

The association between carbohydrate quality and nutrient adequacy in Australian adults

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Abstract

Background/Objectives: To examine the association between various carbohydrate quality indicators and nutrient adequacy in Australian adults.

Subjects/Methods: Dietary data from adult participants of the 2011-2012 Australian Health Survey (weighted $n = 6,150$) who had completed two 24-hour recalls were analyzed. Glycaemic indices (GI) of foods were estimated based on a published method. Quartiles of dietary GI (dGI) and glycaemic load (dGL), and intakes of high ($\text{CHO}_{\text{highGI}}$) and low GI carbohydrates ($\text{CHO}_{\text{lowGI}}$) were derived. Estimated marginal means and standard errors of nutrient and food group intakes by quartiles were calculated using ANCOVA. Odds ratios of not meeting the nutrient reference values for Australia and New Zealand (NRVs) by quartiles of the carbohydrate quality indicators were calculated by logistic regression. Analyses were adjusted for known confounders.

Results: Participants with higher $\text{CHO}_{\text{highGI}}$ had lower intakes of the majority of nutrients examined, except sodium and %energy from free sugars. They were also more than 100% more likely to not meet the NRVs of vitamin A (2.19, 95%CI: 1.89, 2.84), vitamin C (3.93, 95%CI: 1.61, 9.60), vitamin E (2.63, 95%CI: 2.08, 3.31), iron (2.27, 95%CI: 1.48, 3.49), magnesium (2.50, 95%CI: 2.01, 3.12), potassium (2.25, 95%CI: 1.79, 2.83), %EFS (2.74, 95%CI: 2.22, 3.38), and LCn3PUFA (2.35, 95%CI: 1.76, 3.16). Similar results were observed for dGI and dGL, while trends for $\text{CHO}_{\text{lowGI}}$ were in opposite direction in general.

Conclusions: Of the carbohydrate quality indicators examined, $\text{CHO}_{\text{highGI}}$ was the strongest predictor of nutrient adequacy. Improvement in nutrient adequacy likely contributed to the health protective effect of a low -GI diet.

Keywords: dietary glycaemic index, dietary glycaemic load, nutrient adequacy, Australian adults

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INTRODUCTION

In recent years, there is growing research interest in the role of glycemic index (GI) and glycemic load (GL). The GI is a measure for the quality of dietary carbohydrates, where foods with a low GI cause a smaller increase in postprandial blood glucose due to slower digestion and absorption¹. Since the GI only compares equal quantities of carbohydrate for the measurement of carbohydrate quality, the concept of GL was introduced, which quantifies the overall glycemic effect in a serving of food by taking into account the actual amount of carbohydrates consumed².

Most studies have reported that chronic high GI and GL diets were related to increased risks of chronic diseases, such as type 2 diabetes, cardiovascular diseases, and cancers³. It is believed that such association is related to the regular sharp rises in postprandial blood glucose levels which may lead to hyperinsulinemia and promote the development of insulin resistance⁴. However, there is another concern that chronic high GI and GL diets could also be associated with decreased nutrient adequacy, which may be another causative factor of these chronic diseases⁵. High GI foods such as refined grains (e.g. white bread, cornflakes) and foods with high added sugars (e.g. soft drinks) are commonly micronutrient poor^{6,7}. In contrast, low GI foods such as unrefined grains (e.g. whole-meal breads, brown rice, bran flakes, oatmeal), most fruits and dairy products are usually rich in micronutrients, thus it is believed that following a low GI diet may make it easier for individuals to meet their nutrient requirement⁶.

A previous study by our group had examined the association between dietary GI (dGI) and nutrient adequacy in Australian children and adolescents⁸. Since Australian adults tend to consume close to 45% of their energy from carbohydrates in their usual diets⁸, and the contributors to their dietary GI and GL are different from those of Australia children and adolescents^{8,9}, it is interesting to investigate whether carbohydrate quality also impacts on their nutrient adequacy. This study therefore aims to investigate the association between dGI, dietary GL (dGL) and nutrient adequacy among a nationally representative sample of Australian adults. We additionally investigated how nutritional adequacy is linked to carbohydrate intake from high- ($\text{CHO}_{\text{highGI}}$) or low-GI ($\text{CHO}_{\text{lowGI}}$) foods respectively. We hypothesize that among Australian adults, carbohydrate quality is positively associated with nutrient adequacy.

SUBJECTS AND METHODS

Data source

The 2011-2012 Australian Health Survey (AHS) is the latest national health survey conducted in Australia by the Australian Bureau of Statistics (ABS). This secondary analysis used data from the National Nutrition and Physical Activity Survey (NNPAS) component of the 2011-2012 AHS. The methodology of the NNPAS was previously described in details¹⁰. In brief, the survey measured the dietary intakes of foods, drinks and supplements using a 24-hour recall method on two non-consecutive days (1 face-to-face and 1 over the phone), which is based on the US Department of Agriculture (USDA) Automated Multiple Pass Method (AMPM)^{10,11}. These data were collected between 29 May and 9 June 2012 from 12153 participants, of which 9341 were adults aged 19 years or above. Dietary intake data were then translated into nutrient intake using the AUSNUT2011-13 food composition database¹². Free sugars intake was estimated as previously described^{13,14}.

Data cleaning and estimation of usual intake

Adults who completed only one 24-hour recall ($n = 3288$) or with missing data for covariates ($n = 8$) were excluded from the analyses. The final dataset included 6045 participants who provided two plausible 24-hour recalls (**Figure 1**). The Multiple Source Method (MSM) was used to account for day-to-day variations in dietary intakes based on data from the two 24-hour recalls in order to obtain an estimation of habitual nutrient intakes, especially for nutrients and foods (e.g. seafood) that are episodically consumed¹⁵. In brief, the MSM uses data from at least two repeated short-term dietary assessments to statistically model the probability of consumption and usual intake of foods and nutrients on consumption days based on covariates such as age and sex¹⁵. Therefore, the MSM allows better estimation of the usual intake even if a true consumer reported zero intake on both 24-hour recalls. In the current study, the MSM transformation was performed with age, sex and their interaction term as covariates.

Calculation of dietary GL, GI, and intakes of low- and high-GI carbohydrates

The method used to assign GI values to the food items in the AUSNUT2011-2013 database was previously described^{1,8}. The GL of each food item was calculated as the GI of that food item

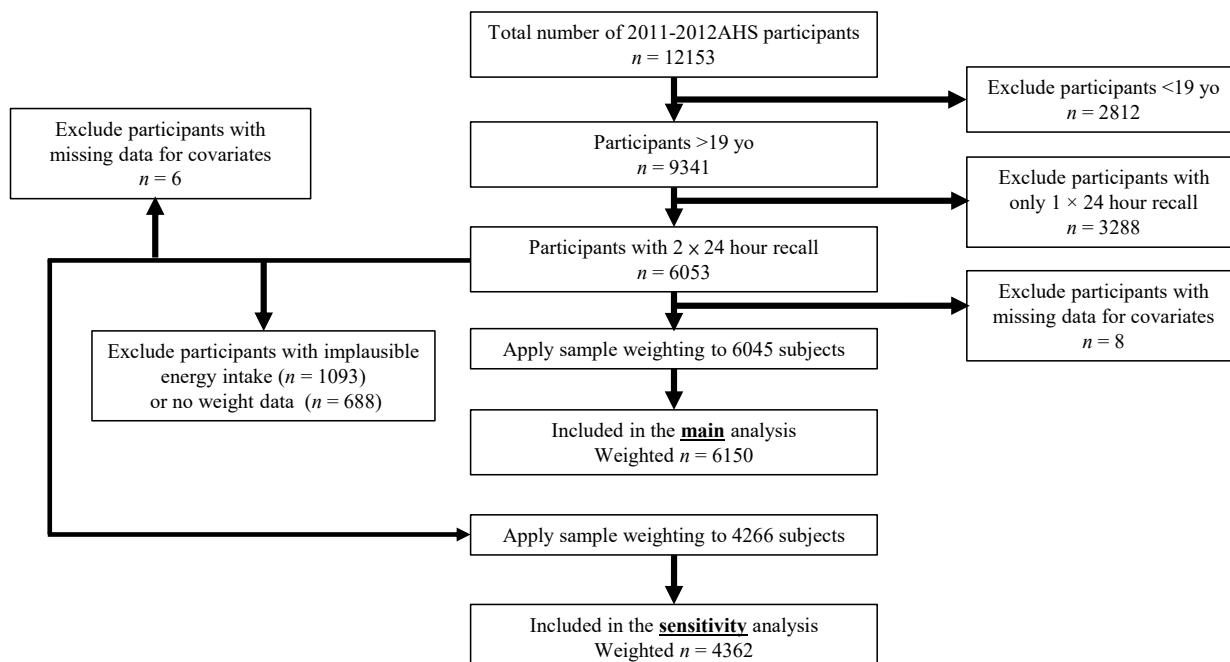


Figure 1 – Flow of participants

(%) × amount (g) of available carbohydrate in a serving of that food, while the daily dGL of each participant was calculated as \sum GL from all foods. The dGI was obtained by $(\text{dGL} / \text{total available carbohydrate intake in the day}) \times 100\%$. Carbohydrates from foods with a GI less than 55 were considered CHO_{lowGI}, whereas those from foods with GI \geq 55 were considered CHO_{highGI}¹⁶.

Comparison against the Nutrient Reference Values for Australia and New Zealand (NRVs)

The usual nutrient intakes calculated by MSM were compared against the NRVs¹⁷. Intake of calcium, iron, iodine, magnesium, zinc, vitamin A (as retinol equivalents), thiamin, riboflavin,

vitamin C and dietary folate equivalents below the estimated average requirement (EAR); intake of potassium, linoleic acid (LA), α -linolenic acid (ALA), long chain omega-3 fatty acid (LCn3PUFA), dietary fiber and vitamin E below the adequate intake (AI); intake of sodium above the upper level (UL) and more than 10% of total energy consumed as saturated fat (%ESFA) were all regarded as not meeting the NRV. While technically not an NRV, intakes above 10% of total energy from free sugars (%EFS) was presented as not meeting the NRV for simplicity in presentation. Dietary vitamin D intake was not assessed in the 2011-2012 AHS¹⁰. Data for phosphorus were not shown because all the participants met its NRV¹⁸.

Table 1 - Characteristics of the 2011-2012 AHS participants ($n = 6,150$) according to quartile of age-, sex- and energy-adjusted CHO_{highGI} residuals

	Q1	Q2	Q3	Q4	p value ¹
Weighted n	1587	1468	1509	1585	-
Age (y)	45.3 \pm 16.9	48.5 \pm 17.8	48.9 \pm 17.8	45.4 \pm 17.7	0.273
BMI (kg/m ²)	27.3 \pm 5.2	27.3 \pm 5.4	27.5 \pm 5.5	27.2 \pm 5.8	0.014
Male (%)	54.2	46.6	40.8	57.0	<0.001
SEIFA (%)					
1 st quintile	15.4	15.1	20.5	19.9	
2 nd quintile	14.3	20.5	18.0	24.7	
3 rd quintile	19.2	20.6	18.8	19.9	<0.001
4 th quintile	20.6	21.2	18.9	16.7	
5 th quintile	30.6	22.7	23.8	18.7	
Household income (%)					
1 st decile	6.4	8.4	8.8	10.8	
2 nd decile	5.2	6.3	9.7	7.9	
3 rd decile	6.4	8.0	7.1	9.0	
4 th decile	7.5	7.4	8.9	6.6	
5 th decile	9.8	10.5	10.5	10.7	
6 th decile	7.4	7.4	7.2	8.7	<0.001
7 th decile	11.5	12.1	9.3	10.5	
8 th decile	9.1	8.6	8.7	8.3	
9 th decile	10.5	9.5	8.5	8.0	
10 th decile	14.9	11.8	8.3	9.4	
Not stated/unknown	11.4	10.2	12.7	10.0	
On diet (%)	18.0	13.8	13.1	9.3	<0.001
Living in urban area (%)	72.5	71.0	72.2	76.7	0.002
Born in English speaking countries (%)	88.0	84.3	81.9	68.7	<0.001
Never smoked (%)	50.7	50.1	47.9	43.2	<0.001
Total energy intake (kJ/day)	8884 \pm 2305	8219 \pm 2153	7863 \pm 2163	8723 \pm 2275	0.006
Fibre (g/day)	23.9 \pm 8.3	22.3 \pm 7.2	21.9 \pm 7.4	23.0 \pm 7.5	<0.001
dGI	50.6 \pm 3.5	53.2 \pm 2.7	55.1 \pm 2.5	57.4 \pm 2.4	<0.001
dGL	101.5 \pm 33.8	104.6 \pm 32.3	111.1 \pm 31.8	139.3 \pm 37.3	<0.001
CHO _{highGI}	69.8 \pm 28.6	90.1 \pm 27.7	106.7 \pm 28.6	150.4 \pm 40.1	<0.001
CHO _{lowGI}	118.0 \pm 48.6	107.3 \pm 35.9	96.8 \pm 33.3	88.9 \pm 33.3	<0.001

Values were presented as mean \pm SD for continuous variables and percentages for categorical variables. Data were weighed to represent the Australian general adult population. BMI, body mass index; CHO_{highGI}, high glycaemic index carbohydrates; CHO_{lowGI}, low glycaemic index carbohydrates; dGI, dietary glycaemic index; dGL, dietary glycaemic load; SEIFA, Socio-Economic Index for Areas

¹Differences between quartiles were tested using one-way ANOVA for continuous variables, and Pearson's χ^2 for categorical variables.

Table 2 - Estimated marginal mean (EMM)¹ ± SE usual intake² of micronutrient according to quartile of age-, sex- and energy-adjusted CHO_{highGI} intake residuals

	Q1	Q2	Q3	Q4	<i>p</i> _{trend} ³
Weighted <i>n</i>	1587	1468	1509	1585	-
Fiber (g)	23.9 ± 0.3	22.3 ± 0.2	22.1 ± 0.3	22.7 ± 0.3	0.108
Vitamin A RE (µg)	874.4 ± 11.9	815.1 ± 10.2	783.3 ± 11.1	754.2 ± 11.0	<0.001
Thiamin (mg)	1.47 ± 0.02	1.48 ± 0.02	1.52 ± 0.02	1.63 ± 0.02	0.108
Riboflavin (mg)	1.94 ± 0.02	1.84 ± 0.02	1.80 ± 0.02	1.85 ± 0.03	<0.001
DFE (µg)	584.0 ± 6.4	585.1 ± 6.9	607.0 ± 6.9	652.0 ± 8.7	0.062
Vitamin C (mg)	112.0 ± 1.9	101.9 ± 1.9	96.1 ± 1.9	92.9 ± 1.9	<0.001
Vitamin E (mg)	11.4 ± 0.1	10.1 ± 0.1	9.6 ± 0.1	9.4 ± 0.1	<0.001
Calcium (mg)	842.0 ± 9.9	775.6 ± 9.3	764.8 ± 9.6	772.2 ± 9.5	<0.001
Iodine (µg)	168.5 ± 1.8	165.8 ± 1.7	167.2 ± 1.8	172.6 ± 1.7	<0.001
Iron (mg)	11.5 ± 0.1	10.8 ± 0.1	10.7 ± 0.1	11.1 ± 0.1	<0.001
Magnesium (mg)	365.6 ± 3.5	328.7 ± 3.1	315.9 ± 3.3	316.6 ± 3.3	<0.001
Phosphorus (mg)	1543.9 ± 12.6	1427.3 ± 11.6	1394.5 ± 12.5	1403.8 ± 12.3	<0.001
Potassium (mg)	3134.2 ± 25.2	2885.1 ± 24.8	2789.5 ± 25.6	2764.2 ± 26.4	<0.001
Zinc (mg)	11.4 ± 0.1	10.6 ± 0.1	10.4 ± 0.1	10.6 ± 0.1	<0.001
Linoleic acid (g)	9.88 ± 0.13	8.87 ± 0.12	8.56 ± 0.11	8.61 ± 0.11	<0.001
α-linolenic acid (g)	1.49 ± 0.02	1.36 ± 0.02	1.27 ± 0.02	1.28 ± 0.02	<0.001
LCn3PUFA (mg)	266.1 ± 5.7	237.0 ± 6.0	206.3 ± 4.3	201.8 ± 4.4	<0.001
Sodium (mg)	2324.8 ± 23.5	2296.0 ± 23.0	2334.8 ± 22.9	2399.4 ± 23.9	<0.001
%ESFA (%)	11.7 ± 0.1	11.8 ± 0.1	11.5 ± 0.1	11.0 ± 0.1	<0.001
%EFS (%)	9.2 ± 0.2	10.0 ± 0.2	10.7 ± 0.2	12.1 ± 0.2	<0.001

%EFS: %energy from free sugars; %ESFA, %energy from saturated fatty acid; CHO_{highGI}, high glycaemic index carbohydrates; DFE, Dietary folate equivalents; LCn3PUFA, Long chain omega 3 polyunsaturated fatty acid; SE, Standard error; RE, Retinol equivalents.

¹EMM ± SE and *p* values were calculated by ANCOVA with age, sex, Socio-Economic Indexes for Areas, equalised household income, country of birth, remoteness of living area and whether on diet as covariates.

²Usual intakes were calculated using the Multiple Source Method (23).

³*p* for trend assessed by linear regression with median of each cut-off as the independent variable, and adjustments for the same covariates as in the ANCOVA.

Assessment of covariates

Age, sex, smoking status, whether on diet, remoteness of living area, equalised household income, socio-economic indexes for areas (SEIFA), and country of birth were obtained during the face-to-face interview of the NNPAS¹⁰. Weight and height of the participants were also measured during the interview and were used to calculate the body mass index. Some of these were recoded into binary variables as follows: whether on diet for health reasons (e.g. low salt diet, diabetic diet) or weight loss (on diet *vs.* normal diet), remoteness of living area (major cities *vs.* rural areas), and country of birth (English speaking countries *vs.* non-English speaking countries).

Food group intakes

Foods included in the AUSNUT2011-2013 were categorized into core and discretionary foods as defined by the ABS¹⁹ (See **Online Supplemental Table 1** for classification), as described previously¹⁸. Core foods were defined as those foods and beverages within the Five Food Groups (“Vegetables”, “Fruit”, “Grain (cereals)”, “Lean meat, poultry, fish, eggs, tofu, nuts and seeds, legumes”, and “Milk, cheese, yoghurt and alternatives”) and plain water, while all other foods were considered as discretionary²⁰. Similar to nutrient intake, the food group intake data were transformed using MSM¹⁵. Results of the food group intakes are presented in **Online Supplemental Tables 2 – 5**.

