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Cereal fibre intake in Australia: a cross sectional analysis of the 2011-12 National Nutrition and Physical Activity Survey

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Abstract

Extensive evidence supports health benefits of cereal fibre, however globally no national intake data exists. This study aimed to determine estimates of intake and food sources of cereal fibre, and relationships to dietary fibre intake in an Australian sample population. A cereal fibre database was applied to dietary intake data from the 2011-12 National Nutrition and Physical Activity Survey (n ¼ 12,153). Usual intake based on 2-day intake data was weighted to infer population results. Median daily cereal fibre intake was 6.4 g/d (9.7 g/10 MJ/d) for adults (19-85 years) and 6.2 g/d (10.2 g/10 MJ/d) for children/adolescents (2-18 years). Individuals with the highest cereal fibre intake were more likely to meet dietary fibre recommendations than those with the lowest intake (males Q4: 17.1% Q1: 3.9%; females Q4: 20.3% Q1: 6.6%). Breakfast cereals, bread and bread rolls provided the most cereal fibre. This study provides first quantification of cereal fibre from all sources in an Australian national sample.

Keywords

activity, physical, nutrition, national, 2011-12, analysis, sectional, cross, australia:, survey, intake, cereal, fibre

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Key words: Australian Health Survey; dietary intake data; cereal fibre; grains; dietary fibre.

Abstract

Extensive evidence supports health benefits of cereal fibre, however globally no national intake data exists. This study aimed to determine estimates of intake and food sources of cereal fibre, and relationships to dietary fibre intake in an Australian sample population. A cereal fibre database was applied to dietary intake data from the 2011-12 National Nutrition and Physical Activity Survey (n=12,153). Usual intake based on 2-day intake data was weighted to infer population results. Median daily cereal fibre intake was 6.4g/d (9.7g/10 MJ/d) for adults (19-85 years) and 6.2g/d (10.2g/10 MJ/d) for children/adolescents (2-18 years). Individuals with the highest cereal fibre intake were more likely to meet dietary fibre recommendations than those with the lowest intake (males Q4: 17.1% Q1: 3.9%; females Q4: 20.3% Q1: 6.6%). Breakfast cereals, bread and bread rolls provided the most cereal fibre. This study provides first quantification of cereal fibre from all sources in an Australian national sample.

Introduction

The analysis of nutrient intakes within population-based surveys can offer insight into relationships between consumption and markers of health, contributing to the evidence-base to inform dietary guidelines. In order to quantify nutrient intakes, a food composition database detailing the nutrient content of each food item consumed by all participants in the survey is needed. For example, the AUSNUT 2011-13 database, developed by Food Standards Australia New Zealand (FSANZ) (2013a), provides the total dietary fibre content of all foods reported by participants within the 2011-12 National Nutrition and Physical Activity Survey (NNPAS) component of the 2011-13 Australian Health Survey (AHS), allowing for estimation of dietary fibre intakes. Similar databases exist internationally and are used for estimation of the intakes of key nutrients related to the development of chronic diseases.

The health benefits of a diet high in dietary fibres are well supported (Pietinen et al. 1996; Rimm et al. 1996; Wolk et al. 1999; Bingham et al. 2003) and are currently reflected in dietary guidelines outlined by governments worldwide, including Australia. Interestingly, the association between fibre intakes and favourable health outcomes is frequently found to be strongest with high cereal fibre intakes specifically, particularly when assessing risk of cardiovascular disease (Pietinen et al. 1996; Rimm et al. 1996; Wolk et al. 1999; Mozaffarian et al. 2003). A pooled analysis of ten prospective cohort studies found that every 10g/day increment of cereal fibre was associated with a 25% decrease in risk of coronary death (Pereira et al. 2004). Similarly, a consistent inverse association between intake of cereal fibre and the risk of type-2 diabetes mellitus has been found in a number of large prospective studies. Cho et al. (2013) conducted a systematic review of the literature and found that 10 of 11 reports showed an 18-40% risk reduction of type-2 diabetes mellitus with high intakes of

cereal fibre. In fact, a 14-year follow up study of 367,422 participants found that participants in the highest quintile of cereal fibre intake (10.22g/day) had a 19% lower risk of all cause mortality and a 15-34% lower risk of disease specific mortality than those in lowest quintile of intake (2.02g/day) (Huang et al. 2015).

