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Research Article

Macronutrient and Mineral Dietary Risk Factors in Indigenous Australians Based on Secondary Data Analysis

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Abstract

Chronic conditions are a major cause of the health gap between Indigenous and non-IndigenousAustralians. Diet is a well-known risk factor for the chronic conditions in general and hence isof critical importance in Indigenous Australians, a group that suffer disproportionately from obesity, hypertension, diabetes and cardiovascular diseases. Limited evidence exists to relate dietary intake with chronic disease causation and prevention in Indigenous Australians. This study investigates dietary differences between various subsets of Indigenous Australians that may relate to observed disparities in chronic health conditions. To this end, macronutrient and mineral dietary differences were examined between Indigenous and non-Indigenous Australians, including between remote and urban Indigenous Australians, using data from thecomprehensive Australian Health Survey (2011 - 13). Dietary intakes of macronutrients such as dietary fibre and cholesterol, and minerals such as calcium, magnesium, potassium, and sodiumin Indigenous Australians are significantly different from non-Indigenous counterparts. The gap between recommended and actual dietary intakes starts early in life for Indigenous children, with the sodium diet-gap starting as early as 2 - 3 years of age, and gaps in dietary fibre, calcium, potassium and zinc emerging by the 4 - 8 years of age Indigenous cohort. Within Indigenous Australians, those living in remote report consumption of higher cholesterol but lower dietary fibre, calcium, and iodine, compared to Urban living. These results broadly indicate that significant public health promotion and interventions be applied to adjust dietary intakes of some of these macronutrients and minerals to reduce disparities from chronic diseasein these populations.

INTRODUCTION

Chronic disease is the leading cause of death globally, accounting for approximately 71% of total deaths [1], and cardiovascular disease in particular is responsible for 31% of total deaths worldwide [2]. Further, cardiovascular disease is the major cause of death in Australia, including in Aboriginal and Torres Strait Islanders, who have a death rate due to cardiovascular disease 1.8 times higher, at 12%, than non-Indigenous Australians (3.8%) in the younger generation of people aged 30-39 years [3]. About 80% of the health gap between Indigenous and non-Indigenous Australians is attributed to diet–related chronic diseases such as heart disease, diabetes, chronic kidney disease and cancer [4]. The rates of associated risk factors such as obesity, high blood glucose levels and high blood pressure are also reported to be higher in Indigenous Australians compared with non- Indigenous Australians [5]. Five of seven such leading risk factors contributing to the Indigenous and non-Indigenous health gap are dietary related [6]. The greatest health disparity between Indigenous and non-Indigenous Australians is witnessed in remote areas (age-standardised disability-adjusted life year (DALY) rates per 1000 people 523.7(Indigenous)vs 217.4(non-Indigenous)),whereaindiet-related diseases such as cardiovascular disease, endocrine diseases (including diabetes) and kidney disease occur at higher rates in remote Indigenous Australians than those living in major cities and regional areas [7].

Lifestyle factors such as tobacco use, physical activity and nutrition play a role in the development of chronic diseases, although specific studies have demonstrated nutrition's direct association with chronic disease biomarkers. The impact of food consumption was studied with 3-day weighted food records and the status of 11 chronic diseases by using biomedical measures, including those for diabetes, hypertension, anemia, hypercholesterolemia and self- reported conditions, in 1020 participants in a longitudinal nutrition study in Jiangsu Province of China (baseline study in 2002 and follow-up in 2007). The study suggested greater consumption of fruits, vegetables and whole grains for lowering the risk of multi morbidity [8]. Similar findings disclosing the benefits of whole grain bread and raw vegetables were reported in a study of 27, 548 participants aged between 35 and 65 years during 8 years in the European

Prospective Investigation into Cancer and Nutrition Potsdam Study.

While the higher intake of whole grains and vegetables were found to be associated with lowering risk of chronic diseases, higher intake of low-fat dairy, butter and red meat with increasing risk of chronic diseases [9]. The benefits of healthy fats intake (omega 3 and polyunsaturated fats in place of trans and saturated fats) and their protective effects on cardiovascular disease, diabetes, cancer and obesity were discussed by Willett et al. [10],in their review of the WHO and the Food and Agriculture Organisation [11], report.