Statistical analysis

Data were weighted to account for over- or under-sampling of the Australian population aged ≥ 19 years in terms of age group, sex and region, and the weighted sample is representative of the general Australian population. Adjustment was made to the weighting factor to consider the removal of participants with only 1-day data. Age-, sex- and energy-adjusted residuals of dGI, dGL, CHO_{highGI} and CHO_{lowGI} were created by linear regression, with total energy intake, age and sex as covariates. Participants' characteristics were examined for statistically significant differences across quartiles of dGI, dGL, CHO_{highGI} and CHO_{lowGI} residuals using Pearson χ^2 test for categorical variables, and one-way ANOVA for continuous variables. ANCOVA was used to calculate the estimated marginal means (EMM) ± SEM of nutrient intakes across quartiles of dGI, dGL, CHO_{highGI} and CHO_{lowGI}. Logistic regression was used to calculate the odds ratios (ORs) of not meeting the NRVs by quartiles of dGI, dGL, CHO_{highGI} and CHO_{lowGI}. Trend analyses across quartiles were performed by linear and logistic regression for continuous and binary outcomes respectively. The analyses were adjusted for age, sex, SEIFA, equalised household income, remoteness of living area, and country of birth. Further adjustment for total energy intake was not performed, in order to reflect the real-life association between carbohydrate quality and nutrient adequacy in the population. A two-sided *p* < 0.001 was considered statistically significant for ANOVA, ANCOVA and linear regression to reduce the chance of type I error, whereas a two-sided *p* < 0.05 was considered statistically significant for Pearson's

χ^2 test and individual odds ratio^{21, 22}. All statistical analyses were performed by using Statistical Packages for Social Science, version 25.0 (IBM Corporation, New York, USA).

Sensitivity analyses

We performed sensitivity analyses which exclude energy mis-reporters to examine the effect of misreporting on our results. Participants whose energy intake:basal metabolic rate ratio not between 0.96 – 2.49 were excluded. This range was used per the advice of the Australian Bureau of Statistics¹⁰, and is similar to that used in previous studies²³⁻²⁵. We excluded 1093 extreme mis-reporters based on this method. We also excluded 688 participants as they did not have their weight recorded which disallowed the computation of the EI:BMR ratio. Another 6 participants were excluded due to missing data for covariates, leaving a final sample size of 4266 (weighted *n* = 4362). Results of the sensitivity analyses were presented in **Online Supplemental Tables 6-9**. Results and conclusions were not materially different from the main analyses, and hence we presented results without excluding energy mis-reporters to increase the sample size.

RESULTS

Demographic characteristics of the included participants (weighted *n* = 6150) by quartiles CHO_{highGI} are presented in **Table 1**. Participants with higher intake of CHO_{highGI} were more likely to have lower socioeconomic statuses (as indicated by lower SEIFA and household income quantiles), less likely to be on diet and born in English speaking country and have ever smoked (all *p* < 0.001). They also tended to have lower intakes of fiber and CHO_{lowGI}, while having higher dGI and dGL (all *p* < 0.001). Demographic characteristics of the participants for dGI, dGL and CHO_{lowGI} quartiles are presented in **Online Supplemental Tables 10 and 11**.

Table 2 shows the EMM ± SEM usual intake of micronutrients across the quartiles of CHO_{highGI}. Participants with higher intakes of CHO_{highGI} had lower intakes of the majority of nutrients examined, except iodine, sodium and %EFS where increase trends across quartiles were observed (all *p*_{trend} < 0.001). Notably, compared with participants in the first quartile of CHO_{highGI}, those who had the highest CHO_{highGI} intake had 24%, 17%, 14% and 8% lower intakes of LCn3PUFA, vitamin C, vitamin A and calcium respectively, while having close to 3%points higher % EFS.

Participants with higher intakes of CHO_{highGI} were found to be less likely to meet the NRVs for most of the examined nutrients as presented in **Table 3**, with strong dose-dependent patterns observed. When compared with participants with the lowest CHO_{highGI} intake, those with the highest CHO_{highGI} intake had more than 100% increase in odds of not meeting NRVs were observe for vitamin A (2.19, 95%CI: 1.89, 2.84), vitamin C (3.93, 95%CI: 1.61, 9.60), vitamin E (2.63, 95%CI: 2.08, 3.31), iron (2.27, 95%CI: 1.48, 3.49), magnesium (2.50, 95%CI: 2.01, 3.12),

Table 3 - Odds ratios (95%CI)¹ of not meeting NRV² according to quartile of age-, sex- and energy-adjusted CHO_{highGI} intake residuals

	Q1 (ref)		Q2		Q3		Q4		P _{trend}
	Cases (%)	OR (95%CI)	Cases (%)	OR (95%CI)	Cases (%)	OR (95%CI)	Cases (%)	OR (95%CI)	
Fiber	72.5	1.00	78.9	1.51 (1.21, 1.89)	78.8	1.53 (1.22, 1.92)	77.8	1.39 (1.10, 1.76)	0.007
Vitamin A RE	16.1	1.00	17.5	1.18 (0.90, 1.55)	22.6	1.71 (1.33, 2.21)	30.2	2.19 (1.89, 2.84)	<0.001
Thiamin	11.8	1.00	13.1	1.06 (0.79, 1.42)	12.7	0.95 (0.70, 1.27)	10.3	0.73 (0.53, 1.02)	0.048
Riboflavin	4.6	1.00	7.4	1.47 (0.94, 2.31)	9.1	1.78 (1.18, 2.69)	10.6	1.87 (1.24, 2.80)	0.002
DfE	4.5	1.00	6.2	1.35 (0.86, 2.14)	4.8	0.94 (0.60, 1.49)	5.1	1.05 (0.62, 1.78)	0.764
Vitamin C	1.0	1.00	2.2	2.23 (0.90, 5.56)	3.6	3.59 (1.48, 8.74)	3.5	3.93 (1.61, 9.60)	<0.001
Vitamin E	24.6	1.00	32.4	1.62 (1.29, 2.03)	37.6	2.26 (1.81, 2.82)	44.3	2.63 (2.08, 3.31)	<0.001
Calcium	57.9	1.00	71.3	1.56 (1.25, 1.95)	74.1	1.66 (1.32, 2.08)	71.2	1.75 (1.38, 2.21)	<0.001
Iodine	5.5	1.00	6.5	1.12 (0.73, 1.70)	8.1	1.27 (0.86, 1.89)	5.3	0.82 (0.54, 1.25)	0.519
Iron	5.2	1.00	9.1	1.89 (1.27, 2.80)	11.9	2.37 (1.60, 3.51)	9.8	2.27 (1.48, 3.49)	<0.001
Magnesium	26.4	1.00	40.3	1.90 (1.53, 2.36)	48.1	2.69 (2.17, 3.32)	49.2	2.50 (2.01, 3.12)	<0.001
Potassium	61.2	1.00	69.4	1.57 (1.27, 1.94)	75.0	2.21 (1.78, 2.74)	78.7	2.25 (1.79, 2.83)	<0.001
Zinc	28.1	1.00	29.9	1.30 (1.02, 1.66)	29.3	1.46 (1.15, 1.85)	35.4	1.31 (1.02, 1.68)	0.023
Linoleic acid	60.3	1.00	68.2	1.62 (1.30, 2.01)	70.7	2.03 (1.62, 2.54)	74.4	1.96 (1.55, 2.48)	<0.001
α -linolenic acid	24.7	1.00	27.9	1.33 (1.05, 1.68)	31.9	1.78 (1.42, 2.23)	36.4	1.74 (1.38, 2.19)	<0.001
LCn3PUFA	13.6	1.00	15.3	1.34 (1.00, 1.80)	18.0	1.93 (1.43, 2.59)	26.8	2.35 (1.76, 3.16)	<0.001
Sodium	49.6	1.00	40.9	0.82 (0.66, 1.01)	43.0	1.01 (0.82, 1.25)	51.5	1.15 (0.93, 1.44)	0.078
%ESFA	77.6	1.00	77.8	1.07 (0.85, 1.35)	73.0	0.84 (0.67, 1.06)	65.4	0.60 (0.47, 0.75)	<0.001
%EFS	37.5	1.00	44.0	1.43 (1.16, 1.76)	49.5	1.86 (1.52, 2.27)	58.2	2.74 (2.22, 3.38)	<0.001
≥ 4 nutrients not meeting NRV	74.6	1.00	84.8	2.19 (1.70, 2.82)	85.0	2.41 (1.86, 3.12)	88.2	2.58 (1.97, 3.38)	<0.001
≥ 7 nutrients not meeting NRV	38.7	1.00	46.9	1.56 (1.26, 1.92)	54.0	2.26 (1.84, 2.79)	57.6	2.16 (1.74, 2.69)	<0.001
≥ 10 nutrients not meeting NRV	11.8	1.00	18.5	1.85 (1.39, 2.47)	22.7	2.57 (1.95, 3.39)	29.1	2.97 (2.24, 3.95)	<0.001

95%CI, 95% Confidence Intervals; %EFS, %energy from free sugars; %ESFA, %energy from saturated fatty acid; CHO_{highGI}, high glycaemic index carbohydrates; DfE, Dietary folate equivalents; LCn3PUFA, Long chain omega 3 polyunsaturated fatty acid; NRV, Nutrient Reference Values for Australia and New Zealand; OR, Odds ratio; RE, Retinol equivalents.

¹Odds ratios and 95%CI calculated using binary logistic regression, adjusted for age, sex, Socio-Economic Indexes for Areas, equivalised household income, country of birth, remoteness of living area and whether on diet. ²To be considered not meeting NRV, the following criteria were used: for vitamin A, thiamin, riboflavin, dietary folate equivalents, vitamin C, calcium, iodine, iron, magnesium, phosphorus and zinc, intakes less than their respective estimated average requirement (EAR); for fiber, vitamin E, potassium, linoleic acid, α -linolenic acid and long-chain omega-3 polyunsaturated fatty acids, intakes below their respective average intake (AI); for sodium, intakes above the upper level (UL), and for %E from saturated fat and free sugars intakes above 10% total energy intake.

potassium (2.25, 95%CI: 1.79, 2.83), %EFS (2.74, 95% CI: 2.22, 3.38), and LCn3PUFA (2.35, 95%CI: 1.76, 3.16). They were also more than 100% more likely to have ≥ 4 , 7 or 10 nutrients not meeting NRVs. Overall there were stronger and more consistent trends in nutrient intakes and odds of not meeting NRVs across quartiles of CHO_{highGI}. Results by dGI and dGL quartiles were similar in pattern, while those by CHO_{lowGI} quartiles were in general in opposite direction. These results are presented in **Online Supplement Table 12 to 16**.

DISCUSSION

This study shows that among a nationally representative sample of Australian adults, carbohydrate quality, as measured by GI, is a strong predictor of nutrient adequacy. In particular, CHO_{highGI} was a stronger predictor than the other carbohydrate quality indicators. That means Australian adults whose diet is lower in CHO_{highGI} tend to have a more nutritionally adequate diet. The present findings enabled us to better understand the potential etiology regarding the association between dGI, dGL and the risks of chronic diseases²⁶. In the past, some dietitians challenged that following a low-GI diet may restrict food choices, which could result in a poorer dietary quality²⁷. Our finding showed the exact opposite.

The results of this study agree with that of a previous study by our group which examined a similar research question among Australian children and adolescents⁶. Two European studies^{28, 29} also similarly concluded that carbohydrate quality is more important than quantity when determining the micronutrient adequacy of a diet, where individuals who had better quality carbohydrates tend to have higher micronutrient intakes. Since a major determinant of the GI of foods is the degree of processing of the grains used (where highly processed refined grains have high GIs usually), it does not come as a surprise that those with a high CHO_{highGI}/dGI/dGL had poorer nutrient intakes in general. In fact, many of these highly processed grain-based foods are nutrient poor unless fortified³⁰, and the range of nutrients that could be fortified is limited by the relevant food standards. A notable exception is thiamin, where fortification in bread flour is mandatory in Australia³¹. Higher intakes of cereal grains and products amongst participants in higher quartiles of the carbohydrate quality indicators therefore reduced their likelihood of not meeting the thiamin NRV.

Our results suggest that these fortified high GI foods were not the major source of CHO_{highGI} in the study population. On the other hand, low GI foods usually tend to be micronutrient-rich (e.g. dairy products, fruits and vegetables), which allowed individuals with lower dGI/dGL and higher intakes of CHO_{lowGI} to easily meet the NRVs. Food group intake analyses (**Online Supplemental Tables 2-5**) revealed that those who had higher dGI tend to have lower intakes of nutrient-dense foods such as fruit and vegetables, dairy products, legumes as well as nuts and seeds, while having higher intakes of energy-dense nutrient poor foods such as sugar-sweetened beverages, savory snacks, sugars and cereal grains and products. In contrast, the pattern across dGL quartiles is less clear cut between nutrient-dense and energy-dense nutrient poor foods. This could be a result of an overall higher dietary food and carbohydrate intake among those with higher dGL, rather than solely an increase in high GI foods consumption, as evident by the concurrent increase in dGL and CHO_{lowGI}. It is therefore important to consider the overall intake when linking dGL to chronic diseases risks, as dGL could be increased by both quality and quantity of carbohydrates consumed. Using CHO_{highGI} may therefore be a better indicator of poor carbohydrate quality than dGL.

Similar to our previous study in Australian children and adolescents⁶, we found that Australian adults who had higher dGL and/or CHO_{highGI} tended to have poorer intake of polyunsaturated fatty acids (PUFAs). Those who had higher dGI and dGL, and those who consume more CHO_{highGI} tend to include less sources of PUFAs such as fish and seafood products in their diet. They were however more likely to meet the NRV for %ESFA, possibly because they had higher energy intake from total carbohydrates which lowered the %ESFA, rather than lower intakes of saturated fat *per se*. Our findings suggest that dietary advice should be given with the consideration of quality of both carbohydrates and fats, because having a low-GI diet does not guarantee sufficient intake of PUFAs⁶.

In contrast, higher likelihood of having more than 10%EFS were observed uniformly across all 4 carbohydrate quality indicators. Although the most common form of free sugar in Australia, sucrose³², has a medium GI of 65², our calculation of dGI/dGL and classification of CHO_{lowGI} vs. CHO_{highGI} were performed at the food level. Therefore, both low or high GI mixed foods can contribute to the overall free sugar intake, and this may have been exacerbated by not adjusting for total energy intake, although it should better reflect the real-life association between carbohydrate quality and nutrient adequacy.

Our results suggest that simple nutrition education messages focusing on reducing the intakes of CHO_{highGI} may indeed lead to significant improvements in nutrient adequacy, especially when the CHO_{highGI} is replaced by CHO_{lowGI}. In fact, it may be easier for a lay person to focus on reducing the intakes the top CHO_{highGI} contributors in the diet, than choosing low GI options for most if not all foods consumed in order to achieve a low dGI/dGL. The top CHO_{highGI} contributors in Australia were breads and bread rolls, cereal-based mixed dishes, flour and grains, and breakfast cereals (data not shown). A simple message to encourage their replacement with lower GI alternatives, together with a list of high vs. low GI items in these food groups, should be easy to follow for most individuals. This message could complement the current dietary guidelines.

The strengths of our study include the use of a published method¹ to assign GI values to the food items in the 2011–2012 AHS, which increased the reliability of the GI values assigned and allowed comparisons to be made across different studies. Another strength is the use of a nationally representative sample, which allowed our results to be generalized to the Australian adult population. Furthermore, the use of the MSM¹⁵ allowed us to account for the day-to-day variation of dietary intake to get a better estimation of usual food and nutrient intake. Although we only modelled the usual intake using age and sex and their interaction term as covariates, our *post hoc* analysis showed including additional socioeconomic status covariates in the transformation model did not result in material difference in the conclusion (data not shown). Thus we used the data from the simple model in the current study in congruence with our previous analyses^{18, 33}.

This study is however limited in several ways. First, any association between CHO_{highGI}, dGI, dGL, CHO_{lowGI} and nutrient adequacy cannot be confirmed with cause-and-effect relationship, due to the cross-sectional nature of the analysis. Second, while the 2011–2012 AHS is the most recent published national nutrition survey in Australia at the time the analysis was conducted, it is already 7 years old. As the food supply is constantly changing, with new food products emerging from the market regularly, some of which may be enriched with a variety of micronutrients, our results may not be fully translatable to the current situation. Our results should be confirmed when a newer national dataset becomes available. Third, the 24-hour recall method relies heavily on the participants to accurately recall the foods and drinks they have consumed in the past 24 hours, which may be affected by memory bias, particularly for elderly participants^{34, 35}. Ideally, the findings of the present study should be confirmed using datasets that are based on a minimum of 3-day weighed food records, which is usually considered as the criterion reference method. This however would result in high respondent burden, and may result in a lower response rate which renders the collected data non-representative³⁶. Fourth, the study only focused on nutrient intake without considering the bioavailability of nutrients by measuring the biomarkers³⁷, as this method is financially and logistically impractical for a national nutrition survey that includes thousands of participants. For example, absorption of some nutrients such as calcium or other divalent ions may be interfered by phytate that is mostly present in carbohydrate-related foods⁷. The true nutrient adequacy may therefore be worse than that reported in the present study.

CONCLUSIONS

Australian adults who had a high dGI and/or dGL were more likely to be at risk of inadequate intake of several key nutrients due to high intake of CHO_{highGI}. The findings in this study reinforced that the health benefits of a low-GI diet were not only due to the reduction in postprandial glycaemia, but possibly also the improvement in nutrient adequacy.

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Conflicts of interest

Both authors declare they have no conflicts of interest relevant to this manuscript.

Authors' contribution

DKYK – statistical analysis and drafting of manuscript. JCYL – designed and supervised the study, and subsequent editing of the final manuscript. Both authors read and approved the final manuscript. JCYL has primary responsibility of the content presented in this manuscript.

