Original Article

Home availability of fruit and vegetables and obesogenic foods as an indicator of nutrient intake in 50 year olds from Canterbury, New Zealand

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Background and Objectives: The home food environment is known to influence children's diet and selected health outcomes. However, similar research in adults is scarce. The home is arguably the most important food environment for New Zealand adults as the majority of food consumed is stored and prepared in the home. Therefore we investigated relationships between home food availability and nutrient intake in 50 year olds from Canterbury, New Zealand. **Methods and Study Design:** A cross-sectional study where participants completed a home food inventory and a four-day estimated food diary. Regression analysis was used to investigate relationships between home availability of 'Fruit and Vegetables' and 'Obesogenic Foods' and intake of selected nutrients, adjusting for Body Mass Index and demographic factors. Men and women (n=216) aged 50 were randomly selected from Canterbury District Health Board area electoral rolls. **Results:** Women with a high 'Obesogenic Foods' score were significantly more likely to have a high intake of saturated fat (OR 5.8, CI: 1.67, 19.6) and high sugar intake (OR 3.1, CI: 1.23, 7.58). Men with a high 'Obesogenic Foods' score were less likely to have high folate (OR 0.14, CI: 0.05, 0.40) and fibre intake (OR 0.21, CI: 0.07, 0.60). Men and women with a higher 'Fruit and Vegetables' score were more likely to have high vitamin C intake (OR 5.6 and 4.5 respectively). **Conclusions:** Home Food Inventory scores are associated with selected nutrient intakes, particularly in women, suggesting that they are useful for identifying those groups with less favourable nutrient intakes. Future research should investigate whether these scores can predict health outcomes.

Key Words: home food availability, nutrient intake, saturated fat, sugar, fruit and vegetables

INTRODUCTION

A balanced, nutritious diet is essential for good health and plays an important role in the prevention of non-communicable chronic diseases (NCD)[1] including obesity and cardiovascular disease (CVD).[1,2] The World Health Organisation (WHO) predicts NCDs will account for 57% of the global disease burden by 2020;[1] making them a major public health concern. In New Zealand (NZ), almost one third of adults are now classified as obese[3] and CVD is responsible for approximately 30% of annual deaths.[4] Furthermore, New Zealand faces the public health challenge of an ageing population,[5] with the Canterbury region having the highest proportion of people over the age of 50.[6] As age is a non-modifiable risk factor for NCDs,[7] it is crucial that modifiable risk factors such as improving diet are addressed to protect the health of New Zealanders. An unbalanced diet may be described as high in energy-dense, nutrient-poor foods (often referred to as obesogenic foods) and low in fruit and vegetables.[8] Diets high in obesogenic foods are positively associated with weight gain[9] and unfavourable changes to CVD risk factors,[10] while the opposite is true of diets that are high in fruit and vegetables.[10,11]

Recently, there has been a surge in research on whether food environments promote overconsumption of obesogenic foods.[12] The research, which has primarily been conducted in the United States of America (US) and Europe, has examined food marketing, density of takeaway shops in neighbourhoods, access to supermarkets/food markets, and food in schools, workplaces and the home.[12] In NZ, the home is arguably the most important food environment because a large proportion of food is stored, prepared, and consumed in the home,[13] making it a feasible target for interventions designed to improve diet. Limited previous research has shown that home food availability of particular foods is associated with intakes of selected macronutrients[14-16] but there is a lack of evidence

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as to whether availability of particular food types in the home is related to a wider range of nutrients. Public health messages for healthy eating in NZ focus around consuming a wide variety of fruit and vegetables and reducing high fat and/or sugary foods. Therefore, the aim of this study was to examine the relationship between aspects of the home food environment that have been shown to be associated with NCD risk, namely fruit and vegetables and obesogenic foods, as measured by a home food inventory (HFI), and nutrient intake in participants of the Canterbury Health, Ageing, and Life Course (CHALICE) study.