Despite these findings, to the knowledge of the authors, there are currently no studies investigating total cereal fibre intakes from all food sources within a large sample. Previous studies have considered cereal fibre intake as a summation of fibre sourced from foods specifically within the cereal and grains food group. This neglects the contributions from mixed foods and many foods with cereals, or even specific cereal fibres as additives. As such, no quantification of cereal fibre composition in the Australian food supply has previously been attainable. The authors have recently expanded the AUSNUT 2011-13 database to include the cereal fibre content of all foods reported within the 2011-12 NNPAS (unpublished results). The application of the expanded AUSNUT database to the NNPAS dietary intake data, weighted to account for usual population intake, allows estimation of reported cereal fibre intakes and reported food sources within the Australian population. This study also explores associations between reported cereal fibre intake and total dietary fibre intake, with comparison to current Nutrient Reference Values (NRV) for dietary fibre, known as adequate intake (AI) values (NHMRC 2006).

Methods

Data and participants

This study used data from the Australian Bureau of Statistics (ABS) Basic Confidentialised Unit Record Files (CURF) for the 2011-12 NNPAS. The NNPAS is a subcomponent of the

2011-13 AHS, the most recent nationally representative survey within Australia at the time of this study. The NNPAS collected data from 12,153 participants aged 2-85 years (ABS 2014).

Dietary intake data within the 2011-12 NNPAS was collected via a 24-hour recall dietary assessment using an adapted version of the Automated Multiple Pass Method (Bliss 2004). Details for the specific phases and tools used are provided elsewhere (ABS 2013a). The assessment included five phases to develop greater layers of detail and accuracy in the answers provided. One day of data were collected for n=12,153 participants, with a second 24-hour recall repeated via telephone for n=7,735 participants, at least eight days after the initial recall. As this study was a secondary analysis of data collected within the NNPAS, permission was granted to utilise the ABS data.

Estimation of cereal fibre intakes

The cereal fibre content of each food item reported within the survey was calculated within the expansion of the current AUSNUT 2011-13 Food Nutrient database. In brief, the cereal fibre content was interpreted as fibre that is sourced from cereals grains and pseudo cereal grains, whether intact or processed within food products, and can include cereal fibres that are both intrinsic and extrinsic to the original food source. Food sources listed in the AUSNUT 2011-13 database containing >0.1g of cereal fibre per 100g-food product were considered sources of cereal fibre, based on the limitations of the analytical tests that measure fibre (Prosky et al. 1985; McCleary et al. 2010). In total, 1918 of a total 5740 food items were considered to contain cereal fibres. The cereal fibre content of foods was calculated using information from the AUSNUT 2011-13 Food Recipe File (FSANZ 2013b), commercial product label, input from food manufacturers and standardised recipes.

This study reports both nutrient level and food level outcomes following application of the expanded cereal fibre component of the AUSNUT 2011-13 food nutrient database. Cereal fibre intakes for each day of the survey were calculated as the amount of each cereal fibre containing food reported (g) by each participant multiplied by the proportion of cereal fibre (g/100g) within each food.

The multiple source method (MSM) (Harttig et al. 2011) was used to establish usual cereal fibre intakes based on data from both days of 24-hour recall assessments. The method employs a three-step formula using two logistic regression models. The first model estimates the individual probability of consumption of the nutrient and the second model estimates intake on consumption days. The individuals' probability of consumption on any day (model 1) is then multiplied by the intake of an individual on a consumption day (model 2) to give an estimate of usual consumption. The method takes into account gender and age within both regression models, which are covariates assumed to be predictive for consumption. Further details of the method have been described elsewhere (EFCOVAL Consortium 2011). Cereal fibre intakes were deemed habitual for all respondents within the MSM model due to the broad range of food products containing cereal fibre within the AUSNUT 2011-13 database. MSM was also applied to energy (kJ/day) and total dietary fibres (g/day) intake data from both days of the survey to obtain usual intake. These additional nutrients were deemed necessary components in the exploration of cereal fibre associations.

For the analysis of cereal fibre intakes within this study, weighting was applied to the data in order to infer results for the total Australian population at the time of the survey (n=21,524,951). Weighting applied was previously calculated and assigned by the ABS for use in the AHS data (ABS 2013b).