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Online Supporting Material

Supplemental Table 1 – Food groups included in each categories

Food categories	Group codes¹	Food group name¹
<i>Core foods</i>		
Core Non-alcoholic beverages	11101C	Tea, regular, caffeinated, prepared with water (core)
	11102C	Tea, regular, caffeinated, prepared with milk or milk substitute (core)
	11103C	Tea, regular, decaffeinated, prepared with water or milk (core)
	11104C	Tea mixed with other foods (core)
	11105C	Herbal tea (core)
	11201C	Coffee beverage, prepared with water (core)
	11202C	Coffee beverage, prepared with milk or milk substitute (core)
	11203C	Coffee beverage, decaffeinated, prepared with water (core)
	11204C	Coffee beverage, decaffeinated, prepared with milk or milk substitute (core)
	11205C	Dry coffee powder, caffeinated or decaffeinated (core)
	11206C	Coffee substitutes, beverage (core)
	11207C	Coffee substitutes, powders and bases (core)
	11301C	Fruit juices, commercially prepared (core)
	11302C	Fruit juices, freshly-squeezed (core)
	11303C	Fruit juices, fortified (core)
	11304C	Vegetable Juices (core)
	11305C	Vegetable juices, freshly squeezed (core)
	11306C	Fruit and vegetable juice blends (core)
	11701C	Domestic water (including tap, tank/rain water) (core)
	11702C	Purchased packaged water including mineral water (core)
11801C	Fortified beverage flavorings prepared with water or milk (core)	
11803C	Unfortified beverage flavorings prepared with water or milk (core)	
11805C	Breakfast cereal beverages (core)	
Core Cereal grains and products	12101C	Grains (other than rice) and grain fractions (core)
	12102C	Rice and rice grain fractions (core)
	12103C	Cereal flours and starches (core)
	12104C	Cereal flours and starches, fortified (core)
	12201C	Breads, and bread rolls, white, mandatorily fortified (core)
	12202C	Breads, and bread rolls, white, additional voluntary fortification (core)
	12203C	Breads, and bread rolls, white, not stated as to fortification (core)
	12204C	Breads, and bread rolls, mixed grain, mandatorily fortified (core)
	12206C	Breads, and bread rolls, mixed grain, not stated as to fortification (core)
	12207C	Breads, and bread rolls, wholemeal and brown, mandatorily fortified (core)
	12208C	Breads, and bread rolls, wholemeal and brown, additional voluntary fortification (core)
	12209C	Breads, and bread rolls, wholemeal, not stated as to fortification (core)
	12210C	Breads, and bread rolls, rye, mandatorily fortified (core)
	12212C	Breads, and bread rolls, rye, not stated as to fortification (core)
	12213C	Breads, and bread rolls, gluten free (core)
	12214C	Breads, and bread rolls, not stated as to major flour or fortification (core)
	12301C	English-style muffins (core)
	12302C	Flat breads (e.g. Pita bread), wheat based (core)
	12303C	Flat breads (e.g. Pita bread), other cereal flours (core)
	12305C	Sweet breads, buns and scrolls, uniced, unfilled (core)
	12401C	Pasta and noodles, wheat based, other than instant noodles (core)
	12402C	Instant noodles and noodle products, wheat based (core)
	12403C	Pasta and noodles, not wheat based (core)
	12404C	Filled pasta (core)

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Food categories	Group codes ¹	Food group name ¹
Core Cereal grains and products (cont'd)	12501C	Breakfast cereal, corn based (core)
	12502C	Breakfast cereal, corn based, fortified (core)
	12503C	Breakfast cereal, rice based (core)
	12504C	Breakfast cereal, rice based, fortified (core)
	12505C	Breakfast cereal, wheat based (core)
	12506C	Breakfast cereal, wheat based, fortified, sugars ≤ 20 g/100g (core)
	12507C	Breakfast cereal, wheat based, fortified, sugars > 20 g/100g (core)
	12509C	Breakfast cereal, wheat based, with fruit and/or nuts, fortified, sugars ≤ 25 g/100g (core)
	12510C	Breakfast cereal, wheat based, with fruit and/or nuts, fortified, sugars > 25 g/100g (core)
	12511C	Breakfast cereal, mixed grain (core)
	12512C	Breakfast cereal, mixed grain, fortified, sugars ≤ 20 g/100g (core)
	12513C	Breakfast cereal, mixed grain, fortified, sugars > 20 g/100g (core)
	12514C	Breakfast cereal, mixed grain, with fruit and/or nuts (core)
	12515C	Breakfast cereal, mixed grain, with fruit and/or nuts, fortified (core)
	12516C	Breakfast cereal, other (core)
	12601C	Porridge style, oat based (core)
12602C	Porridge style, other cereals (core)	
Core Cereal-based products	13201C	Savory biscuits, wheat based, plain, energy ≤ 1800 kJ per 100 g (core)
	13203C	Savory biscuits, rye based (core)
	13204C	Savory biscuits, rice based (includes rice cakes) (core)
	13205C	Savory biscuits, corn based (core)
	13307C	Scones and rock cakes, plain or with added fruit or vegetables only (core)
	13501C	Pizza, saturated fat ≤ 5 g/100 g (core)
	13503C	Sandwiches and filled rolls, saturated fat ≤ 5 g/100 g (core)
	13505C	Burgers, saturated fat ≤ 5 g/100 g (core)
	13507C	Taco and tortilla-based dishes, saturated fat ≤ 5 g/100 g (core)
	13509C	Savory pasta/noodle and sauce dishes, saturated fat ≤ 5 g/100 g (core)
	13511C	Savory rice-based dishes, saturated fat ≤ 5 g/100 g (core)
	13513C	Savory dumplings (core)
	13514C	Sushi, all types (core)
	13515C	Other savory grain dishes (core)
	13601C	Pancakes, crepes and dishes (core)
13602C	Drop scones, pikelets (core)	
13606C	Crumpets (core)	
Core Spreads and oils	14301C	Polyunsaturated margarine spreads, fat content ≥ 65 g/100g (core)
	14302C	Polyunsaturated margarine spreads, fat content < 65 g/100g (core)
	14303C	Monounsaturated margarine spreads, fat content ≥ 65 g/100g (core)
	14304C	Monounsaturated margarine spreads, fat content < 65 g/100g (core)
	14306C	Margarine spreads with added phytosterols (core)
	14307C	Unspecified margarine spread (core)
	14401C	Polyunsaturated oils (core)
	14402C	Monounsaturated oils (core)
14403C	Unspecified vegetable/nut oils (core)	
Core Fish, sea foods and products	15101C	Fin Fish, Fresh, Frozen (core)
	15102C	Smoked Fish (core)
	15201C	Crustacea, Fresh, Frozen (core)
	15202C	Molluscs, fresh, frozen (core)
	15301C	Fish Roe (core)
	15302C	Eel (core)

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Food categories	Group codes¹	Food group name¹
Core Fish, sea foods and products (cont'd)	15303C	Mixtures of finfish and/or shellfish (core)
	15401C	Packed Fin Fish (core)
	15402C	Packed Crustacea And Molluscs (core)
	15601C	Mixed Dishes With Fish As The Major Component, Plus Sauce (core)
	15602C	Mixed dishes with fish as the major component, with rice, pasta or noodles (core)
	15603C	Mixed seafood dishes with crustacea, molluscs or other seafood products as the major component (core)
	15604C	Mixed seafood dishes with crustacea, molluscs or other seafood products as the major component, with rice, pasta or noodles (core)
Core Fruits and fruit-based products	16101C	Apples (core)
	16102C	Apples, Commercially Sterile (core)
	16103C	Pears (core)
	16104C	Pears, commercially sterile (core)
	16105C	Other pome fruit (core)
	16201C	Berry Fruit (core)
	16202C	Berry Fruit, Commercially Sterile (core)
	16301C	Oranges (core)
	16302C	Lemons And Limes (core)
	16303C	Other Citrus Fruit (core)
	16304C	Citrus fruit, commercially sterile (core)
	16401C	Peaches and nectarines (core)
	16402C	Peaches and nectarines, commercially sterile (core)
	16403C	Other stone fruit (core)
	16404C	Other stone fruit, commercially sterile (core)
	16501C	Bananas (core)
	16502C	Pineapples (core)
	16503C	Other tropical and subtropical fruit, edible peel (core)
	16504C	Other tropical and subtropical fruit, inedible peel (core)
	16505C	Tropical and subtropical fruit, commercially sterile (core)
	16601C	Other Fruit (core)
	16701C	Mixtures Of Two Or More Groups Of Fruit (core)
	16702C	Mixtures Of Two Or More Groups Of Fruit, Commercially Sterile (core)
16801C	Dried Vine Fruit (core)	
16802C	Other dried fruit including mixed dried fruit (core)	
16803C	Dried fruit and nut mixes (core)	
16804C	Preserved Fruit (e.g. Glace) (core)	
16901C	Mixed dishes where fruit is the major component (core)	
Core Eggs and egg-based products	17101C	Eggs, Chicken (core)
	17103C	Eggs, other (Core)
	17201C	Egg Dishes, Savory (e.g. omelet, scrambled, quiche) (core)
	17202C	Egg Dishes, Sweet (e.g. soufflé) (core)
Core Meat, poultry and game and their products	18101C	Beef (core)
	18102C	Lamb and mutton (core)
	18103C	Pork (core)
	18104C	Veal (core)
	18201C	Kangaroo (core)
	18301C	Chicken (core)
	18302C	Other Poultry (e.g. Duck, Turkey) (core)
	18303C	Feathered Game (e.g. Quail, Emu) (core)
	18401C	Liver (core)
	18402C	Kidney (core)

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Food categories	Group codes ¹	Food group name ¹
Core Meat, poultry and game and their products (cont'd)	18403C	Other Organ Meats And Offal (core)
	18404C	Liver Paste, pate and dishes (core)
	18405C	Other organ meat, blood and offal dishes (core)
	18503C	Sausages, frankfurts and saveloys, saturated fat content ≤ 5 g/100g (core)
	18701C	Beef dishes with gravy, sauce or vegetables (core)
	18702C	Beef dishes, added pasta, noodles or rice (core)
	18703C	Beef, crumbed, battered, meatloaf or patty type with cereal and/or vegetables (core)
	18704C	Veal, crumbed, battered, meatloaf or patty type with cereal and/or vegetables (core)
	18705C	Lamb or mutton dishes with gravy, sauce or vegetables (core)
	18706C	Lamb or mutton dishes, added pasta, noodles or rice (core)
	18707C	Lamb or mutton, crumbed, battered, meatloaf or patty type with cereal and/or vegetables (core)
	18708C	Pork dishes with gravy, sauce or vegetables (core)
	18709C	Pork dishes, added pasta, noodles or rice (core)
	18710C	Pork, crumbed, battered, meatloaf or patty type with cereal and/or vegetables (core)
	18711C	Mammalian game meat, mixed dishes (core)
	18712C	Unspecified meat, mixed dishes (core)
	18801C	Sausage dishes with gravy, sauce or vegetables (core)
	18802C	Sausage dishes with gravy, sauce or vegetables, added pasta, noodles or rice (core)
	18803C	Other processed meat, mixed dish (core)
	18901C	Poultry dishes, with gravy, sauce or vegetables (core)
18902C	Poultry dishes, with gravy, sauce or vegetables, added pasta, noodles or rice (core)	
18903C	Poultry crumbed, battered, meatloaf or patty type with cereal and/or vegetables (core)	
Core Dairy products	19101C	Milk, cow, fluid, regular whole, full fat (core)
	19102C	Milk, cow, fluid, regular whole, full fat, fortified (core)
	19103C	Milk, cow, fluid, reduced fat, < 2 g/100g (core)
	19104C	Milk, cow, fluid, reduced fat, < 2 g/100g, fortified (core)
	19105C	Milk, cow, fluid, skim, non-fat (core)
	19106C	Milk, evaporated or condensed, undiluted (core)
	19107C	Milk, powder, cow, dry (core)
	19108C	Milk, non-bovine species (core)
	19109C	Milk, fluid, unspecified (core)
	19201C	Yoghurt, natural, regular fat and high fat (> 4 g/100g fat) (core)
	19202C	Yoghurt, natural, reduced fat (core)
	19203C	Yoghurt, natural, skim and non-fat (core)
	19204C	Yoghurt, flavored or added fruit and/or cereal, high fat (> 4 g/100g fat) (core)
	19205C	Yoghurt, flavored or added fruit, full fat (core)
	19206C	Yoghurt, flavored or added fruit with added cereal, full fat (core)
	19207C	Yoghurt, flavored or added fruit, reduced fat (core)
	19208C	Yoghurt, flavored or added fruit, low fat or skim, sugar sweetened (core)
	19209C	Yoghurt, flavored or added fruit, low fat or skim, intense sweetened (core)
	19210C	Yoghurt, drinks, buttermilk (core)
	19211C	Yoghurt, added nutrients or other substances (core)
	19212C	Yoghurt, unspecified fat (core)
	19401C	Cheese, hard cheese ripened styles (core)
	19402C	Cheese, hard cheese ripened styles, reduced fat (core)
	19403C	Cheese, unripened styles, including cream and cottage cheese, regular fat (core)
	19404C	Cheese, unripened styles, including cream and cottage cheese, reduced fat (core)
	19405C	Cheese, camembert, brie and other surface ripened cheeses (core)
19406C	Cheese, processed (core)	

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Food categories	Group codes ¹	Food group name ¹
Core Dairy products (cont'd)	19407C	Cheese, processed, reduced fat (core)
	19408C	Cheese, not further defined (core)
	19601C	Custard, fat content ≥ 4 g/100 g (core)
	19602C	Custard, fat content <4 g/100 g (core)
	19801C	Milk, coffee/chocolate flavored and milk-based drinks, full fat (core)
	19802C	Milk, other flavored and milk-based drinks, full fat (core)
	19803C	Milk, coffee/chocolate flavored and milk-based drinks, reduced fat (core)
	19804C	Milk, other flavored and milk-based drinks, reduced fat (core)
	19805C	Milk, other flavored and milk-based drinks, not stated as to fat (core)
	19806C	Milk-based fruit drinks (core)
Core Dairy alternatives	20101C	Soy-Based Beverage, Plain (core)
	20102C	Soy-Based Beverage, Plain, Fortified (core)
	20103C	Soy-Based Beverage, Plain, Reduced Fat (core)
	20104C	Soy-Based Beverage, Plain, Reduced Fat, Fortified (core)
	20106C	Cereal- or nut-based milk substitute (Core)
	20107C	Dairy milk substitute, unspecified (Core)
	20201C	Soy-based beverage, regular fat, flavored (Core)
	20202C	Soy-based beverage, reduced fat, flavored (Core)
	20301C	Cheese Substitute (core)
	20501C	Soy-based yoghurts, regular fat (Core)
	20502C	Soy-based yoghurts, reduced fat (Core)
	20601C	Meat substitutes (Core)
	20701C	Dishes where meat substitutes are the major component (Core)
Core Soups	21101C	Soup containing meat, poultry or seafood (Core)
	21102C	Soup, vegetable only (Core)
	21301C	Soup containing meat, poultry or seafood (Core)
	21302C	Soup, vegetable only (Core)
	21401C	Soup containing meat, poultry or seafood (Core)
	21402C	Soup, vegetable only (Core)
	21501C	Soup containing meat, poultry or seafood (Core)
	21502C	Soup, vegetable only (Core)
	21601C	Soup containing meat, poultry or seafood (Core)
	21602C	Soup, vegetable only (Core)
Core Seeds and nuts and their products	22101C	Seeds (core)
	22102C	Seed products (Core)
	22201C	Peanuts (Core)
	22202C	Peanut products (Core)
	22203C	Coconut and coconut products (Core)
	22204C	Other nuts and nut products and dishes (Core)
	22205C	Mixed nuts or nuts and seeds (Core)
Core Sauces	23106C	Savory sauces, tomato based, homemade (Core)
	23305C	Vinegar (Core)
Core Vegetables	24101C	Potatoes (Core)
	24103C	Potato mixed dishes (Core)
	24201C	Cabbage and similar brassica vegetables (Core)
	24202C	Broccoli, broccolini and cauliflower (Core)
	24301C	Carrots (Core)
	24302C	Other root vegetables (Core)
	24401C	Leaf vegetables (Core)
	24402C	Stalk vegetables (Core)

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Food categories	Group codes¹	Food group name¹
Core Vegetables (cont'd)	24403C	Herbs, fresh (Core)
	24404C	Seaweeds (Core)
	24501C	Peas and edible-podded peas (Core)
	24502C	Beans (Core)
	24503C	Sprouts (Core)
	24601C	Tomato (Core)
	24602C	Tomato products (Core)
	24701C	Pumpkin (Core)
	24702C	Squash and zucchini (Core)
	24703C	Mushrooms (Core)
	24704C	Sweetcorn (Core)
	24705C	Other fruiting vegetables (Core)
	24801C	Other vegetables (Core)
	24802C	Onion, leek and garlic (Core)
	24803C	Mixtures of two or more vegetables (Core)
	24901C	Vegetables and sauce (Core)
	24902C	Stuffed vegetables and vegetable dishes (Core)
24904C	Salads, vegetable based (Core)	
24905C	Salads, vegetable based, added meat, fish or eggs (Core)	
Core Legumes and legume-based products	25101C	Mature legumes and pulses (Core)
	25102C	Mature legumes and pulses, commercially sterile (Core)
	25201C	Legume and pulse products (Core)
	25202C	Dishes where mature legumes are the major component (Core)
Core Formulated foods	30101C	Biscuit and bar meal replacement (Core)
	30102C	Meal replacement and similar prepared beverages (Core)
	30103C	Meal replacement and similar dry powders (Core)
	30106C	Supplementary and medical foods prepared beverages (Core)
	30107C	Supplementary and medical foods dry powders (Core)
Core Herbs and spices	31101C	Yeast (Core)
	31201C	Intense sweeteners (Core)
	31302C	Herbs(dried) and spices (Core)
	31304C	Stock, prepared (Core)
	31401C	Essences (Core)
	31502C	Gelatine (Core)
Core Infant foods	32101C	Infant formula, prepared (Core)
	32103C	Toddler formula, prepared (Core)
	32201C	Infant cereals (Core)
	32202C	Infant rusks (Core)
	32301C	Infant fruit and fruit-based desserts (Core)
	32302C	Infant savory dishes, commercial (Core)
	32303C	Infant custards or yoghurts (Core)
	32401C	Infant fruit juices (Core)
<i>Extra foods</i>		
Extra Non-alcoholic beverages	11101E	Tea, regular, caffeinated, prepared with water (Extra)
	11102E	Tea, regular, caffeinated, prepared with milk or milk substitute (Extra)
	11104E	Tea mixed with other foods (Extra)
	11106E	Tea powders and bases (Extra)
	11208E	Coffee-based mixes, beverage (Extra)
	11209E	Dry or concentrate coffee-based mixes (Extra)
	11307E	Fruit drinks (ready to drink or made from concentrate) (Extra)