METHODS

Chalice study

This study used data collected as part of the baseline assessment in the Canterbury Health and Lifecourse (CHALICE) study, a prospective longitudinal study including data collected from laboratory tests, interviews and self-completed questionnaires.[17] An up-to-date list of people (health research extract) who were currently 50 years old and registered in territorial authorities that align with the Canterbury District Health Board (CDHB) catchment area was obtained from the Electoral Roll Centre. From this health research extract information on 6,328 people, not of Māori descent, and 413 people who identified as being of Māori descent was extracted. These two extracts were randomly ordered and participants were selected in a ratio of 4:1 non-Māori to Māori.[17] CHALICE methodology has also been described in detail elsewhere.[18] Ethical approval was obtained from the Upper South A Regional Ethics Committee.[17] This manuscript uses baseline data for the first 300 CHALICE study participants, for whom cleaned data were available as of July 2015.

Data collection

Information on gender and ethnicity (self-selected) was obtained from questionnaires administered by a trained study interviewer at a face-to-face interview. For the purpose of these analyses, ethnicity was coded as non-Māori or Māori. Body mass index (BMI) was calculated from height and weight measures collected by the study interviewer. Participants' BMI data was dichotomised by obesity status using the cut point of 30 kg/m^2.

The interviewer gave each participant a four day estimated food diary (4DEFD), a HFI, and instructions (verbal and written) on how to fill these out. Participants were asked to complete the 4DEFD in the week after their interview. The 4DEFD included detailed instructions on how to record portion sizes, using common household measures. Participants were asked to complete the 4DEFD on one weekend day and three week days. The 4DEFD was pretested in a convenience sample of eight men aged 50 years and older before use in CHALICE. The participants who took part in the pretesting were asked to complete the 4DEFD and attend a group interview to discuss the 4DEFD. Based on the returned 4DEFD and feedback received from this group, the 4DEFD was modified to produce more specific instructions with regard to reporting food portion sizes, based on their comments.

CHALICE participants were asked to complete the HFI on the first day after the main food shop for their household. Participants were asked to tick all items present anywhere in their home (open or unopened) and were asked to look in all possible food areas e.g. cupboards, deep freezers, vegetable gardens, and not to complete the questionnaire from memory. The HFI consisted of a checklist of foods commonly consumed in New Zealand. It was a comprehensive list, grouped into 13 food types, comprising 351 items in total and also asked for information on the numbers of individuals living in the house, their age and gender. The HFI was based on one devised and validated by Fulkerson et al[19] for use in the United States. Modifications were made to the original HFI to ensure that it suited the New Zealand context. These changes included addition of foods commonly consumed in New Zealand, such as brussel sprouts and kumara, omission of foods not commonly consumed such as low fat crisps and renaming relevant items e.g. ice-lollies renamed to ice-blocks. These changes were made in consultation with a group of expert nutritionists. Further changes to the order and categories of food were made to improve ease of completion of the checklist, such as grouping canned foods together, and also to address any obvious 'bad food' versus 'good food' category perception. After these modifications were made the HFI was pretested in the same convenience sample used to pre-test the 4DEFD and feedback from this pre-testing was incorporated into the final HFI before use in CHALICE. After completion by CHALICE participants the HFI and 4DEFD were returned by mail. If they were not returned in two weeks a follow-up phone call was made by the interviewers to remind participants to complete and return. All returned HFI and 4DEFD were checked for completion by trained nutritionists and a follow-up contact was made to gather more detailed information if needed.

Raw HFI data were entered into the study wide custom built database Progeny 7 (Progeny Software LLC, FL, USA). Data entry accuracy was confirmed by the study database technician by checking the data entered against the questionnaire answers, and screening for data anomalies. Relevant individual foods from the HFI were categorised into the 'Obesogenic Foods' or 'Fruit and Vegetables' categories used in the current study. Sixty-three items on the HFI were classified as 'Obesogenic Foods', being high in saturated fat (SFA) and/or sugar and included foods such as chocolate bars, potato chips and soft drinks, and 222 items as 'Fruit and Vegetables', which included fresh, canned/jars, frozen and dried. Foods/beverages were given a score of one if they were recorded as being present at home or zero if not. In addition to dried fruit there were 25 different fruits included in the HFI which could be recorded as being fresh, canned/jars or frozen. There were 34 different vegetables which could be recorded as fresh, canned/jars, frozen and dried. Foods such as ready-made soups and coleslaw were also included in the vegetable category. In most cases the obesogenic scoring for the HFI was kept consistent with the original, that is, giving an obesogenic score to foods that are high in fat and/or sugar, for example chocolate bars, potato chips and soft drinks and foods that are the regular fat version of which there are lower fat alterna-

tives (e.g. milk and cheese). Foods that were not in the original HFI were considered obesogenic if they were categorised as an occasional food in the Food and Beverage Classification system. The sum of the total amounts of 'Obesogenic Foods' and 'Fruit and Vegetables' was then calculated. These were also converted to percentages to allow for comparison between HFI scores of differing scales. Participants were categorised as having a high or low score based on the population median for both HFI scores.