Reporting of nutrient-level data

Mean and median cereal fibre intake were reported by age, categorised using NRV age groupings (NHMRC 2006), and gender. Values were reported both as absolute cereal fibre intakes and cereal fibre intakes adjusted for daily energy intake (10 MJ/day) reported within the survey. Adjusting for energy intake allowed for exploration of the relative cereal fibre density of the diet, as absolute cereal fibre intake may be highly influenced by total energy intake.

For further analyses of associations, NRV age groupings were dichotomised with participants categorised into those aged less than 19 years (children and adolescents), and those aged 19 years or older (adults). Participants within each division were then categorised into quartiles based on energy-adjusted cereal fibre intakes.

Statistical analysis comparing total dietary fibre intakes to cereal fibre intake in adults

All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS version 21, 2009, Chicago, IL) software. The distribution of the cereal-fibre data were positively skewed, however, due to the sample size, parametric tests were applied. Statistical significance for tests was $p<0.05$.

Mean and median dietary fibre intake (g), as well as median energy intake (kJ) was calculated between quartiles of energy-adjusted cereal fibre intake of adults. One-way analysis of variance (ANOVA) and Bonferroni post-hoc tests were used to examine differences in mean dietary fibre intake within each quartile. Eta squared, calculated as the sum of squares between groups divided by total sum of squares, was used to calculate the

effect size. The effect size was interpreted based on Cohen's criteria (Cohen 1988), where 0.01 is considered a small effect, 0.06 a medium effect and 0.14 a large effect.

A chi-squared analysis was used to compare the proportion of respondents within each quartile of cereal fibre that are meeting the AI values for dietary fibre, set at 25g/day for females and 30g/day for males. Lastly, correlations were tested between energy-adjusted cereal fibre intakes and total dietary fibre intakes, using uncategorised, continuous data. Pearson's r correlation was used to assess effect size based on Cohen's criteria, where 0.1 indicates a small, 0.3 a medium and 0.5 indicates a large effect size (Cohen 1988).

Reporting of food-level data

Unlike nutrient-level data, major food contributors of cereal fibres were reported using only day-1 dietary intake data from the NNPAS. For these purposes of this study, day-1 data were deemed suitable to provide a snapshot overview of food sources of cereal fibres. Weighting was not applied to analyses at the food level, as the method was designed for scaling of nutrient intakes. The proportion of total cereal fibre sourced from relevant major, sub-major and minor food groups, as defined and categorised by FSANZ (2013c), was determined between children and adolescents (2-18 years old) and adults (19 years and above), as well as between quartiles of energy-adjusted cereal fibre. Foods were also coded as either core or discretionary based on specific nutrient cut-off criteria outlined by the ABS (2013c). The proportion of cereal fibre and the proportion of total intake from core foods were compared between quartiles of energy-adjusted cereal fibre intake.

Results

Cereal fibre intakes in NNPAS 2011-12

At the time of the survey, median cereal fibre intakes were relatively consistent between all NRV age groups ranging from 5.2 g-6.7 g/d (9.1 g-11.1 g/10 MJ/day) (Table 1 reports median and mean values). The reported median cereal fibre intake based on weighted data for total children and adolescents was 6.2g/d (10.2g/10 MJ/day), and for total adults was 6.4g/d (9.7g/10 MJ/day). The highest median cereal fibre (6.7g/d) was reported by persons in the over 70-age group and in the 14-18 years age group. The lowest median cereal fibre was reported by children aged 2-3 years (5.2g/d). However, once adjusted for energy intake, the highest cereal fibre intake relative to energy was reported by those in the 4-8 years age group (11.1g/10 MJ/day), while persons aged 19-30 years reported the lowest intake relative to energy (9.1g/10 MJ/day). Both unadjusted and adjusted cereal fibre reported intakes were skewed towards a higher intake, due to the 99th percentile reporting greater than 17.3g cereal fibre/day (22.4g/10 MJ/day).

Across all age groups, males reported consuming a slightly higher median amount of cereal fibre than females (7.2g/d and 5.7g/d, respectively), however, it was apparent that males and females reportedly consumed similar amounts (9.7g/10 MJ/day and 9.8g/10 MJ/day, respectively) when the values were adjusted for energy intake. The minimum amount of absolute cereal fibre reported was 1.3g/day and the maximum was 34.9g/day (1.6g-68.5g/10 MJ/day) at the time of the survey.

