

# Discretionary intake among Australian adults: prevalence of intake, top food groups, time of consumption and its association with sociodemographic, lifestyle and adiposity measures

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## Abstract

**Objective:** To profile discretionary food and beverage (DF) consumption among Australian adults.

**Design:** Cross-sectional analysis. Dietary and sociodemographic data were used to profile DF intake. Prevalence of DF consumption, DF servings (1 serving = 600 kJ), nutrient contribution from DF and top DF food groups by self-reported eating occasions were determined. DF consumers (>0 g) were classified according to quartile of DF intake and general linear models adjusted for age and sex were used to determine associations.

**Setting:** 2011–12 National Nutrition and Physical Activity Survey (NNPAS).

**Participants:** Adults aged ≥19 years (*n* 9341) who participated in the NNPAS 2011–12.

**Results:** Most adults consumed DF (98%) and over 60% exceeded 3 DF servings/d, with a mean of 5.0 (SE 0.0) DF servings/d. Cakes, muffins, scones, cake-type desserts contributed the most DF energy (8.4%) of all food groups, followed by wines (8.1%), pastries (8.0%) and beers (6.1%), with all these food groups consumed in large portions (2.3–3.0 DF servings). Lunch and dinner together contributed 45% of total DF energy intake. High DF consumers had an average of 10 DF servings, and this group contained more younger adults, males, low socio-economic status, lower usual fruit intake and higher mean waist circumference, but not higher BMI.

**Conclusions:** A focus on DF consumed in large portions at lunch and dinner may help improve interventions aimed at reducing DF intake and addressing negative adiposity-related measures found in high DF consumers.

**Keywords**  
Discretionary foods  
Adults  
BMI  
National nutrition survey  
Portion size

Dietary guidelines worldwide recommend nutritious and health-promoting diets. In Australia, the Australian Dietary Guidelines encourage eating from the five core food groups: (i) fruit; (ii) vegetables and legumes/beans; (iii) lean meats and poultry, fish, eggs, tofu, nuts and seeds and legumes/beans; (iv) grain (cereal) foods; and (v) milk, yoghurt, cheese and/or alternatives<sup>(1)</sup>. Non-core foods and beverages are called ‘discretionary foods and beverages’ (DF). DF are defined as foods and drinks not necessary to provide the nutrients the body needs, and are high in saturated fat, added sugars, added salt or alcohol and low in fibre<sup>(2)</sup>. Other descriptive terms for DF include ‘energy-dense, nutrient-poor foods’, ‘empty calories’, ‘extra foods’ and ‘high-energy-dense foods’<sup>(3–6)</sup>. The Australian Dietary Guidelines recommend DF to be consumed only occasionally and in small amounts, from 0 to 3 servings for

males and 0 to 2.5 servings for females per day, with one serving containing 600 kJ<sup>(7)</sup>. The guidelines recommend that any additional energy requirements, such as for those who are taller or more physically active, should be met with servings from the core food groups or unsaturated spreads and oils in preference to discretionary choices<sup>(1)</sup>. Those who are overweight have no additional energy allowance and discretionary intake is discouraged, because the consumption of DF has been shown to increase the risk of weight gain and chronic disease<sup>(1,8–11)</sup>.

Sixty-three per cent of Australian adults are overweight or obese<sup>(12)</sup> and chronic disease is the leading contributor to morbidity and mortality<sup>(13)</sup>. Therefore a large proportion of Australian adults have no energy allowance for DF, yet DF intake contributes 35% of their total energy intake<sup>(14)</sup>. Large portion sizes may contribute to the

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overconsumption of DF. In an analysis of the 2011–12 National Nutrition and Physical Activity Survey (NNPAS) in Australia, the median portion size of cakes, savoury pastries, hamburgers and pizza exceeded the standard serving set by the dietary guidelines of 600 kJ, by up to 400%<sup>(15)</sup>. Given that the Australian Dietary Guidelines recommend no more than 3 DF servings daily for the majority of adults, many will be exceeding this limit from just a single portion of DF. At the same time, only 3.5% of adult males and 5.2% of adult females met the recommended daily servings of vegetables and legumes/beans, and 29.3% of adult males and 23.0% of adult females met the recommended daily servings of fruit<sup>(16)</sup>. With high discretionary intakes and low consumption of fruit and vegetables, DF could displace core foods, as reported in the USA<sup>(4)</sup>. Inadequate intake of core foods and excess consumption of discretionary foods may lead to the double burden of under- and overnutrition<sup>(17)</sup>. Hence, it is important to gain a deeper understanding of the role of DF in the diet of Australian adults to develop targeted strategies to assist in reducing its intake. While many studies focus on selected discretionary foods or beverages (e.g. sugar-sweetened beverages, salty snacks or foods high in saturated fats), a more thorough analysis of DF consumption patterns, including the highest energy contributors, in combination with consumer sociodemographic factors and adiposity-related measures, is needed to assist both health professionals and government in developing public health strategies to address the excess intake of DF.