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Food categories	Group codes¹	Food group name¹
Extra Non-alcoholic beverages (cont'd)	11308E	Vegetable drinks (Extra)
	11309E	Fruit drink, prepared from dry powder (Extra)
	11401E	Cordials, made from concentrate (Extra)
	11402E	Cordials, made from concentrate, intense sweetened (Extra)
	11403E	Cordial concentrate (Extra)
	11404E	Cordial concentrate, intense sweetened (Extra)
	11501E	Soft drinks, non-cola (Extra)
	11502E	Soft drinks, non-cola, intense sweetened (Extra)
	11503E	Soft drinks, cola (Extra)
	11504E	Soft drinks, cola, intense sweetened (Extra)
	11505E	Flavored mineral waters (Extra)
	11506E	Flavored mineral waters, intense sweetened (Extra)
	11601E	Electrolyte drinks (sports drinks) (Extra)
	11602E	Electrolyte drink bases (sport drink bases) (Extra)
	11603E	Energy drinks (Extra)
	11604E	Energy drinks, intense sweetened (Extra)
	11703E	Purchased packaged water, fortified (Extra)
	11802E	Fortified dry beverage flavorings (Extra)
	11803E	Unfortified beverage flavorings prepared with water or milk (Extra)
11804E	Unfortified dry beverage flavorings (Extra)	
11806E	Other beverages (Extra)	
Extra Cereal grains and products	12304E	Savory filled or topped breads and bread rolls (Extra)
	12306E	Sweet breads, buns and scrolls, iced and/or filled (Extra)
	12307E	Fried bread products and garlic breads (Extra)
	12502E	Breakfast cereal, corn based, fortified (Extra)
	12504E	Breakfast cereal, rice based, fortified (Extra)
	12507E	Breakfast cereal, wheat based, fortified, sugars >20 g/100g (Extra)
	12513E	Breakfast cereal, mixed grain, fortified, sugars >20 g/100g (Extra)
	12516E	Breakfast cereal, other (Extra)
Extra Cereal-based products	13101E	Sweet biscuits, plain or flavored including short bread varieties (Extra)
	13102E	Sweet biscuits, plain with fruit or nuts (Extra)
	13103E	Sweet biscuits, with jam, marshmallow or other sugar-based filling (Extra)
	13104E	Sweet biscuits, cream-filled (Extra)
	13105E	Sweet biscuits, chocolate-coated, chocolate chip (Extra)
	13106E	Sweet biscuits, chocolate-coated, chocolate or cream filled (Extra)
	13202E	Savory biscuits, wheat based, plain, energy >1800 kJ per 100 g (Extra)
	13301E	Cakes and cake mixes, chocolate (Extra)
	13302E	Cakes and cake mixes, sponge (Extra)
	13303E	Cakes and cake mixes, other types (Extra)
	13304E	Muffins, cake type, and muffin mixes (Extra)
	13305E	Cake-type desserts (Extra)
	13306E	Slices, biscuit and cake-type (Extra)
	13308E	Scones and rock cakes, with added cheese, chocolate or similar (Extra)
	13309E	Other desserts containing cereal (Extra)
	13401E	Pastry, plain/unfilled, all types (Extra)
	13402E	Sweet pastry products, fruit and/or nut fillings (Extra)
	13403E	Sweet pastry products, egg or dairy based fillings (Extra)
	13404E	Savory pastry products, quiches and flans (Extra)
	13405E	Savory pastry products, pies, rolls and envelopes (Extra)
13406E	Savory pastry products, pies, rolls and envelopes, fried (Extra)	

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Food categories	Group codes ¹	Food group name ¹	
Extra Cereal-based products (cont'd)	13502E	Pizza, saturated fat >5 g/100 g (Extra)	
	13504E	Sandwiches and filled rolls, saturated fat >5 g/100 g (Extra)	
	13506E	Burgers, saturated fat >5 g/100 g (Extra)	
	13508E	Taco and tortilla-based dishes, saturated fat >5 g/100 g (Extra)	
	13510E	Savory pasta/noodle and sauce dishes, saturated fat >5 g/100 g (Extra)	
	13603E	Waffles (Extra)	
	13604E	Batters and batter puddings (Extra)	
Extra Fats and oils	13605E	Doughnuts (Extra)	
	14101E	Butter (Extra)	
	14102E	Butter products (Extra)	
	14201E	Dairy blend, regular, fat content ≥ 65 g/100g (Extra)	
	14202E	Dairy blend, reduced fat, fat content <65 g/100g (Extra)	
	14203E	Dairy fats, unspecified type (Extra)	
	14305E	Cooking margarine (Extra)	
	14501E	Animal-based solid fats (Extra)	
Extra Fish, Seafood and products	14502E	Vegetable-based solid fats (Extra)	
	14601E	Unspecified dairy-based fat or margarine used as a spread (Extra)	
	15501E	Fin fish, battered or crumbed (Extra)	
	15502E	Crustacea, battered or crumbed (Extra)	
	15503E	Molluscs, battered or crumbed (Extra)	
	15504E	Fish and seafood products (Extra)	
	Extra Meat, poultry and game and their products	18501E	Sausage, saturated fat content >5 g/100g (Extra)
		18502E	Frankfurts and saveloys, saturated fat content >5 g/100g (Extra)
18601E		Bacon (Extra)	
18602E		Ham (Extra)	
18603E		Fermented, comminuted meats (e.g. Salami) (Extra)	
18604E		Processed delicatessen meat, mammalian (Extra)	
18605E		Processed delicatessen meat, poultry (Extra)	
18606E		Processed meat, commercially sterile (includes canned meats) (Extra)	
18607E		Dried meats (Extra)	
18703E		Beef, crumbed, battered, meatloaf or patty type with cereal and/or vegetables (Extra)	
18707E		Lamb or mutton, crumbed, battered, meatloaf or patty type with cereal and/or vegetables (Extra)	
18801E		Sausage dishes with gravy, sauce or vegetables (Extra)	
18903E		Poultry crumbed, battered, meatloaf or patty type with cereal and/or vegetables (Extra)	
Extra Dairy products	19106E	Milk, evaporated or condensed, undiluted (Extra)	
	19301E	Cream, regular and increased fat (Extra)	
	19302E	Cream, reduced fat (Extra)	
	19303E	Cream, sour (Extra)	
	19304E	Cream, sour, reduced fat (Extra)	
	19305E	Cream substitute, artificial cream (Extra)	
	19306E	Cream, unspecified type or fat level (Extra)	
	19501E	Ice cream, tub varieties, fat content >10 g/100 g (Extra)	
	19502E	Ice cream, tub varieties, fat content 4 - 10 g/100 g (Extra)	
	19503E	Ice cream, tub varieties, fat content <4 g/100 g (Extra)	
	19504E	Ice cream, individual bar, stick and cone varieties, fat content >10 g/100 g (Extra)	
	19505E	Ice cream, individual bar, stick and cone varieties, fat content 4 - 10 g/100 g (Extra)	
	19506E	Ice cream, individual bar, stick and cone varieties, fat content <4 g/100 g (Extra)	
	19507E	Frozen yoghurts, all types (Extra)	
19508E	Frozen dairy desserts, other (Extra)		

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Food categories	Group codes¹	Food group name¹
Extra Dairy products (cont'd)	19701E	Dairy desserts, smooth or gelatin-based dairy desserts (Extra)
	19702E	Other milk, cheese or cream-based desserts (Extra)
Extra Dairy alternatives	20401E	Soy-based ice confection (Extra)
Extra Soup	21201E	Dry soup mix containing meat, poultry or seafood (Extra)
	21202E	Dry soup mix, vegetable only (Extra)
Extra Sauces	23101E	Gravies (prepared) (Extra)
	23102E	Dry gravy mixes (Extra)
	23103E	Savory sauces, not tomato based, commercial (Extra)
	23104E	Savory sauces, tomato based, commercial (Extra)
	23105E	Savory sauces, not tomato based, homemade (Extra)
	23107E	Savory sauces, commercial, simmer style (Extra)
	23108E	Savory sauces, dairy based, homemade (Extra)
	23109E	Savory pastes (Extra)
	23110E	Dry savory sauces and casserole bases and dry mixes (Extra)
	23201E	Fruit-based pickles, chutneys and relishes (Extra)
	23202E	Vegetable-based pickles, chutneys and relishes (Extra)
	23301E	Mayonnaise and cream-style dressings, full fat (Extra)
	23302E	Mayonnaise and cream-style dressings, reduced or non-fat (Extra)
	23303E	Italian and French-style dressings, full fat (Extra)
	23304E	Italian and French-style dressings, reduced or non-fat (Extra)
	23401E	Bread-based stuffings (Extra)
	23501E	Dairy based dips (Extra)
	23502E	Vegetable based dips (Extra)
	23503E	Legume based dips (Extra)
	23504E	Other dips (Extra)
24903E	Fried vegetable dishes (Extra)	
Extra Savory snacks	26101E	Potato crisps (Extra)
	26102E	Other vegetable crisps (Extra)
	26201E	Corn chips (Extra)
	26202E	Popcorn (Extra)
	26301E	Extruded snacks (Extra)
	26401E	Other snacks (Extra)
Extra Sugars	27101E	Sugar (Extra)
	27102E	Honey and sugar syrups (Extra)
	27103E	Toppings, all flavors (Extra)
	27201E	Jams and preserves, sugar sweetened (Extra)
	27202E	Jams and preserves, reduced sugar (Extra)
	27203E	Sweet spreads, fruit flavored (Extra)
	27204E	Sweet spreads or sauces, chocolate/coffee flavored (Extra)
	27205E	Sauces, sweet, fruit-based (Extra)
	27301E	Sugar-based desserts (Extra)
	27302E	Sugar-based desserts, intense sweetened (Extra)
	27303E	Water ice confection, gelato, sorbet (Extra)
	27304E	Frostings and icing (Extra)
Extra Confectionery	28101E	Chocolate (plain, unfilled varieties) (Extra)
	28102E	Chocolate-based confectionery with nut fillings or additions (Extra)
	28103E	Chocolate-based confectionery with other fillings or additions (Extra)
	28201E	Fruit bar and fruit-based confectionery (Extra)
	28202E	Nut and seed based confectionery (Extra)

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Food categories	Group codes ¹	Food group name ¹
Extra Confectionery (cont'd)	28301E	Muesli and cereal style bars, no fruit (Extra)
	28302E	Muesli and cereal style bars, with fruit and/or nuts (Extra)
	28303E	Muesli and cereal style bars, added coatings or confectionery (Extra)
	28304E	Muesli bar, with fruit or fruit paste filling (Extra)
	28305E	Snack bar, other (Extra)
	28401E	Lollies and other confectionery, sugar sweetened (Extra)
	28402E	Lollies and other confectionery, intense sweetened (Extra)
	28403E	Chewing gum, sugar sweetened (Extra)
	28404E	Chewing gum, artificially sweetened (Extra)
	28405E	Other confectionery (Extra)
Extra Alcoholic beverages	29101E	Beers, > 3.5% alcohol (Extra)
	29102E	Beers, 1.15- 3.5% alcohol, reduced alcohol / light (Extra)
	29201E	Wines, red (including sparkling varieties and rose styles) (Extra)
	29202E	Wines, white (including sparkling varieties) (Extra)
	29203E	Fortified wines (Extra)
	29204E	Reduced alcohol wines (Extra)
	29205E	De-alcoholized and non-alcoholic wine (including sparkling varieties) (Extra)
	29301E	Spirits (Extra)
	29401E	Cider (Extra)
	29402E	Perry (Extra)
	29501E	Liqueurs (Extra)
	29502E	Cocktails and other mixed drinks (Extra)
	29503E	Pre-mixed drinks, cola- or energy-drink based (Extra)
29504E	Pre-mixed drinks, other (Extra)	
Extra Formulated foods	30104E	Sport and protein prepared beverages (Extra)
	30105E	Sport and protein, dry powders (Extra)
Extra Herbs and spices	31102E	Yeast extracts (Extra)
	31103E	Vegetable and meat extracts (Extra)
	31301E	Salt (Extra)
	31303E	Stock cubes and seasonings (Extra)

¹Food group codes and names from the Australian Health Survey 2011-13¹

References

1. Australian Bureau of Statistics. Australian Health Survey, 2011-13. Canberra, ACT, Australia: ABS; 2014.

Online Supplemental Table 2 - Estimated marginal mean¹ ± SE usual intake² of food groups according to quartiles of age-, sex- and energy-adjusted dGI residuals

Food group	Q1	Q2	Q3	Q4	<i>p</i>_{trend}³
Weighted <i>n</i>	1618	1466	1462	1604	-
Core foods					
Non-alcoholic beverages (g)	1700 ± 29	1644 ± 25	1583 ± 28	1549 ± 26	<0.001
<i>Tea and coffee (g)</i>	452.1 ± 9.7	478.9 ± 10.2	470.4 ± 10.2	437.0 ± 10.1	<0.001
<i>Fruit and vegetable juice (g)</i>	54.0 ± 3.3	52.9 ± 3.5	54.6 ± 3.6	39.9 ± 2.8	<0.001
Cereal grains and products (g)	136.2 ± 2.6	159.3 ± 3.0	163.2 ± 3.8	172.2 ± 3.8	<0.001
Cereal-based products (g)	90.7 ± 2.3	105.8 ± 2.7	107.3 ± 2.4	105.9 ± 2.3	<0.001
Fats and oils (g)	2.51 ± 0.11	3.14 ± 0.15	3.61 ± 0.17	3.43 ± 0.16	<0.001
Fish, seafood and products (g)	23.7 ± 1.1	19.0 ± 1.0	21.7 ± 1.2	18.6 ± 1.1	<0.001
Fruit and fruit-based products (g)	163.3 ± 3.9	155.4 ± 3.3	136.9 ± 3.5	109.2 ± 2.9	<0.001
Eggs and egg-based products (g)	18.5 ± 0.8	16.0 ± 0.7	14.9 ± 0.7	12.3 ± 0.6	<0.001
Meat, poultry and game and their products (g)	127.8 ± 2.0	126.2 ± 2.1	129.9 ± 2.1	132.8 ± 2.3	<0.001
Dairy products (g)	224.6 ± 5.9	222.9 ± 6.5	194.1 ± 5.0	165.3 ± 4.6	<0.001
<i>Flavored Milk (g)</i>	32.0 ± 3.0	29.9 ± 3.4	14.9 ± 2.3	11.2 ± 1.9	-
Dairy alternatives (g)	13.7 ± 1.6	8.6 ± 1.4	11.2 ± 1.6	10.0 ± 1.6	-
Soups (g)	50.3 ± 2.7	48.5 ± 3.1	40.8 ± 2.6	39.5 ± 2.6	0.185
Seeds and nuts and their products (g)	8.17 ± 0.56	5.64 ± 0.38	6.21 ± 0.64	3.97 ± 0.36	<0.001
Sauces (g)	1.43 ± 0.18	1.15 ± 0.13	0.92 ± 0.12	0.74 ± 0.13	<0.001
Vegetables (g)	157.2 ± 2.6	152.7 ± 2.7	154.5 ± 2.7	161.8 ± 3.0	<0.001
Legumes and legume-based products (g)	9.84 ± 1.05	8.75 ± 0.88	8.90 ± 1.32	6.14 ± 0.85	<0.001
Formulated foods (g)	7.99 ± 1.38	2.06 ± 0.60	2.15 ± 0.66	1.13 ± 0.50	-
Herbs and spices (g)	1.20 ± 0.30	1.14 ± 0.46	0.35 ± 0.09	0.53 ± 0.19	<0.001
Infant foods (g)	0.16 ± 0.14	0.01 ± 0.01	0.08 ± 0.06	0.39 ± 0.40	-
Discretionary foods					
Non-alcoholic beverages (g)	184.6 ± 7.6	217.9 ± 8.1	243.4 ± 8.7	240.0 ± 9.2	<0.001
<i>Sugar-sweetened beverages (g)</i>	128.6 ± 6.3	172.4 ± 6.9	190.8 ± 7.7	173.1 ± 6.9	<0.001
<i>Intensely sweetened drinks (g)</i>	52.4 ± 5.6	43.4 ± 4.8	48.6 ± 6.4	66.4 ± 7.3	-
Cereal grains and products (g)	2.57 ± 0.58	2.61 ± 0.29	3.72 ± 0.40	5.26 ± 0.89	<0.001
Cereal-based products (g)	58.4 ± 1.4	67.9 ± 1.8	64.8 ± 1.6	55.1 ± 1.4	<0.001
Fats and oils (g)	1.68 ± 0.09	2.09 ± 0.11	1.96 ± 0.11	2.21 ± 0.12	<0.001
Fish, seafood and products (g)	6.04 ± 0.42	7.88 ± 0.64	8.71 ± 0.68	9.46 ± 0.82	<0.001
Meat, poultry and game and their products (g)	23.1 ± 0.8	23.2 ± 0.8	23.9 ± 0.8	22.4 ± 0.7	<0.001
Dairy products (g)	17.7 ± 0.8	19.4 ± 0.9	18.4 ± 0.9	14.2 ± 0.7	<0.001
Dairy alternatives (g)	0.59 ± 0.32	0.32 ± 0.29	0.06 ± 0.04	0.04 ± 0.05	-
Soups (g)	0.02 ± 0.01	0.02 ± 0.01	0.04 ± 0.02	0.01 ± 0.00	-
Sauces (g)	14.7 ± 0.4	14.8 ± 0.4	14.9 ± 0.5	13.9 ± 0.5	<0.001
Vegetables (g)	10.1 ± 0.4	11.8 ± 0.5	13.2 ± 0.6	14.3 ± 0.7	<0.001
Savory Snack (g)	3.46 ± 0.27	3.94 ± 0.34	4.27 ± 0.30	4.48 ± 0.33	<0.001
Sugars (g)	10.5 ± 0.5	13.5 ± 0.6	14.0 ± 0.6	13.3 ± 0.6	<0.001
Confectionery (g)	11.30 ± 0.45	11.92 ± 0.47	11.61 ± 0.46	8.88 ± 0.32	<0.001
Alcoholic beverages (g)	360.5 ± 16.2	213.6 ± 10.9	174.7 ± 9.9	149.3 ± 9.8	<0.001
Formulated foods (g)	9.85 ± 1.62	5.29 ± 1.23	3.64 ± 1.10	2.52 ± 0.98	-
Herbs and spices (g)	0.63 ± 0.06	0.67 ± 0.06	0.81 ± 0.06	0.71 ± 0.06	<0.001

dGI, dietary glycaemic index

¹Calculated by ANCOVA with age, sex, Socio-Economic Indexes for Areas, equivalised household income, country of birth, remoteness of living area and whether on diet as covariates. All negative EMMs were presented as zero.

²Usual intakes were calculated using the Multiple Source Method (23).

³*p* for trend assessed by linear regression with median of each cut-off as the independent variable, and adjustments for the same covariates as in the ANCOVA. *P* for trend not available for core dairy alternatives, flavored milk, core formulated foods, infant foods, intensely sweetened drinks, extra dairy alternatives, extra soups and extra formulated foods due to low number of consumers which shifted the medians of all quartiles to zero.