Associations to dietary fibre intake

Table 2 displays the trends between quartiles of energy-adjusted cereal fibre intakes and total dietary fibre intakes. For both males and females, mean dietary fibre intake increased

significantly with each higher quartile of energy-adjusted reported cereal fibre intake. On average, males within quartile 4 consumed 6.13g/day more total dietary fibre than males within quartile 1, while females within quartile 4 consumed, on average, 3.78g/day more total dietary fibre than females with quartile 1. The effect size was determined as medium for males (h^2=0.10) and small for females (h^2=0.05). Correlations between energy-adjusted cereal fibre intake and total dietary fibre intake indicated a medium positive correlation for males (r=0.345, p=0.000) and a weak positive correlation for females (r=0.225, p=0.000).

For both males and females, the proportion of participants meeting the AI value for dietary fibre increased with each higher quartile of energy-adjusted cereal fibre intake. In total 17.1% of males and 20.3% of females within quartile 4 were meeting the AI, compared to 3.9% of males and 6.6% of females in quartile 1 (all p<0.05). This means males in quartile 4 were 4.4 times more likely to meet the AI than males in quartile 1, while females in quartile 4 were 3.1 times more likely to meet the AI than females in quartile 1.

Sources of cereal fibre

On day one of the survey, participants reported consuming 1918 foods containing >0.1g cereal fibre. Table 3 presents the contribution of each food group as a percentage of total cereal fibre intakes amongst adults and children and adolescents. Among both adults and children and adolescents, the majority of cereal fibres (69.8% and 62.3%, respectively) consumed was sourced from the *cereal and cereal products* major food group. Within this group, regular bread and bread rolls, as well as ready to eat breakfast cereals were the main (minor) food group contributors of cereal fibre. With consideration of the minor food groups, it is evident that adults were consuming more mixed grain breakfast cereals containing fruits and/or nuts, whereas children and adolescents were consuming very little of these breakfast

cereals. Relatively high proportions of fibre were obtained from refined cereals (e.g. white bread, instant noodles) even though these would be considered low fibre products, reflecting the reasonably high consumption of such products.

The second largest portion of cereal fibres reported for both adults and children and adolescents (23.3% and 27.6%, respectively) was the major group of *cereal based products and dishes*. Other major food groups found to provide cereal fibre included meat products and dishes, where cereal fibre was sourced mainly from crumbed chicken products; snack foods, which included popcorn; and confectionery and cereal/nut/fruit/seed bars, where cereal style bars provided a small proportion of total cereal fibres. The percentage contribution to total cereal fibre intakes within these three groups was higher amongst children and adolescents than adults.

Sources of cereal fibre between quartiles of energy-adjusted cereal fibre intake were also considered. Both adults and children and adolescents within the highest quartile of adjusted cereal fibre intakes (Q4, median intake 14.6g and 14.3g, respectively) were consuming the highest proportion (79% and 72%, respectively) of cereal fibre from *cereal and cereal-based products*, and the lowest proportion from *cereal based products and dishes* (17% and 19%, respectively) on day 1 of the survey. In contrast, participants within the lowest quartile of adjusted cereal fibre intakes (Q1, median intake 6.1g and 6.9g, respectively) were consuming the lowest proportion (55% and 50%, adults and children and adolescents, respectively) of cereal fibre from *cereal and cereal-based products*, and the highest proportion from *cereal based products and dishes* (32% and 36%, adults and children and adolescents, respectively). Participants within the lowest quartile of cereal fibre intakes were consuming 6% of total cereal fibre from meat-based products and dishes such as crumbed and battered meat

products, compared to these products contributing only 1% of total cereal fibre intakes in the highest quartile of intakes. This reflects the low cereal fibre intake of quartile 1 in addition to the poor food choices of this group.

Core food and discretionary food cereal fibre contribution

Among adults, core foods contributed 87% of total cereal fibre intakes, indicating that only a relatively small amount (13%) of cereal fibre for adults was obtained from discretionary foods. Children and adolescents reported 80% of total cereal fibres from core foods on the day of the survey, indicating a slightly higher contribution (20%) from discretionary food sources. The main discretionary sources of cereal fibre for both adults and children and adolescents were from the pastries minor food group (26% and 16% of total cereal fibre from discretionary foods, respectively), as well as cakes, muffins, scones and cake-type desserts minor food group (16% and 13%, respectively). The corn snacks minor food group and the muesli or cereal style bars minor food group were also significant sources among children and adolescents only, providing 10% and 14% of cereal fibre from all discretionary sources, respectively.