Four day estimated food diary data were converted to nutrients using the Diet Cruncher nutrient analysis software (Way Down South Software, Dunedin, New Zealand). Macronutrient data (fats, protein, carbohydrate/sugars, fibre) were converted to a percentage of total energy (%TE) using Atwater factors.[20] All nutrient data was dichotomised into 'low' and 'high' categories, using the Australia and New Zealand Nutrient Reference Values where possible.[20] If any participant's %TE exceeded acceptable macronutrient distribution ranges[20] their intakes was classified as high. As less than 10% of all participants had a carbohydrate or protein intake exceeding recommendations, cut points of 50% TE for carbohydrate and 20% TE for protein were used to classify high intakes. Classification of high intakes for monounsaturated fat (MUFA), polyunsaturated fat (PUFA), and total sugar intake were based on the median intake of participants as there are no specific recommended cut points for these nutrients. Micronutrient intake was classified as 'low' or 'high' based on whether the recommended daily intake (RDI) or adequate intake (AI) was met for each micronutrient. Sodium intake was not included in analyses as discretionary salt use was not accounted for.

Statistical methods

Statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) version 20 (IBM, NY, USA). Means, standard deviations, and frequencies were calculated to describe each variable. The normality of scores produced was assessed using the Shapiro-Wilks test. As there is limited evidence that relationships between HFI and nutrients differ between men and women, separate sex analyses were also undertaken. Two binary logistic regression models were fitted with each nutrient as the dependent variable. The first model included both HFI scores, ethnicity and BMI, number of people in the household, and was run separately for men and women. Model 2 included all variables in model 1, and included data from all participants, so was further adjusted for sex. Odds ratios (OR) and 95% confidence intervals (CI) were reported and statistical significance was assumed at the $p< 0.05$ level. The Hosmer-Lemeshow statistic was used to measure goodness of the regression model fit (good fit: $p>0.05$) and it was confirmed that all assumptions for logistic regression were met. Data were only included from participants who had complete data for all variables included in analyses.

RESULTS

Of the 690 people invited to take part in the study at the date these analyses were undertaken, 546 responded and 320 agreed to take part in CHALICE. Three hundred participants completed the baseline assessment and 216 of these (72%) (110 women and 106 men) had complete data for all variables included in these analyses. There were no meaningful differences in any demographic characteristics between those included in these analyses and the complete CHALICE cohort. Results of the Shapiro Wilks test showed that the distribution of both the 'Obesogenic Foods' ($p=0.29$) and the 'Fruit and Vegetables' ($p=0.47$) scores were normal.

Table 1 shows the cut points used for 'low' and 'high' groups for each variable, the percentage classified as high, and mean scores for each sex. Mean BMI for both sexes was within the overweight range of 25-29. A similar percentage of men and women were classified as having high intakes for the HFI scores and the macronutrients. There were some differences in the percentage of men and women with high vitamin and mineral intakes. Only 9% of women had high iron intakes compared with 97% of men. The majority of participants were classified as having low intakes of calcium and selenium.

Relationships between HFI scores and nutrient intakes

Tables 2 and 3 show results of the multiple regression analyses. For all logistic regression analyses, results of the Hosmer-Lemeshow tests showed that presented covariates fit the data well ($p>0.05$). There were no significant associations between total energy, protein or carbohydrate intake and the two HFI scores. Women in the high 'Obesogenic Foods' category were less likely to be in the high category for total fat (OR 0.34, CI: 0.13, 0.90), MUFA (OR 0.38 , CI: 0.16, 0.90) and PUFA (OR 0.28, CI: 0.11, 0.68) but were almost six times more likely to be in the high category for SFA (CI: 1.68, 19.6) and three times more likely to be in the high category for total sugars (CI: 1.23, 7.58). Women in the high 'Fruit and Vegetables' category were almost six times as likely to be in the high vitamin C group (CI: 1.22, 25.8). Men in the high 'Obesogenic Foods' foods category were less likely to be in the high category for folate (OR 0.14, CI: 0.05, 0.40) and fibre (OR 0.21, CI: 0.07, 0.60).