A study of the difference between whole grain vs refined grain diets on hypertension, a major risk factor for cardiovascular disease, identified reduced risk of hypertension in women who consumed whole grain [12]. Again, more specifically, the benefits of a diet rich in fruits, vegetables and whole grains against the biomarkers of chronic conditions correlated with macronutrients such as dietary fibre ($r = 0.77$, $p < 0.0001$) and minerals such as iron ($r = 0.46$, $p < 0.0001$), magnesium ($r = 0.49$, $p < 0.0001$), and phosphorus ($r = 0.57$, $p < 0.0001$) [8]. Macronutrients such as carbohydrate and protein, and fibre-rich diets that are low in fat and cholesterol, are protective against obesity, diabetes, heart disease and hypertension as they promote satiety and delay hunger, thus helping maintenance of body weight, which is the primary metabolic risk factor for many chronic diseases [13,14]. Not only macronutrients are required in large quantities for healthy functioning of the human body, but minerals are now well established for their essential role in human health. The WHO states that more than 2 billion people worldwide suffer from micronutrient imbalances and this substantially contributes to the global burden of disease, and that micronutrients play an important role in controlling diet–related diseases [15,16]. Micronutrient imbalances are common because of diet Westernization in contrast to traditional food, which is believed to provide a much wider variety of micronutrients [17-19]. Finding the same balance in urban diets as that of traditional foods is difficult to achieve [20-23].

Objectives

Here we focus on dietary risk factors, especially those related to macronutrient and mineral consumption that could be critical causes of the chronic disease–related health gap in Indigenous and non-Indigenous Australians.

METHODS

Secondary Data

This study utilises data from the Australian Health Survey (AHS) (2011–13), NNPAS (2011– 12) and NATSINPAS survey (2012–13). The 2011–13 AHS is the most comprehensive health survey ever conducted in Australia and collected a range of information about health– related issues, including the National Nutrition and Physical Activity Survey (NNPAS). It included detailed information on the dietary intake of over 12,000 participants across Australia, nutrition being part of first ever national survey. The AHS also included Indigenous participants, the National Aboriginal and Torres Strait Islander Nutrition and Physical Activity Survey (NATSINPAS) provided nutrition and physical activity results for Aboriginal and Torres Strait Islander people. The nutrition–relateddetailswerecollectedusin ga24-hourdietaryrecall method asking participants to recall the foods consumed prior to the day of interview [24]. The available secondary datasets provide sufficient volume and breathe to address the stated objectives.

Statistical Analysis

The statistical analyses to determine any differences in the intakes of the Indigenous and non- Indigenous populations were calculated using mean daily intake (MDI) and nutrient density (ND) data from the ABS. The ABS used the method of calculating MDI for each age group by sex group from the distribution of usual nutrient individual intakes simulated by the NCI method [3]. Nutrient Density is the mass of a nutrient in food in relation to the energy provided by the same food, and is expressed as the mass of the nutrient per 1000 kcal or MJ of energy [25], and was used in conjunction with MDI as a quality assessment tool for the difference in the intakes of population groups [26-29]. Consumption values of macronutrients (energy, protein, total fat (saturated fat, monounsaturated fat, polyunsaturated fat, total long-chain omega 3 fatty acids, trans fatty acids), carbohydrates, dietary fibre and cholesterol) and minerals (calcium, iodine, iron, magnesium, phosphorus, potassium, selenium, sodium, and zinc) were calculated for the two population groups. Calculations were done for two gender groups (male and female) and two age-based groups (broad age category, 2–18 years and 19 years and over; finer age category, 2–3 years, 4–8 years, 9–13 years, 14–18 years, 19–30 years and 31–50 years, 51 years and over) for comparison of Indigenous and non-Indigenous populations. Remote and urban Indigenous categories were determined for Indigenous people.

To determine whether any differences in the dietary intakes of macronutrients and minerals by Indigenous and non-Indigenous Australian populations are significant, the statistical significance was tested by calculating the standard error of the difference between two estimates (x and y) to calculate the test statistic (z score) using the formula presented below. A test statistic of greater than 1.96 is good evidence of statistically significant difference at 95% confidence levels between the two populations. If the value is less than 1.96, there is no significant difference between the two populations with respect to that particular dietary characteristic [3].

$$TestStatistic = \frac{1x - y1}{SE(x - y)}$$

Where

$SE\ (x - y) = \sqrt{}\ [SE(x)]2 + [SE(y)]2$

RESULTS & DISCUSSION

Dietary Differences between Indigenous and Non-Indigenous Australians

Z statistics representing the statistically significant differences between macronutrient MDI among Indigenous male and non-Indigenous male participants are presented in Table 3.1 for each age group (2–3 years, 4–8 years, 9–13 years, 14–18 years, 19–30 years, 31–50 years, and 51 years and over) and for two broad age groups (2–18 years, and 19 years and over). Corresponding results for Indigenous female and non-Indigenous female participants are presented in Table 1. Z statistics by ND per 1000 kJ were also calculated and are presented in Tables 3.3 and 3.4 for Indigenous and non-Indigenous male and female participants, respectively.