The aim of the present study was to examine, in a nationally representative sample of the Australian adult population, the prevalence of DF consumption, the top DF food groups in terms of contribution to discretionary energy, their contribution to total sugars, saturated fat and Na intakes, and the eating occasions (EO) where the most DF were consumed. We analysed these nutrients because they form the basis of the definition of DF<sup>(2)</sup> and we wanted to see what influence DF had on the nutrients that should be limited. At the time of analysis, data on added sugars and salt were not available so we chose total sugars as a substitute for added sugars and Na as a substitute for salt. Further, we aimed to examine the sociodemographic and lifestyle characteristics of DF consumers and any associations of DF with adiposity-related measures.

## Methods

### Survey methodology

The Australian Bureau of Statistics conducted the Australian Health Survey (AHS) between 2011 and 2013 on a nationally representative sample of Australians aged 2 years or over. The 2011–12 NNPAS was part of the AHS and collected physical activity data and detailed dietary information from 12 153 respondents. Trained interviewers

used the automated multiple-pass method, which was developed by the Agricultural Research Service of the US Department of Agriculture<sup>(18)</sup> and adapted to reflect the Australian food supply, to capture all foods and beverages consumed by respondents within the 24 h prior to the interview day. A second day of dietary recall was provided by telephone interview by approximately two-thirds ( $n$  7735) of participants. Total energy and nutrient intakes were derived from Food Standards Australia New Zealand's customised nutrient composition database (AUSNUT)<sup>(19)</sup>. To maximise the sample size, data from the first 24 h recall among 9341 adults aged 19 years or over were utilised. A sensitivity analysis was performed to investigate whether there were differences in DF consumed between day 1 and day 2 of recall. The top foods that contributed to discretionary energy were similar across the two days (see online supplementary material, Supplementary Table 1). Further survey details are available from the Australian Bureau of Statistics' website in the *Australian Health Survey: Users' Guide, 2011–13*<sup>(20)</sup>.

Participants were classified by age group (19–30, 31–50, 51–70,  $\geq 71$  years), sex, socio-economic status (SES), physical activity level, adiposity-related measures, usual fruit and vegetable servings, and smoking status. The Socio-Economic Indexes for Areas (SEIFA)<sup>(21)</sup> was used to define SES. SEIFA is a product developed by the Australian Bureau of Statistics that ranks areas in Australia into quintiles according to relative socio-economic advantage or disadvantage in terms of people's access to material and social resources and their ability to participate in society. The lowest SES quintile was defined as the first quintile and the highest as the fifth quintile.

Physical activity was self-reported as the amount of physical activity each respondent undertook in the week prior to the survey. The interviewers collecting the information relied on participants' recall, as no recording devices or other instruments were used to measure physical activity. The total number of minutes of physical activity was recorded, with one session equivalent to 30 min of moderate-intensity physical activity. The amount of time spent sitting or lying down for work, transport and leisure during the week prior to the survey was also self-reported by respondents. Respondents were classified based on the duration and number of sessions of physical activity into three categories: inactive, insufficiently active or sufficiently active for health<sup>(20)</sup>.

Interviewers measured the height, weight and waist circumference of consenting participants. A stadiometer was used to measure height, digital scales to measure weight, and a metal tape measure across the top of the belly button to measure waist circumference. Measured height and weight were used to calculate BMI ( $\text{kg}/\text{m}^2$ ) and respondents were categorised based on the WHO definitions<sup>(22)</sup>. Respondents were categorised according to their measured waist circumference and classified based on their waist size into the WHO categories for level of risk of

metabolic complications: not at risk (<80 cm for females, <94 cm for males), increased risk ( $\geq 80$  and <88 cm for females,  $\geq 94$  and <102 cm for males) or substantially increased risk ( $\geq 88$  cm for females,  $\geq 102$  cm for males)<sup>(23)</sup>.

Respondents were asked to specify the usual number of fruit and vegetable servings consumed per day from the following options: 'don't eat fruit/vegetables', 'less than 1 serve', '1 serve', '2 serves', '3 serves', '4 serves', '5 serves' or '6 or more serves'. To determine mean number of servings we defined 'don't eat fruit/vegetables' as 0, 'less than 1 serve' as 0.5 and '6 or more serves' as 6.

### **Under-reporters**

BMR is the amount of energy needed for an individual's minimum set of body functions necessary for life over a defined time period. BMR is given in kilojoules per 24 h and calculated using age, sex and weight (kilograms) as variables with no adjustment for activity levels. The ratio of energy intake (EI) to BMR (EI:BMR) was used to calculate under-reporters as participants with implausibly low intakes. Participants were classified as under-reporters or not under-reporters based on the Goldberg<sup>(24)</sup> cut-off limit of 0.9 for EI:BMR, which is the lower 95% confidence limit for a single day of data for a single individual, allowing for day-to-day variation in energy intakes and errors in calculation of EI:BMR.