Results from model 2 showed participants with a high 'Obesogenic Foods' score were more than three times as likely to have a high SFA intake (CI: 1.56, 8.02), and also more likely to have lower intakes of PUFA (OR 0.46 CI: 0.24, 0.85) and fibre (OR 0.36 CI: 0.18, 0.72). A low MUFA intake was also associated with a low 'Fruit and Vegetables' score (OR 0.46, CI: 0.29, 0.99). Conversely, participants with a high 'Fruit and Vegetables' score were almost two times as likely to have a high sugar intake (CI: 1.03, 3.64). Women were more than twice as likely as men to have a high sugar intake (CI: 1.31, 4.01); no other differences between the sexes were observed. Adjustment for BMI and ethnicity made no meaningful difference to the results, with the exception that women in the high BMI category were more than twice as likely to have a high total fat intake (CI: 1.04, 6.90). The only significant relationships for minerals and trace elements were that women were almost four times more likely to meet the AI for potassium (CI 2.15, 7.02) and almost seven times more likely to meet the RDI for zinc (CI: 3.67-12.75) than men (data not shown).

Table 1. Variable cut points, percent classified as high and mean intake for women and men

Variable	Women (n=115)			Men (n=101)		
	Cut point for high	% in high group	Mean (SD)	Cut point for high	% in high group	Mean (SD)
BMI (kg/m^2)	≥30	27	27.6	≥30	30	28.1
Home food inventory						
Obesogenic score (% HFI)	≥24.4	47	24.2 (5.67)	≥24.4	54	24.8 (6.48)
Fruit /vegetable score (%HFI)	≥38.5	50	38.9 (6.32)	≥38.5	50	39.1 (6.48)
Energy and macronutrients						
Total energy (kJ)	≥7525	50	7601 (1734)	≥10499	50	10208 (2677)
Total fat (%TE)	≥35	31	32.5 (6.18)	≥35	28	31.6 (5.22)
SFA (%TE)	≥10	78	12.3 (3.06)†	≥10	81	12.4 (2.84)†
MUFA (%TE)	≥11.2	51	11.6 (3.20)	≥11.2	49	11.1 (2.33)
PUFA (%TE)	≥4.51	53	5.17 (2.02)	≥4.51	48	4.62 (1.49)
Protein (%TE)	≥20	21	17.6 (3.51)	≥25	16	16.9 (3.11)
Carbohydrate (%TE)	≥50	12	43.5 (6.58)‡	≥65	14	44.6 (5.76)‡
Total available sugars (%TE)	≥19	58	20.2 (5.83)	≥19.0	41	18.5 (5.94)
Fibre (g/day)	≥25	24	21.3 (6.21)‡	≥30	33	27.0 (9.51)‡
Vitamins						
Total vitamin A (µg/day)	≥700	54	805 (329)	≥900	50	988 (562)
Thiamin (mg/day)	≥1.1	56	1.34 (0.64)	≥1.2	75	1.98 (1.14)
Riboflavin (mg/day)	≥1.1	84	1.85 (0.67)	≥1.3	87	2.27 (1.00)
Niacin equivalents (mg/day)	≥14	100	33.3 (10.2)	≥16	100	44.1 (13.3
Vitamin B-6 (µg/day)	≥1.3	76	1.78 (0.72)	≥1.3	79	2.14 (1.10)
Folate equivalents (µg/day)	≥400	44	390 (158)‡	≥400	57	530 (349
Vitamin B-12 (µg/day)	≥2.4	84	3.83 (1.61)	≥2.4	90	5.11 (2.73)
Vitamin C (mg/day)	≥45	89	112 (77.6)	≥45	86	112 (71.7)
Minerals and trace elements						
Calcium (mg/day)	≥1000	31	876 (343)‡	≥1000	42	962 (389)‡
Potassium (mg/day)	≥2800	71	3299 (840)	≥3800	41	3816 (1148)
Iron (mg/day)	≥18	9	12.2 (3.85)‡	≥8	97	16.2 (5.52)
Selenium (µg/day)	≥60	30	60.1 (65.6)	≥70	26	63.1 (35.6)‡
Magnesium (mg/day)	≥320	47	345 (128)	≥420	36	408 (160)‡
Zinc (mg/day)	≥8	81	10.2 (2.63)	≥14	39	13.7 (4.12)‡

BMI: body mass index; HFI: home food inventory; kJ: kilojoule; TE: total energy; SFA: saturated fatty acids; MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids.
†Exceeds upper limit.
‡Below recommendations.