Consumption for Broad and Fine Age Groups (MDI)

Dietary fibre intake was lower for Indigenous male participants of 2–18 years, starting as early as 9–13 years, and for Indigenous female participants of 19 years and over. Cholesterol and trans fatty acids consumption levels were higher in both genders (19 years and over). Good fatty acids or polyunsaturated fatty acids (PUFAs) and omega 3 consumption levels were lower in Indigenous female participants of 19 years and over (Table 1,2).

Consumption for Broad and Fine Age Groups (ND)

Protein, trans fatty acids and cholesterol were higher, while PUFAs and dietary fiber consumption was lower in Indigenous male participants of 19 years and over. Low dietary fiber and high cholesterol were also found in participants of 2–18 years, with statistically significant differences observed in participants as young as 4–8 years. For female participants, higher protein, trans fatty acids and cholesterol and lower dietary fibre were found in the 2-18 years age group, with differences for dietary fibre found as early as 2– 3 years and for trans fatty acids as early as 4– 8 years. Higher carbohydrate, saturated fat, cholesterol and trans fatty acids and lower PUFAs, omega 3 fatty acids and dietary fibre were found in the group of 19 years and over (Table 3,4).

Dietary Differences between Remote and Urban Indigenous Australians

Mean daily intakes ABS data for both Indigenous males and females from remote and urban locations are presented in Table 3.5 and 3.6. The data marks the difference between the consumption behaviours in both male and female participants within Indigenous category for major macronutrients and minerals. In general, Indigenous male participants from a remote region reported lower consumption of total fat, saturated fat, monounsaturated fat, polyunsaturated fat, calcium and sodium, and higher consumption of omega 3 fatty acids, by both ND and MDI. Indigenous male participants from remote regions also reported higher protein, cholesterol, iron, phosphorous, selenium and zinc consumption by ND, and lower energy intake, carbohydrates, dietary fibre, iodine, magnesium and potassium by MDI, compared with their urban counterparts. In remote Indigenous female participants, higher protein, omega 3 fatty acids, cholesterol, iron, selenium, zinc, and lower calcium, iodine and sodium were found by MDI and ND; by ND, lower total fat, polyunsaturated fatty acids and dietary fibre were found in Indigenous female participants, compared with their Indigenous counterparts in urban region (Table 7). (Table 1,2).

Dietary Fibre

The recommended daily intake (RDI) of dietary fibre is 25 g for women and 30 g for men aged 19 years and over. The RDI of dietary fibre for children depends on age; it is 14 g/day for 2-3 years, 18 g/day for 4-8 years, 24 g/day for boys 9-13 years and 20 g/day for girls of that age, and 28 g/day and 22 g/day, respectively, for boys and girls 14-18 years [30]. MDI for Indigenous adults (over 19 years) was 10 g less than the RDI - 19.4g and 15.8g for men and women, respectively, while for non-Indigenous adults it was only 5 g less - 24.8g and 21.1g for men and women, respectively. Indigenous girls of 2-3 years received less than the RDI (13.2g), and from 4-8 years, both Indigenous boys and Indigenous girls had dietary fibre intakes of less than the RDI (17.8g and 17.1g, respectively). From the age of 9-13 years, both Indigenous boys and girls and non-Indigenous boys and girls had fibre intakes of less than the RDI (20.1g, 19.2g, 22.8g and 19.1g, respectively) [24].

There have been three large population-based studies that explored the correlation between dietary fibre intake and coronary heart disease (CHD). In the study conducted by Pietinen et al. [31], in middle aged men of 50-69 years, those who were in the highest quantile of dietary fibre intake (median 34.8 g/day) had a relatively low risk (0.69) for CHD death compared with those in the lowest quantile of intake (16.1 g/day). In the same study, an increase of 10 g fibre intake was observed to correspond with reduced coronary death incidences of 17%. Another 6- year follow-up study of US males of 40–75 years also showed an inverse relationship between dietary fibre intake and risk of myocardial infarction, where the relative risk for fatal heart disease and total myocardial infarction in the high consuming group (median, 28.9 g/day) was 0.45 and 0.59 compared with the low dietary fibre consuming group (median, 12.4 g/day). A 10 g increase in dietary fibre equated to the relative risk of myocardial infarction of 0.81 [32]. Other than these two studies conducted in men, Wolk et al.'s study was designedforwomenaged37–64yearstodetermineiftherewasanyrelationshipbetween dietary fibre intake and acute myocardial infarction or death due to CHD. In the 10-year follow up study, relative risk was 0.77 for total CHD in the highest total dietary fibre quantile women (median, 22.9 g/day) compared with the lowest quantile (median, 11.5 g/day). In all the above studies, improvements in cardiovascular risk factors were observed at high consumption rates of 29 and 35 g/day for men in two studies and 23 g/day for women in one study. Small improvements in fibre consumption rates as small as 10 g/day reduced risk factors related to cardiovascular events and related incidences. Such population studies, which establish the