### **Dietary intake**

DF are defined by the Australian Dietary Guidelines as foods and beverages not necessary to provide the nutrients the body needs, and are high in saturated fats, added sugars, added salt or alcohol and low in fibre<sup>(2)</sup>. The Australian Bureau of Statistics categorised food groups in the survey as discretionary or non-discretionary based on these definitions and the supporting documents that underpin the Australian Dietary Guidelines. There are discretionary food and beverage items, such as diet soft drinks, that do not contain any energy. While these foods and beverages did not contribute to results relating to discretionary energy intake, they were included in all other relevant results such as prevalence of discretionary consumers. Foods were classified primarily at the minor food group level (5-digit); where it was not possible to determine if a food was discretionary at this level, the unique food code level (8-digit) was used along with the nutrient profiling cut-offs used in the Australian Dietary Guidelines modelling document<sup>(25)</sup>. Discretionary food and beverage groups in the present study are reported at the sub-major food group level (3-digit). There was a total of 132 sub-major food groups in the AUSNUT database, and sixty of these food groups contained a discretionary food or beverage. Henceforth, discretionary food groups (or 'DF food group') refers to the discretionary foods and beverages in the sub-major food group.

As part of the survey, respondents were asked to identify the name of their reported eating occasion (REO) as well as the time they began consuming each food or beverage. There were eleven REO available for selection: breakfast, morning tea, brunch, lunch, afternoon tea, dinner, supper, snack, beverage/drink, extended consumption or other<sup>(20)</sup>. As the choice of REO was subjective, respondents could report similar eating patterns in different ways. For example, a glass of wine with the evening meal could be reported by one respondent as 'dinner' and by another respondent as 'beverage/drink'. We defined an EO as the consumption of one or more foods or beverages at the same time with the same REO.

### **Statistical analysis**

The mean DF intake in servings (1 serving = 600 kJ), the proportion of total energy intake from DF and total daily energy intake were calculated. To investigate frequency and timing of DF intake, we calculated the proportion of the EO that contained DF and the percentage contribution of each REO to total DF energy. For food groups, we determined the prevalence of consumers of each DF food group among DF consumers and the mean intake, in servings and in grams, among consumers of each DF food group. We calculated the percentage contribution of each food group to total DF energy, and to total sugars, saturated fat and Na intakes among DF consumers. Among the top four REO that contributed the most to daily DF energy, we determined the top five sub-major food groups, the percentage of total DF energy that it contributed at the REO and the mean kilojoules among consumers of the food group. Quartiles of the percentage energy contribution from DF were used to classify adults as low consumers (quartile 1) and high consumers (quartile 4).

The statistical software package IBM SPSS Statistics version 23.0 was used for all analyses. Due to the large sample size and the number of tests, we felt that to classify *P* values <0.05 as significant would lead to many type 1 errors; so we treated *P* values <0.001 as significant. Data were weighted to the Australian population using weights provided by the Australian Bureau of Statistics. Descriptive summaries were calculated for all variables of interest. ANOVA tables were produced to calculate *SE* of the mean. Associations between quartiles of DF energy contribution and demographic and adiposity-related measures and lifestyle characteristics were examined using Pearson's  $\chi^2$  tests. General linear models were created using univariate ANOVA to estimate the effect of age group, sex, their interaction and quartiles of DF energy contribution on dietary metrics, adiposity-related measures and lifestyle characteristics. *Post hoc* pairwise comparisons using the Bonferroni correction were performed to show pairwise significance between quartiles of DF energy contribution.

**Results**

Almost all adults consumed DF (97.5%; Table 1). Over 60% of adults had more than the maximum recommended 3 DF servings/d, with a per capita mean of 5.0 (SE 0.0). More than 50% of males and females of all age groups, apart from females 51 years of age or over, consumed more than 3 DF servings/d. Young males and females aged 19–30 years had the highest daily mean DF servings (6.7 (SE 0.2) servings/d for males, 4.6 (SE 0.1) servings/d for females). Consumption of DF decreased with age for both males and females, with the ≥71 years age group having the lowest mean servings for each sex (4.9 (SE 0.2) for males, 3.5 (SE 0.1) for females). Males had a greater DF energy intake than females for all age groups, both in total and as a proportion of total energy intake. The proportion of total energy from DF was greater than 30% for all age and sex groups except females aged 51–70 years (28.6 (SE 0.5)%), and this age group also had the highest prevalence of non-consumers of DF (3.8%). For each age group, males had a lower number of total daily EO than females, but more of their EO contained DF, and therefore the proportion of EO that contained DF was higher among males than females. About half of all EO contained DF: between 55 and 58% for males and between 46 and 51% for females.