Online Supplemental Table 3 - Estimated marginal mean¹ ± SE usual intake² of food groups according to quartiles of age-, sex- and energy-adjusted dGL residuals

Food group	Q1	Q2	Q3	Q4	<i>p</i>_{trend}³
Weighted <i>n</i>	1675	1489	1455	1531	-
Core foods					
Non-alcoholic beverages (g)	1735 ± 28	1613 ± 25	1585 ± 26	1533 ± 28	<0.001
<i>Tea and coffee (g)</i>	490.1 ± 10.2	451.4 ± 9.9	469.3 ± 10.4	422.1 ± 9.7	<0.001
<i>Fruit and vegetable juice (g)</i>	44.2 ± 2.9	48.7 ± 3.0	50.2 ± 3.2	58.3 ± 3.9	<0.001
Cereal grains and products (g)	128.1 ± 2.4	144.0 ± 2.7	159.9 ± 3.0	200.6 ± 4.4	<0.001
Cereal-based products (g)	87.9 ± 2.3	99.0 ± 2.2	109.8 ± 2.4	113.9 ± 2.8	<0.001
Fats and oils (g)	3.01 ± 0.16	3.21 ± 0.15	3.16 ± 0.13	3.27 ± 0.16	<0.001
Fish, seafood and products (g)	25.6 ± 1.2	22.1 ± 1.1	16.5 ± 1.0	18.5 ± 1.0	<0.001
Fruit and fruit-based products (g)	129.2 ± 3.1	145.0 ± 3.5	139.0 ± 3.6	152.1 ± 4.0	<0.001
Eggs and egg-based products (g)	21.4 ± 0.8	16.5 ± 0.7	13.0 ± 0.6	10.2 ± 0.5	<0.001
Meat, poultry and game and their products (g)	146.5 ± 2.2	129.7 ± 2.0	125.8 ± 2.1	113.0 ± 2.0	<0.001
Dairy products (g)	188.3 ± 5.8	196.8 ± 5.1	202.2 ± 5.5	219.8 ± 5.9	<0.001
<i>Flavored Milk (g)</i>	21.8 ± 2.8	18.6 ± 2.3	19.8 ± 2.5	27.6 ± 3.3	-
Dairy alternatives (g)	11.70 ± 1.60	10.64 ± 1.53	11.34 ± 1.59	9.97 ± 1.69	-
Soups (g)	42.3 ± 2.4	45.0 ± 2.8	44.0 ± 2.8	48.1 ± 3.2	<0.001
Seeds and nuts and their products (g)	8.64 ± 0.58	5.64 ± 0.36	5.25 ± 0.60	4.20 ± 0.39	<0.001
Sauces (g)	1.54 ± 0.17	1.12 ± 0.16	0.90 ± 0.12	0.64 ± 0.09	<0.001
Vegetables (g)	166.8 ± 2.6	156.0 ± 2.5	146.1 ± 2.6	156.4 ± 3.2	<0.001
Legumes and legume-based products (g)	8.62 ± 0.94	7.85 ± 0.82	8.39 ± 0.96	8.67 ± 1.20	<0.001
Formulated foods (g)	6.65 ± 1.25	2.53 ± 0.83	2.49 ± 0.71	1.55 ± 0.53	-
Herbs and spices (g)	0.89 ± 0.21	0.57 ± 0.16	1.02 ± 0.43	0.74 ± 0.23	0.097
Infant foods (g)	0.16 ± 0.15	0.00 ± 0.03	0.09 ± 0.06	0.43 ± 0.45	-
Discretionary foods					
Non-alcoholic beverages (g)	165.4 ± 7.0	190.0 ± 7.7	234.2 ± 7.6	299.2 ± 10.8	<0.001
<i>Sugar-sweetened beverages (g)</i>	106.7 ± 5.1	132.5 ± 5.6	184.8 ± 6.7	243.3 ± 9.2	<0.001
<i>Intensely sweetened drinks (g)</i>	56.8 ± 6.2	52.4 ± 7.0	49.4 ± 5.0	52.9 ± 6.4	-
Cereal grains and products (g)	2.18 ± 0.37	3.31 ± 0.39	3.26 ± 0.42	4.62 ± 0.60	<0.001
Cereal-based products (g)	55.1 ± 1.5	60.3 ± 1.5	64.0 ± 1.6	66.7 ± 1.7	<0.001
Fats and oils (g)	1.99 ± 0.10	2.07 ± 0.11	1.81 ± 0.10	2.05 ± 0.11	<0.001
Fish, seafood and products (g)	8.77 ± 0.76	8.14 ± 0.65	8.07 ± 0.62	6.97 ± 0.51	<0.001
Meat, poultry and game and their products (g)	26.8 ± 0.9	22.4 ± 0.7	23.2 ± 0.8	19.9 ± 0.6	<0.001
Dairy products (g)	15.8 ± 0.7	16.1 ± 0.8	17.0 ± 0.8	20.6 ± 1.0	<0.001
Dairy alternatives (g)	0.43 ± 0.29	0.41 ± 0.27	0.10 ± 0.12	0.06 ± 0.04	-
Soups (g)	0.02 ± 0.01	0.01 ± 0.01	0.03 ± 0.01	0.04 ± 0.02	-
Sauces (g)	16.1 ± 0.5	14.6 ± 0.5	13.7 ± 0.4	13.7 ± 0.4	<0.001
Vegetables (g)	11.1 ± 0.5	12.5 ± 0.6	11.9 ± 0.6	13.9 ± 0.7	0.983
Savory Snack (g)	3.89 ± 0.28	3.19 ± 0.25	4.28 ± 0.29	4.77 ± 0.39	<0.001
Sugars (g)	10.4 ± 0.5	11.6 ± 0.5	12.6 ± 0.5	16.8 ± 0.7	<0.001
Confectionery (g)	9.64 ± 0.40	11.06 ± 0.44	10.80 ± 0.45	12.18 ± 0.52	<0.001
Alcoholic beverages (g)	442.8 ± 16.1	193.3 ± 9.2	150.8 ± 9.3	192.9 ± 8.0	<0.001
Formulated foods (g)	9.65 ± 1.54	6.53 ± 1.49	2.43 ± 0.62	2.38 ± 0.99	-
Herbs and spices (g)	0.65 ± 0.06	0.76 ± 0.07	0.60 ± 0.05	0.80 ± 0.06	<0.001

dGL, dietary glycaemic load

¹Calculated by ANCOVA with age, sex, Socio-Economic Indexes for Areas, equivalised household income, country of birth, remoteness of living area and whether on diet as covariates. All negative EMMs were presented as zero.

²Usual intakes were calculated using the Multiple Source Method (23).

³*p* for trend assessed by linear regression with median of each cut-off as the independent variable, and adjustments for the same covariates as in the ANCOVA. *P* for trend not available for core dairy alternatives, flavored milk, core formulated foods, infant foods, intensely sweetened drinks, extra dairy alternatives, extra soups and extra formulated foods due to low number of consumers which shifted the medians of all quartiles to zero.

Online Supplemental Table 4 - Estimated marginal mean¹ ± SE usual intake² of food groups according to quartiles of age-, sex- and energy-adjusted CHO_{highGI} intake residuals

Food group	Q1	Q2	Q3	Q4	<i>p</i>_{trend}³
Weighted <i>n</i>	1587	1468	1509	1585	-
Core foods					
Non-alcoholic beverages (g)	1697 ± 28	1671 ± 25	1561 ± 25	1549 ± 28	<0.001
<i>Tea and coffee (g)</i>	468.6 ± 10.1	467.7 ± 10.2	453.3 ± 10.0	446.4 ± 10.2	<0.001
<i>Fruit and vegetable juice (g)</i>	56.6 ± 3.3	52.0 ± 3.5	51.7 ± 3.3	40.6 ± 3.1	<0.001
Cereal grains and products (g)	148.3 ± 2.9	149.2 ± 2.8	154.4 ± 3.0	177.4 ± 4.2	<0.001
Cereal-based products (g)	89.8 ± 2.4	91.1 ± 2.1	105.9 ± 2.2	121.4 ± 2.7	<0.001
Fats and oils (g)	2.89 ± 0.13	3.01 ± 0.14	3.50 ± 0.17	3.24 ± 0.15	<0.001
Fish, seafood and products (g)	26.1 ± 1.2	21.4 ± 1.2	17.5 ± 0.9	18.0 ± 1.0	<0.001
Fruit and fruit-based products (g)	158.5 ± 3.9	147.8 ± 3.5	133.3 ± 3.2	124.7 ± 3.3	<0.001
Eggs and egg-based products (g)	15.5 ± 0.8	17.0 ± 0.8	13.9 ± 0.6	11.3 ± 0.6	<0.001
Meat, poultry and game and their products (g)	136.0 ± 2.3	131.9 ± 2.0	127.9 ± 2.1	121.2 ± 2.1	0.158
Dairy products (g)	206.7 ± 6.1	198.1 ± 5.1	201.3 ± 5.5	199.6 ± 5.4	0.735
<i>Flavored Milk (g)</i>	25.7 ± 3.0	23.0 ± 2.5	20.6 ± 2.8	18.8 ± 2.5	0.344
Dairy alternatives (g)	14.75 ± 1.74	9.51 ± 1.47	11.16 ± 1.69	8.20 ± 1.40	-
Soups (g)	49.9 ± 2.8	46.1 ± 2.7	44.5 ± 2.9	38.7 ± 2.7	0.036
Seeds and nuts and their products (g)	8.95 ± 0.58	5.74 ± 0.42	4.44 ± 0.31	4.79 ± 0.53	<0.001
Sauces (g)	1.45 ± 0.18	1.20 ± 0.15	0.93 ± 0.14	0.68 ± 0.09	<0.001
Vegetables (g)	166.1 ± 2.6	159.6 ± 2.6	151.7 ± 2.8	149.5 ± 2.9	<0.001
Legumes and legume-based products (g)	8.83 ± 0.97	9.08 ± 0.97	8.28 ± 0.87	7.42 ± 1.10	<0.001
Formulated foods (g)	8.01 ± 1.51	2.20 ± 0.51	2.03 ± 0.59	1.21 ± 0.47	-
Herbs and spices (g)	0.89 ± 0.21	1.25 ± 0.46	0.62 ± 0.24	0.50 ± 0.19	0.368
Infant foods (g)	0.17 ± 0.15	0.04 ± 0.04	0.02 ± 0.05	0.40 ± 0.42	-
Discretionary foods					
Non-alcoholic beverages (g)	187.8 ± 8.6	188.6 ± 7.5	216.4 ± 7.2	288.5 ± 9.5	<0.001
<i>Sugar-sweetened beverages (g)</i>	131.9 ± 6.9	137.2 ± 6.0	163.8 ± 6.0	226.6 ± 7.9	<0.001
<i>Intensely sweetened drinks (g)</i>	55.6 ± 6.6	48.4 ± 5.7	45.9 ± 5.2	61.5 ± 7.0	-
Cereal grains and products (g)	2.24 ± 0.33	3.37 ± 0.42	3.52 ± 0.44	4.14 ± 0.55	<0.001
Cereal-based products (g)	62.3 ± 1.7	62.9 ± 1.6	59.7 ± 1.4	60.5 ± 1.5	<0.001
Fats and oils (g)	1.93 ± 0.10	2.07 ± 0.12	1.93 ± 0.10	2.00 ± 0.11	<0.001
Fish, seafood and products (g)	6.77 ± 0.54	8.49 ± 0.84	8.30 ± 0.57	8.50 ± 0.62	<0.001
Meat, poultry and game and their products (g)	24.2 ± 0.8	23.1 ± 0.8	23.6 ± 0.7	21.7 ± 0.7	<0.001
Dairy products (g)	17.0 ± 0.8	18.3 ± 0.9	16.1 ± 0.7	18.0 ± 0.9	<0.001
Dairy alternatives (g)	0.73 ± 0.39	0.17 ± 0.12	0.08 ± 0.08	0.04 ± 0.06	-
Soups (g)	0.02 ± 0.01	0.04 ± 0.02	0.01 ± 0.01	0.02 ± 0.01	-
Sauces (g)	15.7 ± 0.5	14.4 ± 0.4	14.3 ± 0.4	13.9 ± 0.4	<0.001
Vegetables (g)	9.5 ± 0.4	11.5 ± 0.5	12.2 ± 0.5	16.1 ± 0.8	<0.001
Savory Snack (g)	3.54 ± 0.29	3.67 ± 0.27	3.83 ± 0.26	5.05 ± 0.39	<0.001
Sugars (g)	10.5 ± 0.5	11.9 ± 0.5	13.6 ± 0.6	15.2 ± 0.7	<0.001
Confectionery (g)	10.7 ± 0.4	11.5 ± 0.4	10.4 ± 0.4	11.0 ± 0.5	<0.001
Alcoholic beverages (g)	317.0 ± 14.7	232.9 ± 12.6	187.9 ± 10.1	165.7 ± 11.2	<0.001
Formulated foods (g)	8.32 ± 1.43	6.65 ± 1.52	4.21 ± 0.94	2.35 ± 1.09	-
Herbs and spices (g)	0.62 ± 0.06	0.76 ± 0.07	0.63 ± 0.05	0.81 ± 0.06	<0.001

CHO_{highGI}, high glycaemic index carbohydrates

¹Calculated by ANCOVA with age, sex, Socio-Economic Indexes for Areas, equivalised household income, country of birth, remoteness of living area and whether on diet as covariates. All negative EMMs were presented as zero.

²Usual intakes were calculated using the Multiple Source Method (23).

³*p* for trend assessed by linear regression with median of each cut-off as the independent variable, and adjustments for the same covariates as in the ANCOVA. *P* for trend not available for core dairy alternatives, flavored milk, core formulated foods, infant foods, intensely sweetened drinks, extra dairy alternatives, extra soups and extra formulated foods due to low number of consumers which shifted the medians of all quartiles to zero.

Online Supplemental Table 5 - Estimated marginal mean¹ ± SE usual intake² of food groups according to quartiles of age-, sex- and energy-adjusted CHO_{lowGI} intake residuals

Food group	Q1	Q2	Q3	Q4	<i>p</i>_{trend}³
Weighted <i>n</i>	1685	1585	1450	1429	-
Core foods					
Non-alcoholic beverages (g)	1595 ± 28	1596 ± 25	1633 ± 28	1661 ± 27	<0.001
<i>Tea and coffee (g)</i>	466.5 ± 10.2	449.4 ± 10.3	451.5 ± 9.3	468.0 ± 10.3	<0.001
<i>Fruit and vegetable juice (g)</i>	33.9 ± 2.7	45.6 ± 2.8	53.1 ± 3.2	71.6 ± 4.3	<0.001
Cereal grains and products (g)	145.4 ± 3.4	145.0 ± 3.0	158.4 ± 3.0	184.8 ± 4.1	<0.001
Cereal-based products (g)	104.9 ± 2.5	99.1 ± 2.1	97.9 ± 2.2	106.8 ± 3.0	0.022
Fats and oils (g)	3.33 ± 0.16	3.16 ± 0.14	3.05 ± 0.14	3.07 ± 0.14	<0.001
Fish, seafood and products (g)	22.2 ± 1.1	20.7 ± 1.1	20.9 ± 1.1	19.0 ± 1.0	<0.001
Fruit and fruit-based products (g)	103.7 ± 2.7	124.6 ± 3.2	154.3 ± 3.2	189.7 ± 4.4	<0.001
Eggs and egg-based products (g)	17.9 ± 0.8	14.8 ± 0.6	15.1 ± 0.7	13.5 ± 0.6	<0.001
Meat, poultry and game and their products (g)	142.2 ± 2.3	127.5 ± 1.9	126.2 ± 1.9	118.8 ± 2.1	<0.001
Dairy products (g)	163.0 ± 5.1	188.2 ± 4.7	212.8 ± 5.3	250.1 ± 6.8	<0.001
<i>Flavored Milk (g)</i>	13.9 ± 2.3	15.5 ± 2.0	25.1 ± 2.7	35.6 ± 3.8	-
Dairy alternatives (g)	9.61 ± 1.58	10.60 ± 1.57	9.59 ± 1.41	14.20 ± 1.79	-
Soups (g)	38.3 ± 2.8	41.6 ± 2.4	47.1 ± 2.8	53.6 ± 3.2	<0.001
Seeds and nuts and their products (g)	6.58 ± 0.55	5.48 ± 0.51	5.68 ± 0.47	6.25 ± 0.42	<0.001
Sauces (g)	1.18 ± 0.17	1.04 ± 0.12	0.99 ± 0.13	1.04 ± 0.14	<0.001
Vegetables (g)	159.1 ± 2.7	156.7 ± 2.7	155.6 ± 2.8	155.0 ± 2.9	<0.001
Legumes and legume-based products (g)	5.55 ± 0.72	8.34 ± 0.92	7.55 ± 0.78	12.65 ± 1.66	<0.001
Formulated foods (g)	3.52 ± 0.99	3.37 ± 0.88	2.55 ± 0.73	4.14 ± 0.96	-
Herbs and spices (g)	0.50 ± 0.16	0.55 ± 0.14	0.70 ± 0.18	1.57 ± 0.55	0.242
Infant foods (g)	0.41 ± 0.37	0.14 ± 0.12	0.03 ± 0.04	0.04 ± 0.03	-
Discretionary foods					
Non-alcoholic beverages (g)	224.7 ± 8.8	215.9 ± 7.6	201.6 ± 7.3	241.7 ± 9.7	<0.001
<i>Sugar-sweetened beverages (g)</i>	161.7 ± 6.7	153.3 ± 5.8	153.2 ± 6.5	195.6 ± 8.7	<0.001
<i>Intensely sweetened drinks (g)</i>	59.2 ± 7.0	61.6 ± 6.7	48.5 ± 5.1	40.8 ± 4.6	-
Cereal grains and products (g)	3.13 ± 0.39	3.48 ± 0.52	3.24 ± 0.38	3.42 ± 0.44	<0.001
Cereal-based products (g)	52.6 ± 1.4	58.2 ± 1.5	61.2 ± 1.5	75.3 ± 1.8	<0.001
Fats and oils (g)	2.04 ± 0.11	2.11 ± 0.12	1.92 ± 0.10	1.83 ± 0.10	<0.001
Fish, seafood and products (g)	10.79 ± 0.86	8.57 ± 0.58	6.25 ± 0.49	5.87 ± 0.44	<0.001
Meat, poultry and game and their products (g)	25.5 ± 0.8	22.9 ± 0.7	23.2 ± 0.7	20.6 ± 0.7	<0.001
Dairy products (g)	14.8 ± 0.8	15.4 ± 0.6	18.8 ± 0.9	21.0 ± 1.0	<0.001
Dairy alternatives (g)	0.30 ± 0.24	0.06 ± 0.08	0.46 ± 0.34	0.21 ± 0.13	-
Soups (g)	0.01 ± 0.00	0.01 ± 0.01	0.02 ± 0.01	0.06 ± 0.02	-
Sauces (g)	14.9 ± 0.5	14.5 ± 0.4	14.6 ± 0.4	14.1 ± 0.5	<0.001
Vegetables (g)	15.2 ± 0.7	12.5 ± 0.6	10.9 ± 0.4	10.2 ± 0.4	<0.001
Savory Snack (g)	4.73 ± 0.33	4.09 ± 0.29	3.34 ± 0.23	3.85 ± 0.35	<0.001
Sugars (g)	11.9 ± 0.6	12.2 ± 0.5	12.8 ± 0.6	14.4 ± 0.6	<0.001
Confectionery (g)	8.99 ± 0.42	10.22 ± 0.41	11.68 ± 0.43	13.08 ± 0.53	<0.001
Alcoholic beverages (g)	294.2 ± 13.9	253.3 ± 12.9	194.0 ± 10.3	148.7 ± 10.2	<0.001
Formulated foods (g)	7.53 ± 1.57	4.65 ± 1.14	5.94 ± 1.21	3.06 ± 0.98	-
Herbs and spices (g)	0.73 ± 0.06	0.68 ± 0.06	0.74 ± 0.07	0.66 ± 0.05	<0.001

CHO_{lowGI}, low glycaemic index carbohydrates

¹Calculated by ANCOVA with age, sex, Socio-Economic Indexes for Areas, equivalised household income, country of birth, remoteness of living area and whether on diet as covariates. All negative EMMs were presented as zero.