Table 1: Z statistics for Indigenous male participants (MDI)

Male (MDI)									
Macronutrients	**Z Statistics**								
	2-3 years	**4-8 years**	**9-13 years**	**14-18 years**	**19-30 years**	**31-50 years**	**51 and over**	**2 - 18 years**	**19 and over**
Protein	0.71	-0.16	0.08	-0.11	-0.26	0.11	-1.36	-0.23	0.68
Total fat	0.88	-0.25	-1.53	-1.53	-0.02	-1.43	-2.10	-1.67	-0.38
Saturated fat	1.15	-0.51	-1.87	-1.98	0.28	-0.24	-1.65	-1.94	0.53
Monounsaturated fat	0.73	0.13	-1.14	-1.24	0.00	-1.85	-1.87	-1.25	-0.54
Polyunsaturated fat	0.25	0.13	0.11	-0.30	-0.42	-3.11	-2.59	-0.23	-1.56
Total long chain omega 3 fatty acids	-0.59	-1.26	1.54	0.35	-0.92	-0.13	-1.34	0.40	-1.43
Trans fatty acids	1.46	-0.56	-1.63	-0.97	0.32	1.97	0.49	-1.48	2.17
Carbohydrate	0.13	-0.26	-0.81	-0.89	-1.27	-0.23	-4.38	-1.29	-0.72
Dietary Fibre	-1.32	-1.64	-2.06	-1.12	-3.15	-5.84	-8.54	-2.83	-7.84
Cholesterol	0.13	1.16	0.86	0.19	1.31	1.18	0.03	1.05	2.61
Minerals									
Calcium	0.82	-1.47	-2.91	-2.38	-2.93	-4.14	-6.27	-2.89	-4.97
Iodine	1.91	-1.04	-1.13	-0.72	-0.59	-1.51	-2.99	-1.00	-1.23
Iron	0.74	0.88	1.13	0.10	-1.70	-0.87	-2.81	1.06	-1.86
Magnesium	-0.25	-1.36	-1.43	-1.21	-1.75	-4.35	-7.86	-2.40	-4.82
Phosphorus	0.69	-0.70	-1.16	-0.74	-1.10	-0.73	-3.71	-1.36	-1.36
Potassium	0.43	-1.00	-1.31	-0.08	-0.94	-2.64	-4.56	-1.31	-3.09
Selenium	1.24	0.56	0.96	0.06	-1.37	0.09	-1.62	0.78	-0.15
Sodium(e)	2.24	-0.20	0.23	-1.52	-0.77	-0.28	-2.05	-0.78	-0.09
Zinc	0.68	-1.06	-0.42	-0.55	-0.52	-0.16	0.11	-1.01	0.21

Table 2: Z statistics for Indigenous female participants (MDI)

Female (MDI)									
Macronutrients	**Z Statistics**								
	2-3 years	**4-8 years**	**9-13 years**	**14-18 years**	**19-30 years**	**31-50 years**	**51 and over**	**2 - 18 years**	**19 and over**
Protein	0.69	2.80	0.58	-0.12	-0.19	-1.92	-1.53	1.13	-1.67
Total fat	0.43	2.27	0.78	-1.35	-0.96	-1.77	-0.44	-0.13	-0.96
Saturated fat	0.60	2.10	0.82	-1.95	-0.49	-0.27	0.97	-0.23	0.73
Monounsaturated fat	0.43	2.33	0.40	-1.26	-1.02	-1.86	-1.01	-0.16	-1.35
Polyunsaturated fat	-0.52	0.59	0.97	-0.35	-1.14	-4.76	-2.13	-0.17	-3.35
Total long chain omega 3 fatty acids	0.20	0.46	0.36	-0.13	0.53	-2.71	-2.24	0.42	-2.72
Trans fatty acids	0.44	3.28	1.67	-0.23	1.35	1.47	1.61	1.71	2.96
Carbohydrate	0.04	2.14	0.37	-0.62	0.60	-1.62	-0.76	0.17	0.30
Dietary Fibre	-1.50	-0.33	0.07	-1.61	-5.11	-9.70	-6.43	-1.81	-12.31
Cholesterol	0.25	1.82	0.90	0.58	1.69	1.73	0.65	1.61	2.62
Minerals									
Calcium	0.40	-0.42	-2.23	-2.93	-3.98	-5.48	-4.73	-3.04	-7.18
Iodine	0.77	0.80	0.21	-1.05	-0.77	-1.58	-1.39	-0.34	-1.61
Iron	1.59	2.65	1.14	-0.24	-1.83	-4.10	-2.08	1.70	-4.46
Magnesium	-0.09	0.56	-0.34	-1.99	-5.74	-7.81	-5.98	-1.65	-10.91
Phosphorus	0.36	1.47	-0.53	-1.49	-1.74	-3.43	-3.47	-0.77	-4.35
Potassium	0.15	0.51	-0.01	-0.85	-3.57	-5.67	-5.69	-0.64	-8.30
Selenium	1.00	1.92	1.54	0.21	-0.41	-1.84	-2.41	1.37	-2.43
Sodium(e)	1.80	2.52	1.26	-0.89	-0.58	-0.87	-0.47	0.78	-0.10
Zinc	0.38	2.92	1.05	0.66	0.00	-1.63	-0.81	1.81	-1.41