**Which food groups contributed the most to discretionary intake?**

Among DF consumers, the top four DF food groups ranked by contribution to daily DF energy intake were: cakes, muffins, scones, cake-type desserts (8.4%); wines

(8.1%); pastries (8.0%); and beers (6.1%; Table 2). These top four food groups had large portion sizes, ranging from 2.3 to 3.0 DF servings; however, none of these food groups made the top four when ranked by popularity (prevalence of consumers). The top contributor to DF energy intake – cakes, muffins, scones, cake-type desserts – was consumed by only 16% of DF consumers, but had a large mean portion size of 3 DF servings, or 123 g, per consumer. The top four food groups ranked by popularity (sugar, honey and syrups; soft drinks and flavoured mineral waters; processed meat; sweet biscuits) had between 22.4 and 48.5% of consumers, and small mean portion sizes ranging between 0.5 and 1.1 mean DF servings per consumer. Sugar, honey and syrups was the most popular food group with 48.5% of DF consumers, but the mean DF servings per consumer was 0.5, and it was ranked only seventh by contribution to total DF energy intake.

Three of the top five DF food groups by contribution to DF energy intake were beverages: two alcoholic beverages (wines; beers) and one non-alcoholic beverage (soft drinks and flavoured mineral waters). Of the top twenty DF food groups, processed meat contributed the most to Na, pastries the most to saturated fat, and soft drinks and flavoured mineral waters the most to total sugars.

**Which food groups, during which reported eating occasions, contributed the most to discretionary intake?**

The top four REO by contribution to total discretionary energy were dinner, lunch, snack and beverage/drink,

**Table 1** Baseline characteristics of the sample of Australian adults aged ≥19 years (n 9341) from the 2011–12 National Nutrition and Physical Activity Survey

	19–30 years		31–50 years				51–70 years				≥71 years				All adults ≥19 years			
	Males		Females		Males		Females		Males		Females		Males		Females		n %	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
<b>Prevalence of consumers by DF servings</b>																		
Non-consumers	35	3.1	21	2.0	37	2.1	44	2.5	30	2.2	52	3.8	6	1.3	13	2.3	238	2.5
> 0–1 servings*	79	7.1	154	14.4	149	8.5	257	14.4	115	8.6	226	16.4	42	9.1	69	12.3	1091	11.5
> 1–3 servings	214	19.2	291	27.2	338	19.2	508	28.6	289	21.6	433	31.4	124	26.8	212	37.8	2409	25.5
> 3–5 servings	208	18.6	204	19.0	328	18.7	410	23.0	265	19.9	278	20.2	116	25.1	152	27.1	1961	20.7
> 5 servings	580	52.0	401	37.4	905	51.5	560	31.5	636	47.6	389	28.2	175	37.8	115	20.5	3761	39.8
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
DF servings/d	6.7	0.2	4.6	0.1	6.3	0.1	4.1	0.1	5.5	0.1	3.7	0.1	4.9	0.2	3.5	0.1	5.0	0.0
Energy intake (MJ)	11.0	0.1	7.9	0.1	10.2	0.1	7.5	0.1	9.3	0.1	7.3	0.1	8.2	0.1	6.6	0.1	8.7	0.0
Proportion of energy from DF (%)	34.8	0.7	33.1	0.7	34.6	0.5	31.1	0.5	33.9	0.6	28.6	0.5	33.4	0.9	30.1	0.8	32.5	0.2
EO/d	6.4	0.1	6.6	0.1	7.0	0.1	7.2	0.1	6.9	0.1	7.4	0.1	6.7	0.1	7.0	0.1	6.9	0.0
EO with DF/d	3.5	0.1	3.3	0.0	3.9	0.0	3.5	0.0	3.7	0.1	3.3	0.1	3.8	0.1	3.5	0.1	3.6	0.0
Proportion of EO with DF (%)	55.0	0.7	51.2	0.6	56.4	0.6	49.9	0.5	55.4	0.7	45.5	0.6	57.6	1.1	50.9	1.0	52.4	0.2

DF, discretionary foods and beverages; EO, eating occasion.

\*Includes those who consumed DF that do not contain energy, such as diet or zero-calorie soft drinks.

**Table 2** Proportion of consumers, energy and nutrient contributions, and serving size of the top twenty sub-major food groups that contained discretionary foods and beverages (DF), ranked by percentage energy contribution, among Australian adults aged  $\geq 19$  years ( $n$  9341) from the 2011–12 National Nutrition and Physical Activity Survey