²Usual intakes were calculated using the Multiple Source Method (23).

³*p* for trend assessed by linear regression with median of each cut-off as the independent variable, and adjustments for the same covariates as in the ANCOVA. *P* for trend not available for core dairy alternatives, flavored milk, core formulated foods, infant foods, intensely sweetened drinks, extra dairy alternatives, extra soups and extra formulated foods due to low number of consumers which shifted the medians of all quartiles to zero.

Online Supplemental Table 6 - Characteristics of the 2011-2012AHS participants ($n = 4362$) according to quartile of age-, sex- and energy-adjusted CHO_{highGI} intake residuals – sensitivity analysis

	Q1	Q2	Q3	Q4	<i>p</i> value ¹
Weighted <i>n</i>	1110	1085	1103	1074	-
Age (y)	43.5 ± 16.5	49.5 ± 17.0	48.1 ± 18.2	45.5 ± 17.9	<0.001
BMI (kg/m ²)	26.8 ± 4.9	26.8 ± 4.9	26.9 ± 5.1	26.8 ± 5.5	0.875
Male (%)	59.1	47.7	44.1	59.0	<0.001
SEIFA (%)					
1 st quintile	16.1	13.7	18.5	20.6	
2 nd quintile	14.2	18.9	18.9	26.2	
3 rd quintile	17.5	21.1	21.4	18.7	<0.001
4 th quintile	21.2	22.1	16.1	16.6	
5 th quintile	31.0	24.2	25.1	17.9	
Household income (%)					
1 st decile	5.6	8.2	8.0	10.6	
2 nd decile	4.9	6.4	8.6	8.0	
3 rd decile	6.5	8.2	8.7	8.5	
4 th decile	7.0	7.5	9.6	6.4	
5 th decile	10.2	9.4	10.6	12.5	
6 th decile	8.4	7.5	7.7	8.3	<0.001
7 th decile	11.4	12.0	9.0	10.6	
8 th decile	9.6	9.1	10.5	8.3	
9 th decile	10.4	10.0	9.3	9.3	
10 th decile	16.2	12.8	8.5	9.2	
Not stated/unknown	9.9	9.1	9.4	8.1	
On diet (%)	16.4	12.5	11.7	7.5	<0.001
Living in urban area (%)	72.5	69.4	72.5	74.8	0.045
Born in English speaking countries (%)	87.8	85.2	81.7	70.2	<0.001
Never smoked (%)	50.7	50.1	47.9	43.2	<0.001
Total energy intake (kJ/day)	9295 ± 2038	8671 ± 1998	8428 ± 1853	9238 ± 2127	<0.001
Fibre (g/day)	24.6 ± 7.9	23.6 ± 7.4	23.2 ± 7.2	24.0 ± 7.3	<0.001
dGI	50.8 ± 3.2	53.2 ± 2.7	55.1 ± 2.3	57.1 ± 2.3	<0.001
dGL	106.3 ± 30.8	110.4 ± 30.9	119.4 ± 28.5	146.9 ± 35.1	<0.001
CHO _{highGI}	73.3 ± 26.5	94.4 ± 26.7	114.5 ± 25.9	158.2 ± 38.1	<0.001
CHO _{lowGI}	125.0 ± 46.1	113.6 ± 36.2	103.6 ± 31.9	94.2 ± 33.1	<0.001

Values were presented as mean ± SD for continuous variables and percentages for categorical variables. Data were weighed to represent the Australian general adult population.

BMI, body mass index; CHO_{highGI}, high glycaemic index carbohydrates; CHO_{lowGI}, low glycaemic index carbohydrates; dGI, dietary glycaemic index; dGL, dietary glycaemic load; SEIFA, Socio-Economic Index for Areas

¹Differences between quartiles were tested using one-way ANOVA for continuous variables, and Pearson's χ^2 for categorical variables.

Online Supplemental Table 7 - Estimated marginal mean (EMM)¹ ± SE usual intake² of micronutrient according to quartile of age-, sex- and energy-adjusted CHO_{highGI} intake residuals – sensitivity analysis

	Q1	Q2	Q3	Q4	<i>p</i> _{trend} ³
Weighted <i>n</i>	1110	1085	1103	1074	-
Fiber (g)	24.6 ± 0.3	23.6 ± 0.3	23.4 ± 0.3	23.9 ± 0.3	<0.001
Vitamin A RE (µg)	898.5 ± 15.0	848.6 ± 11.9	812.2 ± 12.2	795.9 ± 13.7	<0.001
Thiamin (mg)	1.51 ± 0.02	1.55 ± 0.02	1.58 ± 0.02	1.69 ± 0.03	<0.001
Riboflavin (mg)	1.98 ± 0.03	1.95 ± 0.03	1.88 ± 0.02	1.95 ± 0.04	<0.001
DFE (µg)	595.2 ± 7.6	617.8 ± 8.4	635.5 ± 7.0	674.3 ± 11.4	<0.001
Vitamin C (mg)	114.8 ± 2.3	106.5 ± 2.3	102.4 ± 2.1	97.1 ± 2.3	<0.001
Vitamin E (mg)	11.7 ± 0.2	10.8 ± 0.1	10.1 ± 0.1	10.0 ± 0.1	<0.001
Calcium (mg)	857.6 ± 11.3	826.9 ± 11.2	804.6 ± 9.4	809.6 ± 11.3	<0.001
Iodine (µg)	173.2 ± 2.2	173.0 ± 2.0	174.8 ± 1.8	180.5 ± 2.0	<0.001
Iron (mg)	11.8 ± 0.1	11.5 ± 0.1	11.3 ± 0.1	11.7 ± 0.1	<0.001
Magnesium (mg)	377.3 ± 4.3	350.8 ± 3.6	331.6 ± 3.4	334.5 ± 4.0	<0.001
Phosphorus (mg)	1592.9 ± 14.5	1513.3 ± 13.3	1467.6 ± 12.5	1478.4 ± 14.7	<0.001
Potassium (mg)	3222.3 ± 28.4	3066.5 ± 28.5	2921.3 ± 27.3	2904.9 ± 31.1	<0.001
Zinc (mg)	11.7 ± 0.1	11.3 ± 0.1	11.0 ± 0.1	11.1 ± 0.1	<0.001
Linoleic acid (g)	10.29 ± 0.16	9.58 ± 0.14	8.93 ± 0.12	9.26 ± 0.14	<0.001
α-linolenic acid (g)	1.54 ± 0.03	1.47 ± 0.03	1.35 ± 0.02	1.37 ± 0.02	<0.001
LCn3PUFA (mg)	269.0 ± 6.8	246.1 ± 7.3	211.3 ± 4.8	214.0 ± 5.7	<0.001
Sodium (mg)	2393.1 ± 28.1	2428.9 ± 26.9	2436.0 ± 25.9	2520.3 ± 29.1	<0.001
%ESFA (%)	11.9 ± 0.1	11.8 ± 0.1	11.6 ± 0.1	11.1 ± 0.1	<0.001
%EFS (%)	9.5 ± 0.2	10.0 ± 0.2	11.2 ± 0.2	12.2 ± 0.3	<0.001

%EFS: %energy from free sugars; %ESFA, %energy from saturated fatty acid; CHO_{highGI}, high glycaemic index carbohydrates DFE, Dietary folate equivalents; LCn3PUFA, Long chain omega 3 polyunsaturated fatty acid; SE, Standard error; RE, Retinol equivalents.

¹EMM ± SE and *p* values were calculated by ANCOVA with age, sex, Socio-Economic Indexes for Areas, equivalised household income, country of birth, remoteness of living area and whether on diet as covariates.

²Usual intakes were calculated using the Multiple Source Method (23).

³*p* for trend assessed by linear regression with median of each cut-off as the independent variable, and adjustments for the same covariates as in the ANCOVA.

Online Supplemental Table 8 - Odds ratios (95%CI)¹ of not meeting NRV² according to quartile of age-, sex- and energy-adjusted CHO_{highGI} intake residuals – sensitivity analysis

	Q1 (ref)		Q2		Q3		Q4		p _{trend}
	Cases (%)	OR	Cases (%)	OR (95%CI)	Cases (%)	OR (95%CI)	Cases (%)	OR (95%CI)	
Fiber	70.6	1.00	73.3	1.26 (0.98, 1.63)	74.8	1.35 (1.04, 1.75)	73.9	1.23 (0.93, 1.61)	0.121
Vitamin A RE	15.1	1.00	12.8	0.95 (0.67, 1.35)	16.8	1.36 (0.99, 1.88)	26.1	2.02 (1.45, 2.81)	<0.001
Thiamin	8.7	1.00	9.3	1.07 (0.67, 1.51)	8.2	0.81 (0.53, 1.25)	9.4	0.91 (0.57, 1.46)	0.525
Riboflavin	3.2	1.00	5.1	1.41 (0.72, 2.76)	5.2	1.40 (0.75, 2.62)	6.9	1.59 (0.87, 2.93)	0.163
DFE	3.0	1.00	4.4	1.57 (0.77, 3.23)	2.6	0.83 (0.41, 1.66)	5.0	1.73 (0.81, 3.70)	0.425
Vitamin C	0.4	1.00	1.0	2.88 (0.88, 9.40)	2.2	5.99 (1.98, 18.09)	2.5	7.25 (2.19, 24.01)	<0.001
Vitamin E	24.0	1.00	24.1	1.14 (0.86, 1.51)	32.6	1.94 (1.47, 2.57)	37.9	2.04 (1.52, 2.73)	<0.001
Calcium	52.1	1.00	65.4	1.34 (1.03, 1.73)	70.1	1.67 (1.28, 2.18)	67.5	1.70 (1.29, 2.24)	<0.001
Iodine	3.5	1.00	4.1	1.15 (0.58, 2.28)	4.5	1.09 (0.60, 2.00)	3.6	0.83 (0.44, 1.57)	0.544
Iron	3.2	1.00	5.4	1.90 (1.08, 3.33)	7.3	2.10 (1.18, 3.72)	8.0	2.97 (1.54, 5.72)	0.001
Magnesium	22.5	1.00	30.2	1.56 (1.18, 2.06)	40.3	2.50 (1.91, 3.27)	40.8	2.17 (1.63, 2.88)	<0.001
Potassium	58.2	1.00	62.3	1.40 (1.10, 1.79)	70.9	2.16 (1.68, 2.76)	74.1	2.06 (1.57, 2.71)	<0.001
Zinc	28.5	1.00	23.1	0.92 (0.68, 1.26)	23.6	1.05 (1.78, 1.42)	29.8	0.97 (0.71, 1.34)	0.966
Linoleic acid	58.1	1.00	62.0	1.42 (1.11, 1.83)	67.4	2.03 (1.56, 2.65)	70.8	1.83 (1.38, 2.42)	<0.001
α-linolenic acid	22.9	1.00	20.8	1.01 (0.75, 1.36)	27.2	1.57 (1.18, 2.09)	29.8	1.35 (1.00, 1.82)	0.006
LCn3PUFA	14.0	1.00	13.2	1.17 (0.82, 1.68)	17.4	1.88 (1.30, 2.71)	23.0	1.89 (1.31, 2.73)	<0.001
Sodium	55.3	1.00	47.9	1.00 (0.78, 1.29)	48.6	1.07 (0.83, 1.37)	58.7	1.39 (1.06, 1.83)	0.017
%ESFA	79.0	1.00	79.0	1.08 (0.81, 1.44)	74.9	0.86 (0.65, 1.15)	67.7	0.62 (0.46, 0.82)	<0.001
%EFS	39.9	1.00	43.2	1.30 (1.02, 1.67)	82.7	2.03 (1.60, 2.58)	87.5	2.68 (2.08, 3.47)	<0.001
≥4 nutrients not meeting NRV	72.1	1.00	80.5	2.05 (1.54, 2.72)	82.7	2.47 (1.83, 3.32)	87.5	2.90 (2.11, 3.99)	<0.001
≥7 nutrients not meeting NRV	37.0	1.00	36.2	1.13 (0.87, 1.45)	48.0	2.02 (1.57, 2.60)	51.2	1.81 (1.38, 2.37)	<0.001
≥10 nutrients not meeting NRV	10.5	1.00	12.2	1.38 (0.93, 2.04)	17.0	2.15 (1.47, 3.15)	22.6	2.42 (1.65, 3.55)	<0.001

95%CI, 95% Confidence Intervals; %EFS, %energy from free sugars; %ESFA, %energy from saturated fatty acid; CHO_{highGI}, high glycaemic index carbohydrate; DFE, Dietary folate equivalents; LCn3PUFA, Long chain omega 3 polyunsaturated fatty acid; NRV, Nutrient Reference Values for Australia and New Zealand; OR, Odds ratio; RE, Retinol equivalents.

¹Odds ratios and 95%CI calculated using binary logistic regression, adjusted for age, sex, Socio-Economic Indexes for Areas, equivalised household income, country of birth, remoteness of living area and whether on diet.

²To be considered not meeting NRV, the following criteria were used: for vitamin A, thiamin, riboflavin, dietary folate equivalents, vitamin C, calcium, iodine, iron, magnesium, phosphorus and zinc, intakes less than their respective estimated average requirement (EAR); for fiber, vitamin E, potassium, linoleic acid, α-linolenic acid and long-chain omega-3 polyunsaturated fatty acids, intakes below their respective average intake (AI); for sodium, intakes above the upper level (UL); and for %E from saturated fat and free sugars intakes above 10% total energy intake.

Online Supplemental Table 9 - Estimated marginal mean¹ ± SE usual intake² of food groups according to quartiles of age-, sex- and energy-adjusted CHO_{highGI} intake residuals – sensitivity analysis

Food group	Q1	Q2	Q3	Q4	<i>p</i>_{trend}³
Weighted <i>n</i>	1110	1085	1103	1074	-
Core foods					
Non-alcoholic beverages (g)	1707 ± 36	1694 ± 30	1568 ± 29	1525 ± 34	<0.001
<i>Tea and coffee (g)</i>	472.3 ± 12.2	470.9 ± 11.9	460.8 ± 10.2	448.5 ± 12.4	<0.001
<i>Fruit and vegetable juice (g)</i>	60.4 ± 4.2	52.9 ± 4.3	56.5 ± 3.9	40.8 ± 3.8	<0.001
Cereal grains and products (g)	152.9 ± 3.6	157.5 ± 3.4	165.2 ± 3.6	187.2 ± 5.5	<0.001
Cereal-based products (g)	93.0 ± 3.0	95.9 ± 2.6	108.8 ± 2.5	129.2 ± 3.5	<0.001
Fats and oils (g)	2.85 ± 0.15	3.21 ± 0.18	3.80 ± 0.20	3.27 ± 0.20	<0.001
Fish, seafood and products (g)	26.8 ± 1.5	21.0 ± 1.2	17.8 ± 1.1	20.1 ± 1.3	<0.001
Fruit and fruit-based products (g)	158.3 ± 4.4	151.78 ± 4.2	142.1 ± 4.1	126.2 ± 3.9	<0.001
Eggs and egg-based products (g)	19.3 ± 1.0	17.4 ± 0.9	14.1 ± 0.7	12.2 ± 0.7	<0.001
Meat, poultry and game and their products (g)	139.4 ± 2.8	135.1 ± 2.5	132.2 ± 2.5	123.1 ± 2.7	<0.001
Dairy products (g)	212.7 ± 7.2	208.6 ± 6.0	211.6 ± 5.6	208.5 ± 6.9	<0.001
<i>Flavored Milk (g)</i>	28.1 ± 3.8	25.8 ± 3.0	21.6 ± 3.0	19.4 ± 3.2	-
Dairy alternatives (g)	15.01 ± 2.13	10.26 ± 1.57	9.11 ± 1.78	9.28 ± 1.81	-
Soups (g)	47.3 ± 3.3	45.8 ± 3.2	42.5 ± 3.3	39.6 ± 3.3	<0.001
Seeds and nuts and their products (g)	9.44 ± 0.75	6.75 ± 0.54	4.49 ± 0.36	5.70 ± 0.75	<0.001
Sauces (g)	1.06 ± 0.14	1.38 ± 0.19	0.95 ± 0.17	0.76 ± 0.12	<0.001
Vegetables (g)	169.0 ± 3.3	164.8 ± 3.1	154.2 ± 3.3	153.1 ± 3.8	<0.001
Legumes and legume-based products (g)	8.89 ± 1.23	9.97 ± 1.24	9.58 ± 1.15	6.17 ± 1.00	<0.001
Formulated foods (g)	4.73 ± 1.32	2.47 ± 0.75	1.45 ± 0.59	0.79 ± 0.28	-
Herbs and spices (g)	1.08 ± 0.31	1.39 ± 0.60	0.26 ± 0.09	0.66 ± 0.25	<0.001
Infant foods (g)	0.02 ± 0.02	0.02 ± 0.02	0.02 ± 0.05	0.62 ± 0.60	-
Discretionary foods					
Non-alcoholic beverages (g)	197.5 ± 11.0	186.3 ± 8.2	226.9 ± 8.5	304.6 ± 11.9	<0.001
<i>Sugar-sweetened beverages (g)</i>	142.4 ± 8.9	144.4 ± 7.0	179.6 ± 7.8	240.8 ± 9.6	<0.001
<i>Intensely sweetened drinks (g)</i>	56.1 ± 8.1	38.6 ± 4.4	40.7 ± 4.7	60.3 ± 9.0	-
Cereal grains and products (g)	2.59 ± 0.44	3.37 ± 0.46	4.75 ± 0.62	4.34 ± 0.69	<0.001
Cereal-based products (g)	66.1 ± 2.0	65.8 ± 1.9	63.8 ± 1.8	64.8 ± 1.9	<0.001
Fats and oils (g)	1.83 ± 0.12	2.26 ± 0.15	2.10 ± 0.12	2.14 ± 0.14	<0.001
Fish, seafood and products (g)	6.65 ± 0.634	9.07 ± 1.05	8.61 ± 0.69	9.16 ± 0.78	<0.001
Meat, poultry and game and their products (g)	25.8 ± 1.0	24.4 ± 0.9	24.8 ± 0.9	22.1 ± 0.9	<0.001
Dairy products (g)	18.2 ± 1.0	19.1 ± 1.1	18.1 ± 0.9	20.2 ± 1.2	<0.001
Dairy alternatives (g)	0.99 ± 0.56	0.23 ± 0.17	0.09 ± 0.11	0.08 ± 0.09	-
Soups (g)	0.01 ± 0.01	0.05 ± 0.03	0.01 ± 0.01	0.02 ± 0.01	-
Sauces (g)	16.6 ± 0.7	15.2 ± 0.5	15.0 ± 0.5	14.3 ± 0.5	<0.001
Vegetables (g)	9.81 ± 0.57	12.26 ± 0.58	12.98 ± 0.66	17.28 ± 0.97	<0.001
Savory Snack (g)	3.74 ± 0.37	4.12 ± 0.34	4.35 ± 0.33	5.63 ± 0.53	0.245
Sugars (g)	10.7 ± 0.6	13.0 ± 0.7	14.3 ± 0.6	16.2 ± 0.9	<0.001
Confectionery (g)	11.8 ± 0.6	12.2 ± 0.5	12.1 ± 0.6	11.8 ± 0.6	<0.001
Alcoholic beverages (g)	348.7 ± 19.0	270.0 ± 15.9	210.4 ± 12.4	185.4 ± 14.1	<0.001
Formulated foods (g)	7.90 ± 1.67	6.81 ± 1.63	5.05 ± 1.25	3.45 ± 1.60	-
Herbs and spices (g)	0.65 ± 0.07	0.74 ± 0.08	0.55 ± 0.05	0.83 ± 0.08	<0.001

CHO_{highGI}, high glycaemic index carbohydrates

¹Calculated by ANCOVA with age, sex, Socio-Economic Indexes for Areas, equivalised household income, country of birth, remoteness of living area and whether on diet as covariates. All negative EMMs were presented as zero.