The proportion of total cereal fibres from core foods increased linearly for participants within each higher quartile of energy-adjusted cereal fibre intakes. On day 1 of the survey, core foods contributed to 92% of adult and to 87% of children and adolescent total cereal fibre intakes within the highest quartile (Q4) of adjusted intakes. Adults and children and adolescents within the lowest quartile (Q1) obtained 77% and 72% of total cereal fibre from core foods, respectively.

A similar pattern was found, whereby subjects within the highest quartile of cereal fibre intake (Q4) consumed the highest proportion of core foods in general. Core foods comprised 87% of Q4 adult and 86% of Q4 children and adolescents total reported intake on day 1 of the survey. In contrast, core foods contributed 74% of intakes in both adult and children and adolescents within the lowest quartile of reported cereal fibre intakes (Q1).

Discussion

The present study reports an estimation of the usual cereal fibre intakes of Australians based on two days of dietary intake data from the 2011-12 NNPAS. Furthermore, it details main food sources of cereal fibre consumed by participants on day-1 of the survey, and presents an analysis of how usual cereal fibre intakes may be associated with total dietary fibre intake. To the knowledge of the authors, this study provides the most comprehensive analysis of cereal fibre intake in an Australian population, which can be used as a baseline to review comparisons in cereal fibre and cereal foods with health data.

This study found reported cereal fibre intake was relatively consistent among all groups. The median intakes of cereal fibre were 6.2g/day for children and adolescents and 6.4g/day for adults, equating to roughly 2-3 slices of wholegrain bread, or 2 cups of cooked brown rice. Participants within the 4-8 year age group and the over-70 years age group were reportedly consuming the most cereal fibre, relative to energy intake. After adjusting for energy intake, children and adolescents reportedly consumed slightly more cereal fibre than adults, and female adults consumed slightly more cereal fibre than male adults.

There are limited studies that have analysed cereal fibre intake to directly compare these findings with. Furthermore, past studies that have analysed cereal fibre intakes considered

contributions only from cereal foods, excluding a significant portion of cereal fibre that may accumulate from non-cereal food sources. The ABS (2016) recently published findings from the 2011-12 NNPAS, comparing consumption of food groups within the survey to the Australian Dietary Guidelines recommended servings. The findings from the ABS report that on average, 30% of Australians were meeting core cereal food group serve recommendations. The over 70-year age group had the highest proportion of participants meeting core cereal serve recommendations. Furthermore, within the report "whole grains or high fibre" varieties made up over half of all grains (55%) consumed by persons aged 71 years, compared to an average of 34% across all participants. As persons in the over-70 year age group were reportedly consuming a higher quantity of cereal products relative to their energy needs, as well as more whole grain and high fibre varieties, it is not unexpected that they would inherently be consuming more cereal fibres.

Within the present study, for adults and children and adolescents, bread and bread rolls, and ready-to-eat breakfast cereals (RTEC) were the most commonly consumed sources of cereal fibre. It is interesting to note that those participants within the lowest quartile of energy adjusted cereal fibre were still consuming some cereal products and dishes, such as bread and RTEC, but were receiving proportionately less cereal fibre from them. This suggests that persons within the lowest quartile of cereal fibre are eating less of these products, but are also more likely choosing the refined cereal products, which would provide significantly less cereal fibre. They also accumulate proportionately more cereal fibre in small amounts through consumption of discretionary foods such as crumbed meat products, pastries, and cakes. These products do not contain a large amount of cereal fibre but rather a lack other significant sources of cereal fibres, which distorts the proportions, making the contribution seem more significant.

An average cereal fibre intake of 6.4g for adults, accumulated from both core and discretionary food sources, suggests that Australians are most likely not eating enough cereal foods, but are also choosing lower fibre, refined variety choices. This is further supported by the ABS findings that 66% of core cereal foods reported within the survey were not "whole grain or high fibre" varieties. A possible mechanism to address low reported cereal fibre consumption may be through encouragement of higher quality cereal foods choices. Commonly eaten products such as, breads and RTEC may be key products to target cereal fibre intakes. Encouraging higher fibre, less refined breads and RTEC may not only improve the fibre intake of individuals (Barr et al. 2013), it may also improve other aspects of the individual diet. Many studies have found breakfast cereal consumption to be associated with higher intakes of various nutrients including calcium, iron, magnesium, zinc, vitamin D and B vitamins (Grieger and Cobiac 2012; Michels et al. 2015). Importantly, these cross-sectional studies only tested association, and RTEC consumption may be a marker of better diet quality rather than the cause of higher nutrient intakes.