Rank	Sub-major food group	Proportion of DF consumers (%)	Contribution to DF energy among DF consumers (%)	DF servings among consumers of the food group (mean)	DF grams among consumers of the food group (mean)	Contribution to total sugars among DF consumers (%)	Contribution to total saturated fat among DF consumers (%)	Contribution to total Na among DF consumers (%)
1.	Cakes, muffins, scones, cake-type desserts	15.6	8.4	3.0	122.5	5.6	4.7	2.4
2.	Wines	18.0	8.1	2.3	428.9	0.5	0.0	0.6
3.	Pastries	14.4	8.0	2.8	169.4	1.1	4.9	4.1
4.	Beers	13.7	6.1	2.6	1122.1	0.1	0.0	0.5
5.	Soft drinks and flavoured mineral waters	27.5	5.2	0.9	545.7	9.2	0.0	0.8
6.	Sweet biscuits	22.4	5.1	1.1	32.2	2.2	3.1	0.9
7.	Sugar, honey and syrups	48.5	4.9	0.5	18.1	7.9	0.0	0.0
8.	Chocolate and chocolate-based confectionery	16.7	4.8	1.5	42.5	3.6	4.1	0.3
9.	Frozen milk products	13.3	3.9	1.5	108.9	2.8	3.6	0.3
10.	Potatoes	11.7	3.9	1.7	98.7	0.0	1.2	0.8
11.	Processed meat	22.6	3.5	0.7	52.3	0.1	2.0	6.4
12.	Sausages, frankfurts and saveloys	6.2	3.3	2.8	154.4	0.0	3.1	3.1
13.	Fish and seafood products (homemade and takeaway)	5.0	3.0	2.9	187.8	0.1	0.8	1.3
14.	Mixed dishes where cereal is the major ingredient	3.6	2.7	4.0	225.0	0.2	1.7	1.7
15.	Salad dressings	14.2	2.3	0.7	22.5	0.2	0.7	0.9
16.	Butters	16.1	2.0	0.6	11.8	0.0	3.7	0.5
17.	Fruit and vegetable juices, and drinks	7.8	2.0	1.2	386.5	3.1	0.0	0.1
18.	Potato snacks	6.1	1.7	1.6	44.1	0.1	0.7	0.8
19.	Cordials	6.3	1.6	1.3	602.5	2.8	0.0	0.1
20.	Other alcoholic beverages	3.1	1.6	2.9	624.6	1.6	0.2	0.1

which in total contributed 75% of total DF energy (Table 3). Lunch and dinner together contributed almost half (45%) of all DF energy, and snack and beverage/drink almost a third (30%). The top contributors at dinner, lunch, snack and beverage/drink were wines (15%), pastries (17%), chocolate and chocolate-based confectionery (21%) and beers (25%), respectively.

In addition to beers, the second-highest contributor to the REO beverage/drink was also an alcoholic beverage (wines contributed 20%), and both these beverages were consumed in substantially higher portion sizes (at least three times more kilojoules per consumer) than the other food groups in this REO. The top four food groups that contributed to DF energy during snack were all significant sources of total sugars and saturated fat, whereas those at lunch and dinner were significant sources of Na and saturated fat. As well as being the top contributor to DF energy at lunch, pastries (croissants,

Danish pastries, pies, sausage rolls, quiches, spring rolls, etc.) contributed the second-most DF energy to dinner. Other food groups that were top-five DF contributors in two different REO were soft drinks and flavoured mineral waters (lunch and beverage/drink) and cakes, muffins, scones, cake-type desserts (lunch and snack).

#### ***Characteristics of adults by proportion of energy from discretionary foods and beverages***

The DF contribution to total daily energy in quartile 1 (low consumers) ranged between 0 and 16% of energy and between 47 and 100% for quartile 4 (high consumers; Table 4). There were differences in sociodemographic, dietary and lifestyle factors between high and low consumers. More than half of low consumers were female (55.6%) and the prevalence of females decreased with

**Table 3** Top five reported eating occasions (REO)\* that contributed the most to total energy intake from discretionary foods and beverages (DF) and the top five sub-major food groups by percentage contribution to DF energy at each REO among Australian adults aged  $\geq 19$  years ( $n$  9341) from the 2011–12 National Nutrition and Physical Activity Survey

Rank	Dinner (27.3% of total DF energy)			Lunch (17.5% of total DF energy)			Snack (16.7% of total DF energy)			Beverage/drink (13.2% of total DF energy)		
	Sub-major food group	Contribution to total DF energy at the REO (%)	kJ among consumers of the food group (mean)	Sub-major food group	Contribution to total DF energy at the REO (%)	kJ among consumers of the food group (mean)	Sub-major food group	Contribution to total DF energy at the REO (%)	kJ among consumers of the food group (mean)	Sub-major food group	Contribution to total DF energy at the REO (%)	kJ among consumers of the food group (mean)
1.	Wines	14.9	1186	Pastries	16.9	1618	Chocolate and chocolate-based confectionery	20.8	869	Beers	25.3	1379
2.	Pastries	10.4	1631	Processed meat	8.3	288	Cakes, muffins, scones, cake-type desserts	11.9	1644	Wines	19.9	1266
3.	Sausages, frankfurts and saveloys	8.1	1797	Potatoes	8.3	1080	Sweet biscuits	11.6	600	Soft drinks and flavoured mineral waters	12.0	451
4.	Fish and seafood products (homemade and takeaway)	7.8	1730	Soft drinks, and flavoured mineral waters	7.4	411	Frozen milk products	10.1	878	Sugar, honey and syrups	10.2	175
5.	Potatoes	6.7	904	Cakes, muffins, scones, cake-type desserts	7.1	1567	Potato snacks	7.4	884	Other alcoholic beverages -	7.5	1686