Table 2. Logistic regression results for high 'Obesogenic Foods' score and nutrient intake

	Women		Men		All participants	
	OR (CI)	*p* value	OR (CI)	*p* value	OR (CI)	*p* value
Total energy	1.19 (0.52, 2.73)	NS	1.10 (0.45, 2.67)	NS	1.12 (0.62, 2.04)	NS
Total fat	0.34 (0.13, 0.90)	0.029	2.61 (0.91, 7.49)	NS	0.83 (0.43, 1.62)	NS
SFA	5.75 (1.68, 19.6)	0.005	2.38 (0.74, 7.70)	NS	3.54 (1.56, 8.02)	0.002
MUFA	0.38 (0.16, 0.90)	0.028	1.61 (0.64. 4.04)	NS	0.70 (0.38, 1.30)	NS
PUFA	0.28 (0.11, 0.68)	0.005	0.71 (0.29, 1.75)	NS	0.46 (0.24, 0.85)	0.013
Protein	0.86 (0.31, 2.36)	NS	0.93 (0.28, 3.10)	NS	0.87 (0.41, 1.88)	NS
Carbohydrate	1.18 (0.33, 4.14)	NS	0.42 (0.11, 1.64)	NS	0.79 (0.32, 1.94)	NS
Total sugar	3.06 (1.23, 7.58)	0.016	0.73 (0.29, 1.85)	NS	1.57 (0.84, 2.95)	NS
Fibre	0.55 (0.21, 1.50)	NS	0.21 (0.07, 0.60)	0.004	0.36 (0.18, 0.72)	0.004
Total vitamin A	1.23 (0.53, 2.83)	NS	0.69 (0.28, 1.69)	NS	0.93 (0.51, 1.71)	NS
Thiamin	1.43 (0.62, 3.30)	NS	0.62 (0.22, 1.79)	NS	1.02 (0.54, 1.94)	NS
Riboflavin	1.65 (0.52, 5.21)	NS	1.23 (0.33, 4.56)	NS	1.45 (0.62, 3.42)	NS
Vitamin B-6	0.78 (0.30, 2.03)	NS	0.75 (0.25, 2.21)	NS	0.81 (0.39, 1.65)	NS
Folate equivalents	0.55 (0.23, 1.29)	NS	0.14 (0.05, 0.40)	<0.0001	0.30 (0.16, 0.58)	<0.0001
Vitamin B-12	2.00 (0.63, 6.36)	NS	1.84 (0.36, 9.37)	NS	1.90 (0.76, 4.74)	NS
Vitamin C	2.30 (0.59, 8.87)	NS	0.76 (0.19, 3.08)	NS	1.33 (0.52, 3.41)	NS
Vitamin E	1.19 (0.47, 3.04)	NS	0.87 (0.36, 2.12)	NS	0.99 (0.52, 1.86)	NS

BMI: body mass index; OR: odds ratio; CI: confidence interval; NS: not significant ($p<0.05$); SFA: saturated fatty acids; MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids.
Results were adjusted for BMI and ethnicity.

Table 3. Logistic regression results for high 'Fruit and Vegetables' score and nutrient intake