risk of low dietary fibre consumption with CHD, point towards the significance of an adequate daily dietary fibre intake and the for the purposes of this study the importance of identifying and mitigating relative risks in the Indigenous population as compared to the non-Indigenous population in Australia. (Table 3-7).

Dietary Fats

The review by FNB: IOM [33], suggests the optimal range for total fat as 20-35% of total energy. Total fat contribution was within this range for all Indigenous and non-Indigenous male and female participants, ranging from 29% to 32% [34,35]. However, combined intake of saturated fat and trans fatty acid exceeded

Table 3: Z statistics for Indigenous male participants (ND)

Male (ND)									
Macronutrients	**Z Statistics**								
	2-3 years	**4-8 years**	**9-13 years**	**14-18 years**	**19-30 years**	**31-50 years**	**51 and over**	**2 - 18 years**	**19 and over**
Protein	0.22	0.54	1.16	0.20	1.47	1.67	1.46	1.31	2.74
Total fat	0.74	0.00	0.36	-0.40	1.14	-1.08	1.54	0.00	1.57
Saturated fat	1.41	-1.32	-0.67	-0.72	1.87	0.00	1.80	0.00	1.85
Monounsaturated fat	0.49	0.78	0.78	0.00	0.67	-2.45	1.25	0.00	0.00
Polyunsaturated fat	-1.18	0.00	1.10	1.36	-1.40	-3.76	0.00	0.00	-2.41
Total long chain omega 3 fatty acids	-0.56	-0.82	1.73	0.37	-0.65	0.56	-1.19	0.50	-1.11
Trans fatty acids	1.60	-0.16	-0.27	-0.05	1.56	3.18	2.56	0.29	3.92
Carbohydrate	-0.65	-0.37	-0.73	0.52	-1.22	-0.90	-0.82	-0.47	-1.19
Dietary Fibre	-1.82	-2.58	-1.77	-0.91	-2.94	-4.59	-4.55	-3.29	-8.02
Cholesterol	-0.12	1.99	1.84	0.38	2.92	1.58	1.78	2.65	3.59
Minerals									
Calcium	0.08	-2.17	-2.39	-2.66	-2.41	-6.10	-2.42	-3.36	-5.91
Iodine	1.45	-1.30	0.79	0.00	0.90	-1.51	0.34	0.35	-0.18
Iron	0.92	1.18	2.70	1.46	0.00	0.00	0.00	2.53	0.00
Magnesium	-1.81	-2.33	-1.45	-1.19	-1.26	-5.20	-2.05	-3.14	-5.24
Phosphorus	-0.01	-0.02	0.38	-0.52	0.53	-0.47	-0.52	0.06	-0.68
Potassium	-1.36	-1.80	-1.14	0.31	-0.24	-3.26	-0.88	-1.62	-3.73
Selenium	1.44	1.36	2.20	0.65	0.53	1.27	1.46	2.95	1.65
Sodium(e)	2.01	0.18	1.19	-0.36	0.06	0.30	0.89	1.16	0.93
Zinc	1.26	2.02	0.00	-1.31	0.00	0.00	1.96	0.00	2.62

Table 4: Z statistics for Indigenous female participants (ND)