\*The remaining 25.3% of DF consumption came from breakfast 8.2%, brunch 0.4%, morning tea 4.4%, afternoon tea 4.7%, supper 2.7%, extended consumption 4.6%, and other 0.3%.

increasing quartile. DF intake decreased with age: 59.2% of low consumers were aged 19–50 years, compared with 65.2% of high consumers. High consumers had a higher prevalence of adults from the lowest SES quintile compared with all other quartiles. There was a higher prevalence of low consumers who met physical activity guidelines based on duration and session: 46.5% of low consumers met guidelines, and this decreased with increasing quartile, of which 38.3% of high consumers met guidelines.

The prevalence of overweight and obese adults was not significantly different across quartiles of DF intake. Prevalence of no risk of chronic disease was significantly higher among low consumers (42.0%) than among high consumers (36.1%).

The higher the quartile of DF energy, the higher the prevalence of smokers: 26% of high consumers were smokers compared with 12% of low consumers. Under-reporting of energy intake was more prevalent among low consumers: 33%, compared with 13% among high consumers.

Based on general linear models adjusted for age, sex and their interaction, total daily energy and DF energy intake both increased with increasing quartile ( $P < 0.001$ ), and high DF consumers had an average intake of 10.1 DF servings/d (Table 5). The number of daily EO was significantly lower among low consumers compared with the second and third quartiles ( $P < 0.001$ ) but not among high consumers. The number of EO with DF increased across quartiles: high consumers had more than double the EO with DF compared with low consumers ( $P < 0.001$ ). Similarly, the proportion of EO that contained DF doubled from 34.4 (SE 0.4)% among low consumers to 67.6 (SE 0.4)% among high consumers.

Low consumers had a higher number of minutes doing physical activity (236 (SE 6) min) than high consumers (189 (SE 6) min) and spent less time sitting or lying down for work, transport and leisure (35 h 25 min (SE 27 min) *v.* 38 h 20 min (SE 29 min);  $P < 0.001$ ).

There was no significant difference in mean BMI; however, low consumers had a significantly lower waist circumference (91.6 (SE 0.3) cm) than adults in quartile 3 (93.4 (SE 0.3) cm) and high consumers (93.9 (SE 0.3) cm;  $P < 0.001$ ).

Self-reported usual daily fruit servings decreased with increasing DF quartile, and high DF consumers self-reported fewer daily vegetable servings (2.2 (SE 0.0)) than low consumers (2.4 (SE 0.0)) and those from the second quartile (2.5 (SE 0.0);  $P < 0.001$ ).

The top five food groups by DF energy contribution among low consumers were those consumed in smaller portion sizes such as sugar, honey and syrups and sweet biscuits (Table 6). In contrast, the top DF food groups among high consumers were those consumed in larger portion sizes, such as pastries, cakes and alcoholic beverages.

Results based on the same models are reported by age group and sex in the online supplementary material, Supplemental Table 2.

## Discussion

The results of the present study demonstrate that virtually all Australian adults consumed DF, with an average intake of five DF servings; well above the maximum recommended three servings stipulated in the Australian Dietary Guidelines<sup>(7)</sup>. DF intake varied by sex and age, with younger males having the highest intakes. Food groups that contributed the most to DF energy intake (cakes, muffins, scones, cake-type desserts; wines; pastries; beers) were characterised by large portion sizes. Lunch and dinner combined contributed almost half of daily DF energy intake, with pastries and wines, respectively, the most popular at those occasions. High DF consumption was correlated with lower SES, physical activity, usual fruit intake and higher waist circumference, but not higher BMI.

The high intake of DF by Australian adults is consistent with other national nutrition surveys globally. A high intake of DF as a proportion of total energy intake has been reported in studies in Belgium, the USA, Mexico and Canada. In Belgium, 92% of people aged 15 years or older consumed more than the maximum recommendation of less than 100 g of nutrient-poor, energy-dense foods daily<sup>(26)</sup>. In the USA, energy-dense, nutrient-poor foods contributed 27% of total energy intake and alcohol contributed an additional 4%<sup>(4)</sup>. In Mexico, results from the national nutrition survey for people aged 5 years or older reported that sugar-sweetened beverages and foods high in saturated fat and/or added sugars contributed 26% of total energy intake<sup>(27)</sup>; and in Canada, non-core foods contributed 22.7% of total daily energy for adults<sup>(28)</sup>. Direct comparisons between countries are limited due to the lack of a universal definition for DF and different methodologies in food classification<sup>(29)</sup>. In Australia, an analysis of the 1995 National Nutrition Survey reported that 99% of adults consumed 'extra' foods and that these contributed 36% of total energy intake<sup>(5)</sup>. These findings suggest Australian DF intakes have largely remained unchanged since 1995, although there are minor differences in the definitions between 'extra foods' and 'discretionary foods' between the two surveys.