	Women		Men		All participants	
	OR (CI)	*p* value	OR (CI)	*p* value	OR (CI)	*p* value
Total energy	1.13 (0.49, 2.63)	NS	0.91 (0.37, 2.26)	NS	1.05 (0.58, 1.91)	NS
Total fat	0.38 (0.14 ,0.99)	0.05	0.63 (0.23, 1.74)	NS	0.54 (0.28, 1.05)	NS
SFA	0.75 (0.26, 2.16)	NS	1.06 (0.33, 3.40)	NS	0.83 (0.39, 1.80)	NS
MUFA	0.50 (0.20, 1.20)	NS	0.52 (0.21, 1.30)	NS	0.53 (0.29, 0.99)	0.045
PUFA	0.47 (0.19, 1.19)	NS	0.68 (0.27, 1.69)	NS	0.64 (0.35, 1.20)	NS
Protein	0.76 (0.28, 2.10)	NS	2.50 (0.69, 9.08)	NS	1.17 (0.54, 2.52)	NS
Carbohydrate	1.08 (0.31, 3.80)	NS	1.23 (0.31, 4.89)	NS	1.24 (0.51, 3.05)	NS
Total sugar	1.58 (0.63, 3.92)	NS	2.53 (0.97, 6.61)	NS	1.94 (1.03, 3.64)	0.04
Fibre	0.87 (0.32 , 2.35)	NS	0.58 (0.21, 1.64)	NS	0.77 (0.39, 1.55)	NS
Total vitamin A	1.56 (0.68, 3.61)	NS	2.03 (0.82, 5.02)	NS	1.69 (0.92, 3.11)	NS
Thiamin	1.23 (0.53, 2.83)	NS	0.68 (0.23, 1.96)	NS	1.00 (0.53, 1.90)	NS
Riboflavin	2.23 (0.69, 7.16)	NS	1.95 (0.51, 7.40)	NS	2.08 (0.87, 4.96)	NS
Vitamin B-6	1.25 (0.47, 3.29)	NS	1.81 (0.61, 5.42)	NS	1.48 (0.72, 3.04)	NS
Folate equivalents	0.53 (0.22, 1.25)	NS	0.62 (0.22, 1.74)	NS	0.58 (0.31, 1.11)	NS
Vitamin B-12	0.87 (0.29, 2.65)	NS	0.71 (0.14, 3.65)	NS	0.86 (0.35, 2.10)	NS
Vitamin C	5.60 (1.22, 25.8)	0.027	3.78 (0.85, 16.8)	NS	4.46 (1.54, 12.9)	0.006
Vitamin E	1.31 (0.51, 3.35)	NS	1.62 (0.66 – 3.97)	NS	1.39 (0.73, 2.64)	NS

BMI: body mass index; OR: odds ratio; CI: confidence interval; NS: not significant ($p<0.05$); SFA: saturated fatty acids; MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids.
Results were adjusted for BMI and ethnicity.

DISCUSSION

HFI scores are associated with intakes of selected nutrients, particularly in women, which suggests that a HFI is a potentially useful tool in large population-based studies for identifying groups who may be at higher risk of chronic disease due to less than optimal dietary intakes. In agreement with previous research, it seems that less healthy habits, such as a greater availability of high fat or sugar foods, seem to have more of an association with dietary intake than healthier habits.[9,12] The 'Obesogenic Foods' score was associated with high SFA intake, and low PUFA and fibre intake, all of which are known dietary risk factors for NCDs.[10] Neither HFI score was associated with energy, carbohydrate or protein intake, which was not surprising given that many study participants had a low %TE for protein or carbohydrate. A high 'Obesogenic Foods' score was associated with high SFA intake, and low PUFA and fibre intake, demonstrating that the obesogenic score is associated with dietary risk factors for NCDs. A high 'Fruit and Vegetables' score was associated with higher sugar intake, but some sugar may be accounted for by that which occurs naturally in fruit, and with a high vitamin C intake, which is to be expected as the main sources of vitamin C in the New Zealand diet are fruit and vegetables.[3]

Although total fat intake was not associated with HFI scores, the associations with SFA were striking. However, given that 78% of women and 81% of men had high SFA intake but mean energy and total fat intakes were better aligned with New Zealand recommendations, this result is, unfortunately, not surprising. Previous work in the CHALICE cohort has shown that the majority of

participants do not consume a heart healthy diet[21] and SFA is one of the nutrients most detrimental to cardiovascular health.[22-24] This finding is also in line with the results of studies where short HFIs were used to measure fat intake. Although the three previously published studies[14-16] did not examine fatty acid groups and focused more broadly on high fat or low fat foods the results are still comparable. Many of the foods included in these inventories were high in SFA and low in MUFA/PUFA such as full fat dairy products, processed meats, and bakery items, all of which are known to be major contributors to SFA intake in NZ adults.[3]

There are no examples in previous literature comparing fruit/vegetable availability from HFI with SFA intake in adults, possibly because of the sheer number of fruit and vegetables that would warrant inclusion. For example, in the HFI used in the present study, 63 items were classified as obesogenic, and 222 were classified as fruit/vegetable. It is of great concern that despite there being such a wide variety of fruit and vegetables available in NZ, SFA intake is so high. This may be because obesogenic foods high in SFA are often cheap and available in a wider range of food outlets compared to fruit and vegetables. NZ Adult Nutrition Survey[3] data showed that a large proportion of NZ adults do not meet the recommendations for fruit and vegetable consumption. Our results suggest that those who have higher home availability of fruit and vegetables may eat more fruit and vegetables compared with those with lower home availability, as evidenced by a higher vitamin C intake, but are also consuming similar amounts of high SFA foods.