²Usual intakes were calculated using the Multiple Source Method (23).

³*p* for trend assessed by linear regression with median of each cut-off as the independent variable, and adjustments for the same covariates as in the ANCOVA. *P* for trend not available for core dairy alternatives, flavored milk, core formulated foods, infant foods, intensely sweetened drinks, extra dairy alternatives, extra soups and extra formulated foods due to low number of consumers which shifted the medians of all quartiles to zero.

Online Supplemental Table 10 - Characteristics of the 2011-2012AHS participants ($n = 6,150$) according to quartile of age-, sex- and energy-adjusted dGI and dGL residuals

	Dietary glycaemic index					<i>p</i> value ¹	Dietary glycaemic load					<i>p</i> value ¹
	Q1	Q2	Q3	Q4	Q1		Q2	Q3	Q4			
Weighted <i>n</i>	1618	1465	1463	1604	-	1675	1489	1455	1530	-		
Age (y)	47.1 ± 16.9	46.9 ± 18.1	46.5 ± 17.7	47.4 ± 17.4	0.508	44.1 ± 15.8	46.8 ± 16.9	48.5 ± 18.0	48.9 ± 18.9	<0.001		
BMI (kg/m ²)	27.5 ± 5.3	26.8 ± 5.1	27.5 ± 5.4	27.4 ± 5.9	0.002	27.5 ± 5.2	27.3 ± 5.4	27.5 ± 5.8	27.1 ± 5.6	0.154		
Male (%)	49.4	48.4	52.0	49.5	0.241	54.7	42.5	45.6	55.5	<0.001		
SEIFA (%)												
1 st quintile	14.8	17.0	17.2	21.9		15.4	18.3	17.6	20.0			
2 nd quintile	17.0	17.4	19.1	23.8		15.9	20.4	18.4	23.0			
3 rd quintile	19.9	20.9	19.9	17.9	<0.001	18.7	20.3	19.3	20.2	<0.001		
4 th quintile	21.7	20.4	19.8	15.6		21.0	19.3	20.8	16.1			
5 th quintile	26.7	24.4	24.0	20.8		29.0	21.8	23.9	20.6			
Household income (%)												
1 st decile	7.5	8.0	7.3	11.3		7.4	7.5	8.6	10.9			
2 nd decile	5.1	7.8	6.6	9.5		4.1	7.4	8.3	9.5			
3 rd decile	7.4	7.1	7.8	8.2		5.1	7.6	8.9	9.1			
4 th decile	7.2	6.8	8.7	7.6		7.2	8.1	8.4	6.6			
5 th decile	9.6	10.0	12.3	9.6		9.6	11.3	10.0	10.6			
6 th decile	7.5	7.0	7.5	8.7	<0.001	8.0	6.9	8.9	7.1	<0.001		
7 th decile	12.6	10.9	10.0	9.7		10.8	10.5	11.8	10.2			
8 th decile	8.8	10.1	9.7	6.4		9.3	9.5	7.2	8.6			
9 th decile	11.3	8.0	10.4	6.9		12.1	8.5	8.9	6.7			
10 th decile	13.2	12.3	9.9	9.0		15.7	9.9	9.5	8.8			
Not stated/unknown	9.7	12.0	9.7	13.3		10.7	12.8	9.5	11.9			
On diet (%) ²	19.3	12.6	11.8	10.2	<0.001	16.9	13.3	14.1	9.6	<0.001		
Living in urban area (%)	72.5	70.1	73.5	76.3	0.001	74.1	71.3	72.4	74.7	0.119		
Born in English Speaking Countries (%)	88.3	84.2	80.2	70.2	<0.001	88.4	83.0	80.2	70.3	<0.001		
Total energy intake (kJ/day)	8280 ± 2288	8652 ± 2344	8633 ± 2178	8122 ± 2207	<0.001	8843 ± 2365	7940 ± 2145	7994 ± 2118	8795 ± 2246	<0.001		
Fiber (g/day)	23.0 ± 8.2	23.6 ± 7.6	23.0 ± 7.5	21.6 ± 7.3	<0.001	21.6 ± 7.5	21.9 ± 7.2	22.5 ± 7.3	25.1 ± 8.2	<0.001		
dGI	49.5 ± 2.7	53.3 ± 0.9	55.3 ± 0.9	58.4 ± 1.8	<0.001	51.4 ± 4.1	53.7 ± 3.0	55.0 ± 2.8	56.5 ± 2.8	<0.001		
dGL	95.4 ± 31.4	115.8 ± 35.6	122.3 ± 34.7	124.7 ± 38.8	<0.001	94.3 ± 29.4	103.6 ± 29.2	115.9 ± 29.8	145.1 ± 37.7	<0.001		
CHO _{highGI}	71.6 ± 32.3	98.6 ± 33.9	117.9 ± 37.7	130.8 ± 44.2	<0.001	81.4 ± 35.3	91.5 ± 34.7	107.7 ± 36.0	139.4 ± 44.1	<0.001		
CHO _{lowGI}	113.0 ± 45.6	117.9 ± 39.8	101.9 ± 32.2	79.3 ± 27.9	<0.001	97.5 ± 38.5	100.3 ± 37.0	101.9 ± 37.5	111.8 ± 44.9	<0.001		

Values were presented as mean ± SD for continuous variables and percentages for categorical variables. Data were weighed to represent the Australian general adult population.

BMI, body mass index; CHO_{highGI}, high glycaemic index carbohydrates; CHO_{lowGI}, low glycaemic index carbohydrates; dGI, dietary glycaemic index; dGL, dietary glycaemic load; SEIFA, Socio-Economic Index for Areas

¹Differences between quartiles were tested using one-way ANOVA for continuous variables, and Pearson's χ^2 for categorical variables.

Online Supplemental Table 11 - Characteristics of the 2011-2012AHS participants ($n = 6,150$) according to quartile of age-, sex- and energy-adjusted CHO_{lowGI} residuals

	Low glycaemic index carbohydrate				<i>p</i> value ¹
	Q1	Q2	Q3	Q4	
Weighted <i>n</i>	1685	1585	1451	1429	-
Age (y)	42.2 ± 15.7	47.4 ± 16.9	49.6 ± 18.0	49.4 ± 18.5	<0.001
BMI (kg/m ²)	27.6 ± 5.7	27.3 ± 5.5	27.4 ± 5.3	27.0 ± 5.5	0.070
Male (%)	54.7	46.9	43.8	53.4	<0.001
SEIFA (%)					
1 st quintile	19.1	18.6	17.8	15.2	
2 nd quintile	21.4	17.8	21.1	16.9	
3 rd quintile	18.1	20.6	18.2	21.8	<0.001
4 th quintile	20.3	19.0	18.7	19.2	
5 th quintile	21.1	24.0	24.2	26.9	
Household income (%)					
1 st decile	10.0	7.9	9.4	6.7	
2 nd decile	5.8	7.4	9.3	6.7	
3 rd decile	5.7	7.9	7.6	9.7	
4 th decile	7.4	9.0	6.2	7.6	
5 th decile	10.0	10.0	10.5	11.1	
6 th decile	7.8	8.5	7.6	6.7	<0.001
7 th decile	10.0	8.8	12.5	12.4	
8 th decile	8.0	8.8	8.6	9.3	
9 th decile	10.1	9.3	9.2	7.8	
10 th decile	11.4	11.3	10.3	11.4	
Not stated/unknown	13.8	11.2	8.7	10.5	
On diet (%)	12.0	14.0	13.7	14.7	0.143
Living in urban area (%)	76.1	73.4	72.2	70.5	0.119
Born in English Speaking Countries (%)	78.1	78.2	81.8	85.2	<0.001
Never smoked (%)	50.5	50.0	46.2	44.4	<0.001
Total energy intake (kJ/day)	8758 ± 2497	7950 ± 2154	7977 ± 1990	8955 ± 2172	<0.001
Fibre (g/day)	20.8 ± 6.9	21.3 ± 7.2	22.6 ± 7.1	26.9 ± 8.1	<0.001
dGI	55.7 ± 4.6	54.8 ± 3.5	53.5 ± 2.7	52.0 ± 2.6	<0.001
dGL	115.5 ± 41.9	108.2 ± 35.0	108.2 ± 30.5	126.0 ± 36.7	<0.001
CHO _{highGI}	121.8 ± 54.6	105.9 ± 38.8	94.9 ± 33.0	92.3 ± 36.7	<0.001
CHO _{lowGI}	70.3 ± 27.6	89.6 ± 24.1	108.7 ± 22.9	149.6 ± 33.8	<0.001

Values were presented as mean ± SD for continuous variables and percentages for categorical variables. Data were weighed to represent the Australian general adult population.

BMI, body mass index; CHO_{highGI}, high glycaemic index carbohydrates; CHO_{lowGI}, low glycaemic index carbohydrates; dGI, dietary glycaemic index; dGL, dietary glycaemic load; SEIFA, Socio-Economic Index for Areas

¹Differences between quartiles were tested using one-way ANOVA for continuous variables, and Pearson's χ^2 for categorical variables.

Online Supplemental Table 12 - Estimated marginal mean (EMM)¹ ± SE usual intake² of micronutrient according to quartile of age-, sex- and energy-adjusted dGI and dGL residuals

	dGI					dGL				
	Q1	Q2	Q3	Q4	<i>p</i> _{trend} ³	Q1	Q2	Q3	Q4	<i>p</i> _{trend} ³
Weighted <i>n</i>	1618	1465	1463	1604	-	1675	1489	1455	1530	-
Fiber (g)	23.1 ± 0.3	23.7 ± 0.3	22.9 ± 0.3	21.5 ± 0.3	<0.001	21.5 ± 0.3	22.2 ± 0.2	22.5 ± 0.3	24.9 ± 0.3	<0.001
Vitamin A RE (µg)	839.1 ± 11.6	826.3 ± 9.8	798.2 ± 10.8	764.6 ± 12.0	<0.001	838.9 ± 11.1	797.0 ± 11.0	770.7 ± 9.8	816.0 ± 12.3	<0.001
Thiamin (mg)	1.43 ± 0.02	1.53 ± 0.02	1.61 ± 0.02	1.53 ± 0.02	<0.001	1.42 ± 0.02	1.48 ± 0.02	1.52 ± 0.02	1.68 ± 0.02	<0.001
Riboflavin (mg)	1.93 ± 0.02	1.94 ± 0.02	1.90 ± 0.03	1.68 ± 0.02	<0.001	1.88 ± 0.02	1.82 ± 0.02	1.79 ± 0.02	1.93 ± 0.03	<0.001
DFE (µg)	566.7 ± 6.3	620.2 ± 7.4	628.8 ± 7.1	617.4 ± 8.5	<0.001	560.7 ± 6.4	589.2 ± 6.5	607.5 ± 6.9	676.2 ± 9.0	<0.001
Vitamin C (mg)	109.4 ± 1.9	105.5 ± 2.0	98.1 ± 1.8	90.0 ± 1.9	<0.001	101.4 ± 1.7	97.7 ± 1.8	95.6 ± 1.9	108.0 ± 2.3	<0.001
Vitamin E (mg)	10.5 ± 0.1	10.5 ± 0.1	10.2 ± 0.1	9.3 ± 0.1	<0.001	11.1 ± 0.1	10.0 ± 0.1	9.6 ± 0.1	9.7 ± 0.1	<0.001
Calcium (mg)	835.1 ± 9.5	834.2 ± 10.3	787.4 ± 9.3	703.4 ± 8.9	<0.001	799.9 ± 10.2	776.1 ± 8.8	769.3 ± 9.7	809.1 ± 9.8	<0.001
Iodine (µg)	167.1 ± 1.7	175.5 ± 1.9	172.0 ± 1.7	160.6 ± 1.6	<0.001	166.6 ± 1.9	164.9 ± 1.6	166.5 ± 1.7	176.4 ± 1.8	<0.001
Iron (mg)	11.0 ± 0.1	11.3 ± 0.1	11.2 ± 0.1	10.6 ± 0.1	<0.001	11.1 ± 0.1	10.7 ± 0.1	10.7 ± 0.1	11.6 ± 0.1	<0.001
Magnesium (mg)	352.5 ± 3.4	342.4 ± 3.3	328.5 ± 3.5	304.8 ± 3.2	<0.001	357.5 ± 3.5	324.2 ± 3.0	314.6 ± 3.1	328.1 ± 3.5	<0.001
Phosphorus (mg)	1481.6 ± 12.0	1479.6 ± 12.8	1454.5 ± 12.5	1361.1 ± 12.0	<0.001	1533.5 ± 12.8	1419.7 ± 11.4	1387.9 ± 11.9	1420.0 ± 12.6	<0.001
Potassium (mg)	3014.3 ± 24.5	2976.7 ± 25.6	2885.3 ± 25.6	2707.8 ± 26.8	<0.001	3053.5 ± 25.2	2847.0 ± 23.4	2764.1 ± 24.7	2891.8 ± 28.9	<0.001
Zinc (mg)	10.8 ± 0.1	10.9 ± 0.1	10.9 ± 0.1	10.5 ± 0.1	<0.001	11.5 ± 0.1	10.6 ± 0.1	10.3 ± 0.1	10.5 ± 0.1	<0.001
Linoleic acid (g)	9.0 ± 0.1	9.2 ± 0.1	9.2 ± 0.1	8.6 ± 0.1	<0.001	9.8 ± 0.1	8.9 ± 0.1	8.7 ± 0.1	8.5 ± 0.1	<0.001
α-linolenic acid (g)	1.36 ± 0.02	1.39 ± 0.02	1.39 ± 0.02	1.27 ± 0.02	0.002	1.47 ± 0.02	1.34 ± 0.02	1.30 ± 0.02	1.28 ± 0.02	<0.001
LCn3PUFA (mg)	242.5 ± 5.5	225.1 ± 4.8	229.9 ± 5.8	213.8 ± 4.7	<0.001	281.2 ± 6.3	235.5 ± 5.2	198.1 ± 4.2	190.4 ± 4.3	<0.001
Sodium (mg)	2258.1 ± 22.3	2378.6 ± 21.8	2424.7 ± 23.8	2308.6 ± 24.7	<0.001	2372.9 ± 24.3	2277.3 ± 21.8	2325.8 ± 23.5	2376.8 ± 23.7	<0.001
%ESFA (%)	11.5 ± 0.1	11.7 ± 0.1	11.6 ± 0.1	11.2 ± 0.1	<0.001	11.9 ± 0.1	11.8 ± 0.1	11.5 ± 0.1	10.7 ± 0.1	<0.001
%EFS (%)	9.6 ± 0.2	11.0 ± 0.2	11.3 ± 0.2	10.2 ± 0.2	<0.001	7.9 ± 0.1	9.8 ± 0.2	11.4 ± 0.2	13.2 ± 0.2	<0.001

%EFS, %energy from free sugars; %ESFA, %energy from saturated fatty acid, DFE, Dietary folate equivalents; dGI, dietary glycaemic index; dGL, dietary glycaemic load; LCn3PUFA, Long chain omega 3 polyunsaturated fatty acid; SE, Standard error; RE, Retinol equivalents.

¹EMM ± SE and *p* values were calculated by ANCOVA with age, sex, Socio-Economic Indexes for Areas, equivalised household income, country of birth, remoteness of living area and whether on diet as covariates.

²Usual intakes were calculated using the Multiple Source Method (23).

³*p* for trend assessed by linear regression with median of each cut-off as the independent variable, and adjustments for the same covariates as in the ANCOVA

Online Supplemental Table 13 - Estimated marginal mean (EMM)¹ ± SE usual intake² of micronutrient according to quartile of age-, sex- and energy-adjusted CHO_{lowGI} intake residuals

	Q1	Q2	Q3	Q4	<i>p</i> _{trend} ³
Weighted <i>n</i>	1685	1585	1451	1429	-
Fiber (g)	20.7 ± 0.2	21.3 ± 0.3	22.8 ± 0.2	26.8 ± 0.3	<0.001
Vitamin A RE (µg)	766.3 ± 11.0	772.3 ± 10.7	820.3 ± 11.3	879.5 ± 11.1	<0.001
Thiamin (mg)	1.49 ± 0.02	1.49 ± 0.02	1.51 ± 0.02	1.62 ± 0.02	<0.001
Riboflavin (mg)	1.77 ± 0.03	1.77 ± 0.02	1.89 ± 0.02	2.03 ± 0.02	<0.001
DFE (µg)	586.4 ± 7.1	592.9 ± 8.0	607.4 ± 6.8	648.4 ± 7.1	<0.001
Vitamin C (mg)	86.9 ± 1.6	94.5 ± 1.6	103.2 ± 2.0	121.6 ± 2.3	<0.001
Vitamin E (mg)	10.2 ± 0.1	9.6 ± 0.1	10.0 ± 0.1	10.7 ± 0.1	<0.001
Calcium (mg)	732.7 ± 10.0	751.3 ± 8.8	800.5 ± 8.9	886.3 ± 9.8	<0.001
Iodine (µg)	163.8 ± 1.9	163.6 ± 1.7	169.4 ± 1.7	179.1 ± 1.8	<0.001
Iron (mg)	10.8 ± 0.1	10.6 ± 0.1	10.8 ± 0.1	12.0 ± 0.1	<0.001
Magnesium (mg)	324.5 ± 3.4	316.5 ± 3.1	329.6 ± 3.5	360.3 ± 3.5	<0.001
Phosphorus (mg)	1451.6 ± 13.0	1384.3 ± 11.5	1424.5 ± 11.8	1517.8 ± 12.7	0.543
Potassium (mg)	2817.1 ± 25.1	2776.1 ± 25.4	2874.9 ± 25.0	3138.1 ± 26.5	<0.001
Zinc (mg)	11.1 ± 0.1	10.5 ± 0.1	10.6 ± 0.1	11.0 ± 0.1	<0.001
Linoleic acid (g)	9.53 ± 0.14	8.47 ± 0.10	8.61 ± 0.12	9.29 ± 0.11	<0.001
α-linolenic acid (g)	1.41 ± 0.02	1.27 ± 0.02	1.30 ± 0.02	1.42 ± 0.02	<0.001
LCn3PUFA (mg)	251.3 ± 5.7	228.9 ± 5.3	220.8 ± 5.5	206.3 ± 4.4	<0.001
Sodium (mg)	2416.5 ± 25.7	2287.3 ± 21.7	2279.1 ± 21.1	2368.4 ± 22.6	<0.001
%ESFA (%)	11.6 ± 0.1	11.5 ± 0.1	11.6 ± 0.1	11.3 ± 0.1	<0.001
%EFS (%)	9.2 ± 0.2	10.0 ± 0.2	10.6 ± 0.2	12.5 ± 0.2	<0.001

%EFS: %energy from free sugars; %ESFA, %energy from saturated fatty acid; CHO_{lowGI}, low glycaemic index carbohydrates; DFE, Dietary folate equivalents; LCn3PUFA, Long chain omega 3 polyunsaturated fatty acid; SE, Standard error; RE, Retinol equivalents.