We found that young males were the highest consumers of DF, with more than half consuming five or more servings of DF in a day, similar to the previous 1995 National Nutrition Survey in Australia, where 19–24-year-old males had the highest percentage energy intake from 'extra' foods of all adults<sup>(5)</sup>. Similar findings have also been reported globally. In the USA, 19–30-year-old males were the most likely to exceed the daily maximum DF allowances<sup>(30)</sup>; and in Canada, 19–30-year-old males, of all adult

**Table 4** Associations between quartiles of percentage energy contribution from discretionary foods and beverages (DF) and demographic, adiposity-related measures and lifestyle characteristics among Australian adults aged  $\geq 19$  years ( $n$  9341) from the 2011–12 National Nutrition and Physical Activity Survey

	Q1 (low consumer)	Q2	Q3	Q4 (high consumer)	
Range of % energy from DF	0–16.2	16.2–30.6	30.6–46.6	46.6–100	
Characteristic	%	%	%	%	<i>P</i> value from Pearson's $\chi^2$ test
Sex (within quartile)					<0.001
Female	55.6	52.6	48.4	45.3	
Male	44.4	47.4	51.6	54.7	
Age group (within quartile)					<0.001
19–30 years	22.1	21.9	22.5	26.2	
31–50 years	37.1	37.1	36.4	39.0	
51–70 years	30.7	29.3	28.6	25.9	
$\geq 71$ years	10.1	11.7	12.6	8.9	
Age and sex groups (within quartile)					
Females					<0.001
19–30 years	20.6	19.8	24.1	25.9	
31–50 years	36.4	37.4	35.7	39.4	
51–70 years	32.1	30.1	26.4	25.2	
$\geq 71$ years	10.8	12.7	13.7	9.5	
Males					0.025
19–30 years	23.9	24.3	20.9	26.4	
31–50 years	38.0	36.7	37.0	38.6	
51–70 years	28.9	28.3	30.5	26.6	
$\geq 71$ years	9.1	10.6	11.5	8.4	
Quintiles SEIFA* (within quartile)					<0.001
Lowest 20%	18.0	16.4	17.4	20.6	
Highest 20%	23.1	24.0	21.7	19.8	
Met physical activity guidelines† (duration and session)	46.5	45.5	42.7	38.3	<0.001
BMI group‡ (within quartile)					0.003
Underweight	2.2	1.3	1.3	2.3	
Normal weight	38.3	34.9	34.4	34.1	
Overweight	35.6	35.9	37.8	36.6	
Obese	23.9	27.9	26.5	27.0	
Waist circumference group§ (within quartile)					<0.001
No risk of chronic disease	42.0	36.4	34.7	36.1	
Increased risk of chronic disease	20.9	23.5	24.5	22.6	
Substantially increased risk of chronic disease	37.1	40.0	40.8	41.3	
Current smoker (within quartile)	12.3	14.3	19.2	25.6	<0.001
Under-reporters   (within quartile)	32.7	21.8	17.7	13.1	<0.001

Q, quartile; SEIFA, Socio-Economic Indexes for Areas.

\*SEIFA was developed by the Australian Bureau of Statistics and ranks areas in Australia according to their relative socio-economic advantage<sup>(21)</sup>.

†For adults aged  $\geq 18$  years, at least 150 min of physical activity over five or more sessions per week is recommended<sup>(20)</sup>.

‡Based on BMI: underweight ( $<18.5$  kg/m<sup>2</sup>); normal weight ( $\geq 18.5$ – $<25.0$  kg/m<sup>2</sup>); overweight ( $\geq 25.0$ – $<30.0$  kg/m<sup>2</sup>); obese ( $\geq 30.0$  kg/m<sup>2</sup>)<sup>(22)</sup>.

§Based on WHO cut-offs for waist circumference: not at risk of metabolic complications ( $<80$  cm for females,  $<94$  cm for males); increased risk of metabolic complications ( $\geq 80$  and  $<88$  cm for females,  $\geq 94$  and  $<102$  cm for males); substantially increased risk of metabolic complications ( $\geq 88$  cm for females,  $\geq 102$  cm for males)<sup>(23)</sup>.

||Participants were classified as under-reporters based on the Goldberg cut-off limit of an energy intake to BMR ratio of 0.9<sup>(24)</sup>.

groups, consumed the greatest percentage of energy from 'other foods' outside the four main food groups<sup>(28)</sup>. Compared with females, males are less likely to have a high level of nutrition knowledge<sup>(31)</sup>, are less likely to be health conscious<sup>(32,33)</sup> and are less likely to be involved in meal preparation<sup>(34)</sup>. Since eating behaviour can persist into later life<sup>(35–37)</sup>, there is a need for the development of DF-reducing interventions that target younger males.