Cereal fibre intake within the diet was unsurprisingly associated with total dietary fibre consumption in both males and females, highlighting the key role consumption of foods high in cereal fibre play in meeting daily fibre requirements. Males with the diets highest in cereal fibre (adjusted for energy) were 4.4 times more likely to meet the AI values for dietary fibre, and females with diets highest in cereal fibre (adjusted for energy) were 3.1 times more likely. Despite these findings that high cereal fibre intake was associated with higher dietary fibre, median dietary fibre within all quartiles still fell short of the AI values for both males and females. Even within the highest quartile of energy adjusted cereal fibre intakes, 82.9% of males and 79.7% of females are failing to meet the AI values. This is not surprising, as

dietary fibre guidelines are often not met internationally either. The 2013-2014 United States NHANES What We Eat in America report (2016) shows that average dietary fibre intakes for US persons over 2 years was 16.3g/day. As cereal fibre appears to be a significant factor in total dietary fibre intakes, encouragement of higher fibre cereal foods may be a key target to increasing intake of total dietary fibre among Australians. This is supported by a previous study by Reicks et al. (2014), which found that whole grain, high fibre cereal foods made a significant contribution to total dietary fibre intake in adults and children.

There are some limitations to this study. The 24-hour recall method of gathering dietary information from participants within the 2011-12 NNPAS can be limited by participant recall bias and under reporting of intake (Macdiarmid and Blundell 1998), likely indicated by the low median values of energy intake reported within this study. This method is also limited by the inability to capture an accurate representation of day-to-day variation, however, this is partially accounted for by use of the Multiple Source Method adjustment. Assumptions made within the creation of the cereal fibre database carry through to the analysis and may under- or overestimate cereal fibre intake within the study. The descriptive, cross-sectional design of the 2011-12 NNPAS poses a limitation in results, as it is impossible to determine causation between cereal fibre intake and dietary fibre intakes, and the results can only determine associations. Despite these limitations, this study provides insight into cereal fibre intakes a within a large Australian sample, weighted to be representative of the Australian population.

Conclusion

This study provides the first quantification of cereal fibre intake within Australia at the time of the study. The study indicates that while Australians are consuming cereal foods, the choices they are making are likely more refined, lower-fibre varieties, evident by low cereal

fibre intake. This suggests future focus within public health messaging should include strategies to increase consumption of higher fibre, whole grain cereal products. As there is no distinct group consuming considerably less cereal fibre than others, males and females of all ages are suitable targets for communication and education strategies.

As bread and ready to eat cereals were commonly consumed sources of cereal fibre within this study, encouragement of higher fibre bread and cereal choices may be an effective strategy to achieve a higher cereal fibre intake. This may also contribute significantly to an increase in total dietary fibre, as persons with diets highest in cereal fibre tended to have significantly higher total dietary fibre intakes.

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Tables

Table 1: Reported cereal fibre intakes (g/day) of Australians based on weighted data from the 2011-12 NNPAS[a] by age group and gender