Female (ND)									
Macronutrients	**Z Statistics**								
	2-3 years	**4-8 years**	**9-13 years**	**14-18 years**	**19-30 years**	**31-50 years**	**51 and over**	**2 - 18 years**	**19 and over**
Protein	0.79	0.99	0.00	1.88	0.26	0.96	-0.50	2.09	0.00
Total fat	0.32	0.86	0.73	-2.08	-0.39	1.20	1.19	-0.67	0.84
Saturated fat	0.54	0.00	0.66	-2.03	0.00	3.19	2.11	-1.14	4.26
Monounsaturated fat	0.77	1.06	0.84	-1.38	-0.86	1.31	-1.07	0.00	0.00
Polyunsaturated fat	-1.53	-1.69	1.09	-1.15	-2.26	-4.97	-1.60	0.00	-5.94
Total long chain omega 3 fatty acids	0.18	-0.13	0.67	1.06	0.40	-2.29	-1.94	0.72	-2.20
Trans fatty acids	0.26	2.34	2.08	0.72	2.74	3.82	2.81	2.53	5.41
Carbohydrate	-0.62	-0.81	-0.71	-1.07	1.81	0.88	0.87	-1.50	2.91
Dietary Fibre	-2.80	-2.36	-0.72	-0.64	-5.93	-6.41	-6.67	-2.85	-13.21
Cholesterol	0.52	0.77	0.81	1.65	2.43	2.62	1.44	1.97	3.46
Minerals									
Calcium	-0.16	-3.54	-4.21	-3.41	-6.25	-4.45	-3.95	-5.78	-8.35
Iodine	0.45	-1.36	-0.38	-0.85	-1.49	0.84	-0.23	-1.31	-0.77
Iron	1.39	0.00	0.00	1.23	-1.99	0.00	0.00	2.73	0.00
Magnesium	-1.20	-3.18	-1.40	-0.85	-6.12	-4.02	-5.99	-3.14	-9.28
Phosphorus	0.31	-0.82	-2.04	-0.84	-2.26	-1.08	-2.55	-1.77	-3.82
Potassium	-0.50	-2.25	-1.12	0.69	-4.09	-5.10	-4.73	-1.33	-10.15
Selenium	1.08	-0.47	1.34	1.66	0.00	1.19	-1.84	1.68	-0.27
Sodium(e)	2.21	0.80	0.89	-1.06	-0.27	1.30	0.16	0.77	1.35
Zinc	0.00	1.93	1.44	2.31	1.65	0.00	0.00	4.27	0.00

Table 5: ABS data mean daily intakes remote and urban Indigenous males

Indigenous Male	Remote	Urban
Protein	98 g/d	95.5 g/d
Carbohydrate	226.4 g/d	257.1 g/d
Cholesterol	370.4 mg/d	325.1 mg/d
Dietary fibre	16.8 g/d	19.9 g/d
Iron	11.9 mg/d	11.6 mg/d
Phosphorous	1415.1 mg/d	1488.7 mg/d
Selenium	96.1 µg/d	90.1 µg/d
Iodine	154.9 µg/d	189.1 µg/d
Zinc	12.2 mg/d	11.3 mg/d
Magnesium	267.9 mg/d	305.2 mg/d
Potassium	2435.6 mg/d	2805.6 mg/d

Table 6: ABS data mean daily intakes remote and urban Indigenous females

Female	Remote	Urban
Protein	82.5 g/d	70.8 g/d
Omega 3 fatty acids	276.6 g/d	143.7 g/d
Cholesterol	312.2 g/d	252.8 g/d
Total fat	60.5 g/d	63.5 g/d
PUFA	8.1 g/d	9.0 g/d
Dietary fiber	15.4 g/d	16.6 g/d
Calcium	495.2 mg/d	642.6 mg/d
Iodine	134.2 µg/d	153 µg/d
Iron	10.0 mg/d	8.6 mg/d
Selenium	79.4 µg/d	68.0 µg/d
Sodium	1959.8 mg/d	2165.0 mg/d
Zinc	10.6 mg/d	8.5 mg/d

Table 7: Z statistics in remote vs urban Indigenous male and female participants (MDI, ND)

Macronutrients	Z Statistics Male - Remoteness		Z Statistics Female - Remoteness	
	MDI	ND	MDI	ND
Energy	2.36		0.09	
Protein	-0.51	-5.30	-3.65	-4.82
Total fat	3.02	1.97	1.14	2.50
Saturated fat	3.08	2.25	1.71	1.17
Monounsaturated fat	2.78	2.06	0.49	1.36
Polyunsaturated fat	3.44	2.06	1.75	2.42
Total long chain omega 3 fatty acids	-2.86	-3.57	-4.08	-4.07
Trans fatty acids	-0.38	-1.92	-0.75	-1.47
Carbohydrate	2.61	1.43	0.91	1.68
Dietary Fibre	3.30	1.29	1.90	2.44
Cholesterol	-1.74	-3.07	-3.54	-2.96
Minerals				
Calcium	5.97	4.60	5.32	6.18
Iodine	4.45	1.49	3.27	3.82
Iron	-0.55	-4.38	-3.27	-6.07
Magnesium	3.03	1.22	1.50	1.20
Phosphorus	1.27	-2.20	-1.16	-1.95
Potassium	3.52	1.11	1.07	1.94
Selenium	-1.26	-4.30	-3.84	-3.27
Sodium	4.24	2.45	2.05	3.67
Zinc	-1.50	-5.35	-3.67	-4.33