¹EMM ± SE and *p* values were calculated by ANCOVA with age, sex, Socio-Economic Indexes for Areas, equivalised household income, country of birth, remoteness of living area and whether on diet as covariates.

²Usual intakes were calculated using the Multiple Source Method (23).

³*p* for trend assessed by linear regression with median of each cut-off as the independent variable, and adjustments for the same covariates as in the ANCOVA.

Online Supplemental Table 14 - Odds ratios (95%CI)¹ of not meeting NRV² according to quartile of age-, sex- and energy-adjusted dGI residuals

	Q1 (ref)		Q2		Q3		Q4		p _{trend}
	Cases (%)	OR	Cases (%)	OR (95%CI)	Cases (%)	OR (95%CI)	Cases (%)	OR (95%CI)	
Fiber	74.8	1.00	73.5	0.96 (0.77, 1.19)	77.2	1.17 (0.93, 1.46)	81.9	1.63 (1.28, 2.08)	<0.001
Vitamin A RE	18.2	1.00	16.7	0.90 (0.70, 1.17)	22.4	1.26 (0.98, 1.62)	29.1	1.83 (1.44, 2.33)	<0.001
Thiamin	14.6	1.00	10.4	0.64 (0.48, 0.87)	9.3	0.56 (0.40, 0.77)	13.0	0.74 (0.56, 0.98)	0.032
Riboflavin	6.3	1.00	5.6	0.80 (0.53, 1.21)	5.5	0.76 (0.51, 1.15)	13.9	1.86 (1.32, 2.61)	<0.001
DFE	6.7	1.00	3.8	0.52 (0.34, 0.80)	3.9	0.54 (0.32, 0.92)	5.8	0.77 (0.50, 1.17)	0.281
Vitamin C	1.6	1.00	1.5	0.93 (0.40, 2.17)	2.2	1.46 (0.70, 3.07)	5.0	3.44 (1.68, 6.98)	<0.001
Vitamin E	31.6	1.00	28.0	0.84 (0.68, 1.05)	33.7	1.10 (0.88, 1.37)	44.9	1.91 (1.54, 2.37)	<0.001
Calcium	62.7	1.00	61.2	0.90 (0.73, 1.12)	68.5	1.35 (1.08, 1.70)	81.2	2.51 (1.96, 3.21)	<0.001
Iodine	6.8	1.00	5.4	0.75 (0.51, 1.11)	3.0	0.40 (0.24, 0.65)	9.7	1.27 (0.89, 1.81)	0.403
Iron	8.1	1.00	7.7	0.92 (0.63, 1.35)	8.8	1.10 (0.73, 1.64)	11.1	1.49 (1.03, 2.15)	0.021
Magnesium	31.5	1.00	34.5	1.14 (0.92, 1.40)	43.1	1.61 (1.31, 1.99)	54.3	2.45 (1.99, 3.02)	<0.001
Potassium	65.9	1.00	66.5	1.03 (0.83, 1.27)	72.6	1.32 (1.07, 1.64)	78.9	1.89 (1.51, 2.37)	<0.001
Zinc	30.7	1.00	28.6	0.90 (0.71, 1.14)	28.4	0.80 (0.63, 1.01)	34.7	1.15 (0.90, 1.46)	0.450
Linoleic acid	68.8	1.00	64.7	0.83 (0.66, 1.03)	67.0	0.87 (0.70, 1.09)	72.5	1.18 (0.94, 1.48)	0.135
α-linolenic acid	29.6	1.00	26.4	0.88 (0.70, 1.09)	26.5	0.82 (0.65, 1.04)	37.7	1.46 (1.17, 1.82)	0.002
LCn3PUFA	16.5	1.00	16.7	1.03 (0.78, 1.35)	17.4	0.99 (0.74, 1.31)	23.1	1.49 (1.13, 1.97)	0.009
Sodium	42.4	1.00	49.5	1.41 (1.15, 1.74)	52.1	1.53 (1.23, 1.90)	42.5	1.09 (0.88, 1.35)	0.304
%ESFA	72.9	1.00	78.3	1.35 (1.07, 1.69)	75.3	1.17 (0.93, 1.47)	67.7	0.87 (0.70, 1.09)	0.128
%EFS	39.0	1.00	52.8	1.77 (1.45, 2.16)	54.6	1.95 (1.60, 2.39)	44.1	1.34 (1.09, 1.64)	0.002
≥4 nutrients not meeting NRV	78.9	1.00	82.1	1.22 (0.95, 1.57)	83.3	1.29 (1.00, 1.67)	88.1	1.99 (1.51, 2.61)	<0.001
≥7 nutrients not meeting NRV	44.8	1.00	42.9	0.92 (0.75, 1.13)	50.3	1.23 (1.00, 1.51)	58.9	1.79 (1.45, 2.20)	<0.001
≥10 nutrients not meeting NRV	16.4	1.00	16.0	0.97 (0.75, 1.26)	19.9	1.22 (0.94, 1.59)	29.6	2.10 (1.64, 2.69)	<0.001

95%CI, 95% Confidence Intervals; %EFS, %energy from free sugars; %ESFA, %energy from saturated fatty acid; DFE, Dietary folate equivalents; dGI, dietary glycaemic index; LCn3PUFA, Long chain omega 3 polyunsaturated fatty acid; NRV, Nutrient Reference Values for Australia and New Zealand; OR, Odds ratio; RE, Retinol equivalents.

¹Odds ratios and 95%CI calculated using binary logistic regression, adjusted for age, sex, Socio-Economic Indexes for Areas, equivalised household income, country of birth, remoteness of living area and whether on diet.

²To be considered not meeting NRV, the following criteria were used: for vitamin A, thiamin, riboflavin, dietary folate equivalents, vitamin C, calcium, iodine, iron, magnesium, phosphorus and zinc, intakes less than their respective estimated average requirement (EAR); for fiber, vitamin E, potassium, linoleic acid, α-linolenic acid and long-chain omega-3 polyunsaturated fatty acids, intakes below their respective average intake (AI); for sodium, intakes above the upper level (UL); and for %E from saturated fat and free sugars intakes above 10% total energy intake.

Online Supplemental Table 15 - Odds ratios (95%CI)¹ of not meeting NRV² according to quartile of age-, sex- and energy-adjusted dGL residuals

	Q1 (ref)		Q2		Q3		Q4		p _{trend}
	Cases (%)	OR	Cases (%)	OR (95%CI)	Cases (%)	OR (95%CI)	Cases (%)	OR (95%CI)	
Fiber	81.7	1.00	80.2	0.95 (0.75, 1.20)	78.3	0.86 (0.66, 1.09)	67.3	0.48 (0.38, 0.60)	<0.001
Vitamin A RE	18.3	1.00	20.9	1.32 (1.02, 1.69)	23.2	1.49 (1.16, 1.90)	24.6	1.44 (1.12, 1.85)	0.003
Thiamin	13.8	1.00	13.3	0.84 (0.63, 1.11)	10.6	0.65 (0.48, 0.88)	9.8	0.57 (0.41, 0.80)	<0.001
Riboflavin	5.9	1.00	7.8	1.19 (0.80, 1.77)	10.1	1.52 (1.04, 2.23)	8.3	1.00 (0.69, 1.45)	0.745
DFE	5.8	1.00	5.0	0.75 (0.49, 1.15)	5.8	0.90 (0.56, 1.43)	3.9	0.59 (0.35, 1.02)	0.105
Vitamin C	1.9	1.00	3.4	1.67 (0.84, 3.31)	3.0	1.61 (0.81, 3.19)	2.0	1.10 (0.56, 2.15)	0.792
Vitamin E	28.3	1.00	32.5	1.41 (1.13, 1.75)	36.1	1.62 (1.30, 2.02)	42.6	1.93 (1.55, 2.40)	<0.001
Calcium	62.1	1.00	71.4	1.22 (0.98, 1.52)	72.3	1.28 (1.02, 1.61)	69.1	1.05 (0.84, 1.32)	0.476
Iodine	5.4	1.00	7.1	1.16 (0.78, 1.72)	8.1	1.37 (0.92, 2.05)	4.9	0.75 (0.49, 1.14)	0.340
Iron	7.0	1.00	11.7	1.58 (1.11, 2.26)	10.5	1.60 (1.11, 2.33)	7.0	1.12 (0.72, 1.75)	0.492
Magnesium	30.8	1.00	41.7	1.64 (1.34, 2.02)	48.3	2.12 (1.72, 2.62)	44.1	1.58 (1.28, 1.95)	<0.001
Potassium	64.4	1.00	72.1	1.62 (1.31, 2.00)	76.0	1.96 (1.57, 2.45)	72.6	1.41 (1.13, 1.77)	<0.001
Zinc	26.8	1.00	27.9	1.39 (1.10, 1.77)	33.1	1.79 (1.40, 2.30)	35.4	1.50 (1.18, 1.92)	<0.001
Linoleic acid	61.2	1.00	66.5	1.54 (1.24, 1.92)	72.0	1.91 (1.52, 2.40)	74.7	1.88 (1.49, 2.36)	<0.001
α-linolenic acid	24.0	1.00	27.0	1.40 (1.11, 1.75)	33.7	1.86 (1.48, 2.35)	36.8	1.84 (1.47, 2.31)	<0.001
LCn3PUFA	10.5	1.00	14.5	1.89 (1.39, 2.58)	20.3	2.93 (2.18, 3.95)	29.5	4.11 (3.07, 5.49)	<0.001
Sodium	51.3	1.00	40.8	0.80 (0.65, 0.98)	43.6	0.93 (0.75, 1.15)	49.1	1.11 (0.89, 1.37)	0.248
%ESFA	81.4	1.00	77.5	0.82 (0.65, 1.04)	73.5	0.68 (0.54, 0.87)	60.5	0.39 (0.31, 0.49)	<0.001
%EFS	26.9	1.00	45.6	2.67 (2.16, 3.30)	54.4	4.22 (3.39, 5.25)	64.6	7.31 (5.82, 9.18)	<0.001
≥4 nutrients not meeting NRV	76.6	1.00	84.8	2.04 (1.58, 2.62)	87.5	2.54 (1.96, 3.31)	84.4	1.68 (1.29, 2.18)	<0.001
≥7 nutrients not meeting NRV	41.8	1.00	48.4	1.51 (1.23, 1.86)	53.9	1.88 (1.52, 2.32)	54.0	1.63 (1.32, 2.01)	<0.001
≥10 nutrients not meeting NRV	14.1	1.00	18.7	1.58 (1.21, 2.07)	23.6	2.12 (1.63, 2.75)	26.6	2.16 (1.67, 2.80)	<0.001

95%CI, 95% Confidence Intervals; %EFS, %energy from free sugars; %ESFA, %energy from saturated fatty acid; DFE, Dietary folate equivalents; dGL, dietary glycaemic load; LCn3PUFA, Long chain omega 3 polyunsaturated fatty acid; NRV, Nutrient Reference Values for Australia and New Zealand; OR, Odds ratio; RE, Retinol equivalents.

¹Odds ratios and 95%CI calculated using binary logistic regression, adjusted for age, sex, Socio-Economic Indexes for Areas, equivalised household income, country of birth, remoteness of living area and whether on diet.

²To be considered not meeting NRV, the following criteria were used: for vitamin A, thiamin, riboflavin, dietary folate equivalents, vitamin C, calcium, iodine, iron, magnesium, phosphorus and zinc, intakes less than their respective estimated average requirement (EAR); for fiber, vitamin E, potassium, linoleic acid, α-linolenic acid and long-chain omega-3 polyunsaturated fatty acids, intakes below their respective average intake (AI); for sodium, intakes above the upper level (UL); and for %E from saturated fat and free sugars intakes above 10% total energy intake.

Online Supplemental Table 16 - Odds ratios (95%CI)¹ of not meeting NRV² according to quartile of age-, sex- and energy-adjusted CHO_{lowGI} intake residuals

	Q1 (ref)		Q2		Q3		Q4		<i>p</i> _{trend}
	Cases (%)	OR	Cases (%)	OR (95%CI)	Cases (%)	OR (95%CI)	Cases (%)	OR (95%CI)	
Fiber	85.6	1.00	83.5	0.90 (0.69, 1.18)	77.4	0.61 (0.67, 0.79)	59.0	0.24 (0.19, 0.31)	<0.001
Vitamin A RE	27.2	1.00	25.4	0.99 (0.79, 1.25)	19.6	0.73 (0.57, 0.92)	13.1	0.41 (0.32, 0.54)	<0.001
Thiamin	13.1	1.00	14.8	1.13 (0.84, 1.50)	12.9	0.97 (0.71, 1.32)	6.3	0.47 (0.34, 0.66)	<0.001
Riboflavin	9.9	1.00	10.9	1.04 (0.74, 1.47)	6.3	0.56 (0.38, 0.83)	4.0	0.36 (0.24, 0.55)	<0.001
DFE	7.3	1.00	6.3	0.81 (0.53, 1.24)	4.0	0.50 (0.31, 0.82)	2.3	0.31 (0.19, 0.52)	<0.001
Vitamin C	4.0	1.00	2.9	0.74 (0.45, 1.23)	2.3	0.58 (0.32, 1.04)	0.8	0.19 (0.10, 0.38)	<0.001
Vitamin E	37.0	1.00	39.9	1.22 (0.98, 1.51)	33.0	0.88 (0.71, 1.09)	28.1	0.60 (0.48, 0.76)	<0.001
Calcium	73.0	1.00	73.1	0.78 (0.62, 1.00)	69.6	0.59 (0.46, 0.76)	57.0	0.35 (0.28, 0.45)	<0.001
Iodine	8.3	1.00	8.6	0.98 (0.68, 1.41)	3.9	0.43 (0.28, 0.67)	3.9	0.49 (0.32, 0.74)	<0.001
Iron	10.2	1.00	12.4	1.28 (0.92, 1.78)	8.7	0.79 (0.54, 1.17)	3.8	0.38 (0.25, 0.57)	<0.001
Magnesium	44.6	1.00	48.0	1.17 (0.96, 1.42)	42.1	0.92 (0.74, 1.13)	27.4	0.45 (0.36, 0.56)	<0.001
Potassium	74.7	1.00	75.9	1.17 (0.93, 1.47)	71.9	0.98 (0.78, 1.23)	60.4	0.52 (0.42, 0.66)	<0.001
Zinc	29.9	1.00	32.7	1.47 (1.15, 1.88)	30.4	1.41 (1.11, 1.80)	29.7	1.08 (0.84, 1.39)	0.582
Linoleic acid	64.2	1.00	72.8	1.69 (1.36, 2.10)	71.6	1.62 (1.29, 2.05)	65.1	0.99 (0.79, 1.25)	0.959
α -linolenic acid	29.0	1.00	34.9	1.47 (1.17, 1.84)	30.5	1.22 (0.97, 1.54)	26.3	0.86 (0.68, 1.09)	0.110
LCn3PUFA	16.8	1.00	19.3	1.51 (1.12, 2.02)	16.0	1.28 (0.96, 1.71)	22.2	1.68 (1.26, 2.23)	0.002
Sodium	53.6	1.00	42.2	0.75 (0.61, 0.92)	39.9	0.73 (0.59, 0.91)	49.3	0.97 (0.78, 1.21)	0.665
%ESFA	76.1	1.00	72.5	0.88 (0.70, 1.10)	73.8	0.93 (0.74, 1.19)	70.7	0.77 (0.61, 0.97)	0.050
%EFS	37.8	1.00	42.1	1.38 (1.13, 1.69)	49.8	1.97 (1.60, 2.43)	61.9	3.25 (2.62, 4.04)	<0.001
≥ 4 nutrients not meeting NRV	84.8	1.00	86.5	1.31 (0.99, 1.73)	93.4	1.04 (0.78, 1.38)	77.1	0.61 (0.46, 0.80)	<0.001
≥ 7 nutrients not meeting NRV	52.5	1.00	53.9	1.18 (0.96, 1.45)	50.8	1.07 (0.86, 1.32)	39.0	0.57 (0.46, 0.70)	<0.001
≥ 10 nutrients not meeting NRV	22.8	1.00	27.3	1.43 (1.13, 1.83)	18.2	0.86 (0.67, 1.11)	12.9	0.51 (0.39, 0.67)	<0.001

95%CI, 95% Confidence Intervals; %EFS, %energy from free sugars; %ESFA, %energy from saturated fatty acid; CHO_{lowGI}, low glycaemic index carbohydrates; DFE, Dietary folate equivalents; LCn3PUFA, Long chain omega 3 polyunsaturated fatty acid; NRV, Nutrient Reference Values for Australia and New Zealand; OR, Odds ratio; RE, Retinol equivalents.

¹Odds ratios and 95%CI calculated using binary logistic regression, adjusted for age, sex, Socio-Economic Indexes for Areas, equivalised household income, country of birth, remoteness of living area and whether on diet.

²To be considered not meeting NRV, the following criteria were used: for vitamin A, thiamin, riboflavin, dietary folate equivalents, vitamin C, calcium, iodine, iron, magnesium, phosphorus and zinc, intakes less than their respective estimated average requirement (EAR); for fiber, vitamin E, potassium, linoleic acid, α -linolenic acid and long-chain omega-3 polyunsaturated fatty acids, intakes below their respective average intake (AI); for sodium, intakes above the upper level (UL); and for %E from saturated fat and free sugars intakes above 10% total energy intake.