People may also enjoy obesogenic foods more than fruit and vegetables: previous work in CHALICE[21] shows that 'having to give up foods I enjoy' is a barrier to eating a more balanced diet. Previous research has shown that dietary advice to improve health must include advice to both increase fruit/vegetable intake and decrease fat intake; and that fruit and vegetables should displace high fat foods in the diet for maximum health benefits.[25, 26] Even though the current study found little evidence of associations between high fruit/vegetable score and better nutrient intake, further work is required in larger samples. Bryant et al[27] in a study using an open HFI, reported a non-significant trend between home fruit/vegetable availability and intake in adults. Also, Satia et al[16] reported higher home availability of low-fat foods was associated with decreased consumption of high-fat foods. There are many strengths in the overall CHALICE design, including the high response rates and a return rate of food diaries of around 75%.[17] This cohort contains a high proportion of men and food diary return rates from men was high.[17] The use of the electoral roll to recruit participants provides a wide participant pool and allows identification of those identifying as Māori, but the Canterbury population may not be representative of the NZ population. The questionnaires used in CHALICE were based on those used in other large and successful studies, for example the HFI developed by Fulkerson et al.[19] The HFI was modified for use in NZ and pre-tested before use in CHALICE to make sure that it was suitable for use in the study. The HFI itself provides a comprehensive list of foods available in NZ. The HFI was completed by participants, which may lead to potentially less accurate results than using an interviewer-administered HFI. However, the use of such an HFI could lead to lower rates of participation.

This research has several limitations related to the HFI. In these analyses, we only adjusted for the total number of people in the household. We were unable to weight these responses by the age and sex of occupants. A boy aged 7 years will not consume as much food as an 18 year old boy, and it is possible that by allocating different weights by age and sex results may change. We also did not adjust for seasonality in these analyses. Availability of particular types of obesogenic foods in shops should not vary by season, but fruit and vegetable availability might differ. In New Zealand prices of fruit and vegetables vary greatly by season. For example the price of broccoli and pumpkins fluctuates considerably by 4-5 times. This means that those with financial constraints may choose different fresh fruit and vegetables over different seasons. However, this would not necessarily result in seasonal effects on variety as they may rely on frozen forms of these instead.

The HFI does not incorporate foods purchased and eaten outside the home and the HFI only measures variety of types/forms of foods rather than quantity. Additionally the HFI does not allow assessment of proportions (in terms of quantity) of healthy versus unhealthy foods. Results may not be generalised to the entire New Zealand population as participants were of a specific age (50 years old) and living in one province in New Zealand.

The 4DEFD is a valid way to measure dietary intake of individuals, is used in many large population studies,[28] and has been shown to correlate well with the gold standard weighed food diary which has a greater respondent burden.[28] The high return rate of 4DEFD by CHALICE participants reflects this. Sodium intake, another key nutrient related to chronic disease risk,[29] was unable to be measured in the current study as participants were not specifically asked to record salt added to food or during cooking. The Diet Cruncher nutrient analysis program also has limitations in that not every food consumed is available in the programme, it cannot distinguish between added and natural sugars, and nutrition composition is based on averages. These issues were minimised in the present study by data entry operators meeting regularly to discuss appropriate estimations to make, use of a standardised operating procedure, and double checking of data entry accuracy. One limitation of this study is its cross-sectional design and we are unable to deduce whether the availability of certain foods in the home actually determines dietary intake. However, future research in this cohort will provide longitudinal information and further research will assess these longitudinal relationships.

In conclusion, HFI is a quick and simple tool which it has been shown are able to identify groups with a high SFA and low PUFA intake, and thus may be at increased risk of chronic disease. Further work is required to ascertain the utility of using a more comprehensive HFI scoring system, compared with scores targeting only obesogenic foods and fruit and vegetables to gain a wider picture of diet quality in relation to the home food environment.

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AUTHOR DISCLOSURES

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