the current Australian Dietary Guidelines and the New Zealand Food and Nutrition Guidelines of consuming no more than 10% of daily energy intake. Both types of fat are associated with risk of heart diseases. While trans fatty acids are within the 1% limit as recommended by the WHO, saturated fatty acids are on the higher side and exceed the recommendation of 10% of total daily energy intake [24]. Studies show that each 1% increase in energy from saturated fats causes blood low-density lipoprotein (LDL) cholesterol concentrations to rise between 0.33 mmol/L and 0.045 mmol/L, thereby increasing the risk of CHD-associated mortality [36].

Carbohydrate and Protein

The carbohydrate intake recommendation for both adults and children is 45– 65% of energy intake, based on increased risk of CHD at rates higher than 65% and increased obesity risk with less than 45% carbohydrate intake and high fat intake [33]. Additionally, both CHD and type 2 diabetes risk have recently been discussed in relation to the nature of dietary carbohydrate consumed[40]. Forprotein,15-25%energyrequirementsis considered adequate, keeping in view the attainment of micronutrient adequate requirement, total energy intakes of individuals and physical activity levels [41]. Higher protein intakes might be good for very active populations, but data are lacking on the effects of high protein intake in sedentary populations. Studies show high protein diets associated with upper digestive tract and kidney cancer [42,43]. Protein intakes were higher across the age groups in the Indigenous male group than the non- Indigenous male group [24]. Carbohydrate intake was below 45% for both Indigenous and non-Indigenous male adults (over 19 years) - 42.7% for Indigenous and 43.4% for non-Indigenous male participants.

Minerals

Calcium: There was statistically significant difference in Ca intake in all age groups by both MDI and ND, except for 2–3 and 4–8 years. Ca intake in Indigenous and non-Indigenous participants was less than the RDI, except for children up to the ages of 3 and 8 years, respectively [24,44].

Iron: By ND, both male and female young Indigenous participants aged 2-18 years had statistically significant lower iron consumption than their non-Indigenous counterparts. Indigenous female participants continue to have lower intakes at 19 years and over. None of the MDIs exceeded the toxic limits of consumption. In both Indigenous and non-Indigenous groupsasearlyas2–3yearsreportedintakeslowerthantheRDI [45]. The difference between the RDI and the MDI was greater in higher age group female participants, where requirements are also high – 2– 3 years (0.8, 1.8); 4– 8 years (0.7, 2); 14– 18 years (6,5.8), 19–30 years (9, 8.2), 31–50 years (10, 8.4).

Magnesium: The Indigenous young and adult population had statistically lower magnesium intake than non-Indigenous young and adult participants. There were significant statistical differences for 4– 8 years, male and female participants (ND); 2–18 years, male participants (MDI, ND), female participants (ND); 14– 18 years, female participants (MDI). In all other age groups, 19-30 years, 31-50 years, 51years and over ,and 19years and over, significant differences were observed in both male and female participants (MDI, ND). MDI of Mg in male and female participants

was less than RDI, starting at 14– 18 years (male participants - 116.8 (Indigenous), 91.1 (non-Indigenous); (female subjects: 130.6 (Indigenous), 93.4 (non- Indigenous)) [46].

Phosphorous: Significant statistical differences in phosphorous intake were observed especially in female participants 9– 13 years (ND), 19– 30 years (ND), 31– 50 years (MDI), 51 & over years (MDI, ND), 19 & over years (MDI, ND), and for male participants in 51 years and over (MDI). Intakes were higher than the RDIs across age groups in both gender participants except 9-13 years Indigenous and non-Indigenous female participants [47].

Potassium: Significant statistical differences in potassium intake were observed between Indigenous and non-Indigenous male participants of 31– 50 years (MDI, ND), 51 years and over (MDI), and 19 years and over (MDI), and between Indigenous and non-Indigenous female participants of 4–8 years (ND), 19–30 years (MDI, ND), 31–50 years (MDI, ND), 51 years and over (MDI, ND), and 19 years and over (MDI, ND). Indigenous children as young as 4–8 years had lower than the RDI levels in both genders [48]. All the Indigenous and non- Indigenous male and female population groups' daily intake of potassium were less than WHO [49], recommendation of 3510 mg/d; the Indigenous population intake deficit from the recommendation level is greater than that of the non-Indigenous population.