Age group, years (n, % of total sample)		Total cereal fibre intake (g/day)			Energy-adjusted cereal fibre intake (g/10MJ/day)		
		Male	**Female**	**Total**	**Male**	**Female**	**Total**
2-3 (n=464, 3.8%)	Median (IQR)[b]	5.4 (4.3-6.9)	5.1 (4.0-6.2)	**5.2 (4.2-6.6)**	10.4 (8.1-12.6)	10.4 (8.3-12.7)	**10.4 (8.1-12.6)**
	Mean	5.8	5.1	**5.5**	10.9	10.7	**10.8**
4-8 (n=789, 6.5%)	Median (IQR)	6.9 (5.3-8.6)	5.7 (4.5-6.9)	**6.1 (4.9-7.7)**	10.9 (8.8-13.1)	11.1 (8.8-12.8)	**11.1 (8.8-13.0)**
	Mean	7.2	5.9	**6.5**	11.1	11.0	**11.1**
9-13 (n=787, 6.5%)	Median (IQR)	7.1 (5.5-9.4)	5.7 (4.5-7.5)	**6.5 (5.0-8.3)**	10.2 (8.0-12.8)	9.2 (7.7-11.7)	**9.6 (7.9-12.1)**
	Mean	7.8	6.1	**6.9**	10.7	9.7	**10.2**
14-18 (n=772, 6.3%)	Median (IQR)	7.5 (5.6-9.9)	5.9 (4.4-7.1)	**6.7 (4.9-8.7)**	9.7 (7.5-12.5)	9.8 (7.8-11.8)	**9.7 (7.7-12.1)**
	Mean	8.2	6.2	**7.2**	10.4	10.1	**10.3**
19-30 (n=1592, 13.1%)	Median (IQR)	7.3 (5.5-9.8)	5.5 (4.1-7.2)	**6.3 (4.7-8.5)**	8.9 (7.4-11.7)	9.3 (7.5-11.4)	**9.1 (7.4-11.5)**
	Mean	7.8	6.0	**6.9**	9.6	9.8	**9.7**
31-50 (n=3565, 29.2%)	Median (IQR)	7.2 (5.4-9.6)	5.6 (4.1-7.5)	**6.4 (4.6-8.6)**	9.4 (7.3-11.9)	9.6 (7.3-11.9)	**9.5 (7.3-11.9)**
	Mean	7.8	6.1	**6.9**	9.9	10.0	**9.9**
51-70 (n=2906, 23.9%)	Median (IQR)	7.1 (5.1-9.6)	5.8 (4.4-7.6)	**6.3 (4.6-8.5)**	9.7 (7.4-12.7)	10.0 (8.0-12.6)	**9.9 (7.6-12.7)**
	Mean	7.8	6.3	**7.0**	10.3	10.6	**10.5**
>70 (n=1278, 10.5%)	Median (IQR)	7.5 (5.7-9.7)	6.1 (4.5-8.0)	**6.7 (5.0-8.8)**	10.8 (8.5-13.5)	10.8 (8.7-13.5)	**10.8 (8.6-13.5)**
	Mean	8.0	6.6	**7.2**	11.3	11.5	**11.4**
Total children & adolescents, 2-18 yrs (n=2812, 23.1%)	Median (IQR)	7.0 (5.3-9.0)	5.6 (4.4-7.1)	**6.2 (4.8-8.0)**	10.4 (8.2-12.8)	10.0 (8.1-12.3)	**10.2 (8.1-12.5)**
	Mean	7.5	5.9	**6.7**	10.8	10.3	**10.5**
Total adults, 19+ yrs (n=9340, 76.9%)	Median (IQR)	7.2 (5.4-9.7)	5.7 (4.2-7.5)	**6.4 (4.7-8.6)**	9.5 (7.4-12.2)	9.8 (7.7-12.2)	**9.7 (7.5-12.2)**
	Mean	7.8	6.2	**7.0**	10.1	10.3	**10.2**
Total participants (n=12152, 100%)	Median (IQR)	7.2 (5.4-9.5)	5.7 (4.3-7.4)	**6.4 (4.7-8.4)**	9.7 (7.6-12.3)	9.8 (7.7-12.2)	**9.8 (7.7-12.3)**
	Mean	7.7	6.1	**6.9**	10.2	10.3	**10.3**

a. 2011-12 National Nutrition and Physical Activity Survey

b. Interquartile range: 25^{th}-75^{th} percentile values

519 **Table 2: Dietary fibre and energy intake showing % meeting Adequate Intake recommendations, for a sample of Australian adults[a,b]**

