamilla R, Obbagy JE, Altman JM, et al. Dietary Energy Density and Body Weight in Adults and Children: A Systematic Review. *JAND* 2012;112:671-84.
29. Block G, Kant AK, Nestle M, Schatzkin A, Ziegler RG. Food group intake patterns and associated nutrient profiles of the US population. *J Am Diet Assoc* 1991;91:1532-7.
30. Hankin JH, Wilkins LR, Kolonel LN, Yoshizawa CN. Validation of a Quantitative Diet History Method in Hawaii. *Am J Epidemiol* 1991;133:616-28.
31. Rothenberg E, Bosaeus I, Lernfelt B, Landahl S, Steen B. Energy intake and expenditure: validation of a diet history by heart rate monitoring, activity diary and doubly labeled water. *Eur J Clin Nutr* 1998;52:832-8.
32. Black AE, Welch AA, Bingham SA. Validation of dietary intakes measured by diet history against 24 h urinary nitrogen excretion and energy expenditure measured by the doubly-labelled water method in middle-aged women. *Br J Nutr* 2000;83:341-54.
33. Trabulsi J, Schoeller DA. Evaluation of dietary assessment instruments against doubly labeled water, a biomarker of habitual energy intake. *Am J Physiol Endocrinol Metab* 2001;281:891-9.
34. Sjöberg A, Slinde F, Arvidsson D, et al. Energy intake in Swedish adolescents: validation of diet history with doubly labelled water. *Eur J Clin Nutr* 2003;57:1643-52.
35. Kuhnle GGC. Nutritional biomarkers for objective dietary assessment. *J Sci Food Agric* 2012;92:1145-9.