Selenium: Significant statistical differences in selenium intake were observed at 9– 13 years (ND) and 2– 18 years (ND) between Indigenous and non-Indigenous male participants, and at 4– 8 years (MDI), 51 years and over (MDI), and 19 years and over (MDI) between Indigenous and non-Indigenous female participants. In all the age groups, both male and female participants had MDI values for Se that was higher than the RDI [50].

Sodium: Significant statistical differences in sodium daily intakes were observed in boys (MDI, ND) and girls (ND) as young as 2–3 years. The age groups as young as 2– 3 years had intakes above adequate intake levels and upper limits of consumption [51].

Zinc: Significant statistical differences in zinc intake were observed in both male and female Indigenous children asyoungas4–8years.All Indigenous and non-Indigenous female participants had higher than RDI intake; however, Indigenous and non-Indigenous adults had less than the RDI intake [52]. All Indigenous non-Indigenous boys and girls aged 2– 3 years exceeded the upper limit of consumption [52].

Minerals of Interest and Associated Health Conditions

The major minerals of interest identified in this study are calcium, magnesium, potassium, and sodium. Calcium deficiency is associated with osteoporosis, a condition related to bone density. In adults with a baseline calcium intake of 500–900 mg/day, increasing the intake by a further 500–1000 mg/day can have beneficial effects on bone mineral density [53]. Magnesium has a role to play in diabetes, which has now been demonstrated and explained in several studies. Magnesium levels are altered in diabetic patients, and increased levels can help in blood glucose metabolism while depletion can cause insulin resistance [54-57]. Low potassium intake is associated with chronic disease risk factors, and increased intake has been found to show beneficial effects by reducing blood pressure and cardiovascular disease, bone mineral density problems and negative effects of high sodium consumption [58-60]. The WHO recommends enhanced potassium intake from dietary sources for its blood pressure and cardiovascular –related beneficial effects [61], Finally, excess sodium intake is associated with elevated blood pressure and thus is a proven risk factor for deadly conditions such as stroke and chronic kidney disease [62-65]. An intake of 6 g salt (equivalent to one meal's intake) increased plasma sodium intake by 3.13±0.75 mmol/l, and a 1 mmol/l increase in plasma sodium was associated with 1.91 mmHg increase in systolic blood pressure.

CONCLUSIONS

Dietary fibre and cholesterol are two critical macronutrients that need more attention to combat obesity, diabetes and cardiovascular disease in Indigenous Australians. Lower dietary fibre and higher cholesterol intakes in young people as well as adults need to be managed, because the consumption pattern is statistically significantly different not only in Indigenous Australians compared with non-Indigenous Australians but also in remote Indigenous Australians compared with urban Indigenous Australians. Imbalances in carbohydrates, saturated fat and protein intakes are found in comparison with non-Indigenous population findings. Greater dietary fibre intake is associated with reduced incidence of death due to CHD (coronary heart disease). Based on our results, and with the current pattern of consumption, a relative risk study for coronary incidences in the two populations with regard to their dietary fibre fraction intake appears warranted. CHD was prevalent in both the Indigenous and the non-Indigenous groups, and was a significant cause of the health gap between the two populations (ABS, 2015). Saturated fat intake is particularly concerning for females, with statistically significant higher consumption by ND starting in the age group of 14–18 years. The intake of linoleic acids is associated with improvements in CHD incidence through their mechanism of action on total cholesterol, HDL and LDL. Non-Indigenous males and females have higher contributions of linoleic acid to energy, but both Indigenous and non-Indigenous people have less than the recommended percentage contribution to energy intake. Hence, linoleic acid dietary intake could be a potential dietary strategy for prevention of CHD in Indigenous Australians.

Lower calcium, magnesium, potassium, and higher sodium intake in Indigenous populations, starting as young as 2–3 years, compared with non-Indigenous population groups warrants further investigation for associated health conditions such as osteoporosis, high blood pressure and cardiovascular diseases. Even when the intake of these minerals is lower than the

recommended intakes in both Indigenous and non-Indigenous population groups, the Indigenous groups are further from the RDI than the non-indigenous group. The diet gap starting small in the early ages only widens in the higher age groups, implications being evident in the form of comparatively higher occurrence of diet related health diseases in Indigenous people than non-Indigenous people.

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