	Quartile 1 (lowest)			Quartile 2			Quartile 3			Quartile 4 (highest)		
	Males	**Females**	**Total**	**Males**	**Females**	**Total**	**Males**	**Females**	**Total**	**Males**	**Females**	**Total**
Population weighted n= 21,524,951	2071500	2120305	**4191805**	2064935	2120561	**4185495**	2069002	2120180	**4189183**	2067229	2121145	**4188374**
Median energy intake (kJ/day)	8099kJ	6150kJ	**7125kJ**	7650kJ	5886kJ	**6660kJ**	7649kJ	5883kJ	**6755kJ**	7168kJ	5581kJ	**6309kJ**
Median cereal fibre intake (g/10 MJ/day)	6.0	6.3	**6.1**	8.4	8.7	**8.6**	10.7	10.9	**10.8**	14.3	14.3	**14.3**
Mean dietary fibre intake (g/day)	17.3	16.1	**16.7**	18.7	16.3	**17.5**	20.7	18.3	**19.5**	23.5	19.9	**21.7**
Median dietary fibre intake (g/day)	16.4	14.8	**15.6**	17.4	15.5	**16.5**	20.1	17.3	**18.6**	22.2	18.8	**20.3**
% Meeting AI value[c]	3.9%	6.6%	**5.2%**	5.8%	7.5%	**6.7%**	7.3%	11.1%	**9.3%**	17.1%	20.3%	**18.7%**
% Not meeting AI value	96.1%	93.4%	**94.8%**	94.2%	92.5%	**93.3%**	92.7%	88.9%	**90.7%**	82.9%	79.7%	**81.3%**

520 a. Based on dietary intake data from the 2011-12 National Nutrition and Physical Activity Survey

521 b. Organised by quartiles of energy-adjusted cereal fibre intake (g/10 MJ/day)

522 c. Adequate intake (AI) values defined as 30g for males and 25g for females

523 * All cells significantly different at <0.05.

Table 3: Contribution (%) of major, sub-major and minor food groups[a] to total cereal fibre consumption in 2011-12[b]

Food Group	Adults (19+yrs) n= 9340	Children & adolescents (2-18yrs) n= 2812
Cereal and cereal products	**69.8%**	**62.3%**
Regular breads, and bread rolls (plain/unfilled/untopped varieties)	***29.1%***	***27.0%***
Breads, and bread rolls, white, mandatorily fortified	6.6%	6.7%
Breads, and bread rolls, white, not stated as to fortification	3.2%	6.0%
Breads, and bread rolls, wholemeal and brown, mandatorily fortified	5.4%	3.3%
Breads, and bread rolls, wholemeal, not stated as to fortification	3.2%	4.2%
Breads, and bread rolls, mixed grain, mandatorily fortified	4.6%	2.0%
Breakfast cereals, ready to eat	***24.6%***	***19.0%***
Breakfast cereal, wheat based, fortified, sugars ≤20 g/100g	9.5%	9.6%
Breakfast cereal, mixed grain, with fruit and/or nuts	6.8%	0.8%
Flours and other cereal grains and starches	***5.4%***	***3.7%***
Rice and rice grain fractions	3.5%	2.9%
Breakfast cereals, hot porridge style	***4.2%***	***2.7%***
Porridge style, oat-based	4.2%	2.7%
Pasta and pasta products (without sauce)	***3.2%***	***6.4%***
Pasta and noodles, wheat based, other than instant noodles	1.7%	2.7%
Instant noodles and noodle products, wheat based	1.3%	3.6%
English style muffins, flat breads, and savoury and sweet breads	***3.1%***	***3.5%***
Cereal based products and dishes	**23.3%**	**27.6%**
Mixed dishes where cereal is the major ingredient	***13.0%***	***15.6%***
Savoury pasta/noodle and sauce dishes, saturated fat ≤5 g/100g	5.5%	6.4%
Pastries	***3.4%***	***3.2%***
Savoury pastry products, pies, rolls and envelopes	2.2%	2.4%
Cakes, muffins, scones, cake-type desserts	***2.4%***	***2.8%***
Savoury biscuits	***2.3%***	***3.0%***
Sweet biscuits	***1.4%***	***2.0%***
Meat products and dishes	**2.4%**	**2.4%**
Mixed dishes where poultry or feathered game is the major component	***1.4%***	***1.6%***
Poultry crumbed, battered, meatloaf or patty type with cereal and/or vegetables	0.9%	1.3%
Snack foods	**1.0%**	**2.9%**
Corn snacks	***0.7%***	***2.2%***
Pop corn	0.3%	1.5%
Confectionery and cereal/nut/fruit/seed bars	**1.3%**	**2.8%**
Muesli or cereal bars	***1.2%***	***2.7%***
Muesli and cereal style bars, with fruit and/or nuts	0.7%	1.1%
Muesli and cereal style bars, added coatings or confectionery	0.4%	1.4%

a. Categorised by the Australian Bureau of Statistics (ABS)

b. Based on day 1 reported intakes from 12,153 participants.