Our analysis found that the top food groups that contributed to DF energy intake each had high mean DF servings per consumer, at quantities close or equal to three DF servings, the maximum recommended for an entire day<sup>(7)</sup>. Interestingly, the most popular DF food groups –

including sugar, honey and syrups; sweet biscuits; and soft drinks and flavoured mineral waters – were not among the highest contributors to DF energy intake as they had much smaller portion sizes. These smaller portion-sized food groups were more likely to be the top DF energy contributors among low DF consumers. However, the top food groups among high consumers were foods typically consumed in larger portion sizes. It is likely that portion sizes are an important contributing factor to high DF intake. There is considerable evidence that the portion sizes of many foods, particularly DF, have increased in the USA<sup>(38,39)</sup>, the Netherlands<sup>(40)</sup> and Australia<sup>(15)</sup>, and it is well established that increasing portion size increases



**Table 5** Estimated effects of quartiles of percentage energy contribution from discretionary foods and beverages (DF) on diet, lifestyle and adiposity-related characteristics among Australian adults aged  $\geq 19$  years ( $n$  9341) from the 2011–12 National Nutrition and Physical Activity Survey

Characteristic*	Q1 (low consumer)		Q2		Q3		Q4 (high consumer)		P value†
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	
Energy intake (MJ)‡	7.5 <sup>a</sup>	0.1	8.3 <sup>b</sup>	0.1	8.7 <sup>c</sup>	0.1	9.6 <sup>d</sup>	0.1	<0.001
DF energy intake (MJ)‡	0.6 <sup>a</sup>	0.03	2.0 <sup>b</sup>	0.03	3.4 <sup>c</sup>	0.03	6.0 <sup>d</sup>	0.03	<0.001
Non-DF energy intake (MJ)‡	6.8 <sup>a</sup>	0.05	6.3 <sup>b</sup>	0.05	5.3 <sup>c</sup>	0.05	3.6 <sup>d</sup>	0.05	<0.001
Proportion of energy from DF (%)§	8.3 <sup>a</sup>	0.1	24.1 <sup>b</sup>	0.1	39.0 <sup>c</sup>	0.1	61.7 <sup>d</sup>	0.2	<0.001
DF servings‡	1.1 <sup>a</sup>	0.05	3.3 <sup>b</sup>	0.05	5.7 <sup>c</sup>	0.06	10.1 <sup>d</sup>	0.06	<0.001
Total EO	6.6 <sup>a</sup>	0.05	7.0 <sup>b</sup>	0.05	7.1 <sup>b</sup>	0.05	6.9 <sup>a,b</sup>	0.05	<0.001
EO with DF	2.2 <sup>a</sup>	0.03	3.4 <sup>b</sup>	0.03	4.1 <sup>c</sup>	0.03	4.5 <sup>d</sup>	0.04	<0.001
Proportion of EO with DF (%)	34.4 <sup>a</sup>	0.4	50.5 <sup>b</sup>	0.4	59.7 <sup>c</sup>	0.4	67.6 <sup>d</sup>	0.4	<0.001
Physical activity (min)‡	236 <sup>a</sup>	6	217 <sup>a,b,c</sup>	6	229 <sup>b</sup>	6	189 <sup>c</sup>	6	<0.001
Time sitting or lying down for work, transport and leisure (min)‡	2125 <sup>a</sup>	27	2261 <sup>a,b</sup>	27	2344 <sup>b</sup>	28	2300 <sup>b</sup>	29	<0.001
BMI (kg/m <sup>2</sup> )	26.9	0.1	27.3	0.1	27.4	0.1	27.4	0.1	0.014
Waist circumference(cm)	91.6 <sup>a</sup>	0.3	92.8 <sup>a,b</sup>	0.3	93.4 <sup>b</sup>	0.3	93.9 <sup>b</sup>	0.3	<0.001
Self-reported fruit servings	1.9 <sup>a</sup>	0.02	1.8 <sup>b</sup>	0.02	1.6 <sup>c</sup>	0.02	1.4 <sup>d</sup>	0.02	<0.001
Self-reported vegetable servings	2.4 <sup>a</sup>	0.03	2.5 <sup>a</sup>	0.03	2.3 <sup>a,b</sup>	0.03	2.2 <sup>b</sup>	0.03	<0.001

Q, quartile; EO, eating occasion.

<sup>a,b,c,d</sup>Mean values within a row with unlike superscript letters were significantly different ( $P < 0.001$  *post hoc*, Bonferroni).

\*Adjusted for quartile of percentage energy from DF, age group, sex and their interaction using univariate ANOVA.

†Univariate ANOVA denote the effect of quartiles of percentage energy from DF.

‡Age group, sex and their interaction were all significant ( $P < 0.001$ , univariate ANOVA).

§No variables (apart from quartile percentage of energy from DF) were significant in the model (univariate ANOVA).

||Age group and sex were significant ( $P < 0.001$ ) but not their interaction (univariate ANOVA).

**Table 6** Top five sub-major food groups by quartiles of percentage energy contribution from discretionary foods and beverages among Australian adults aged  $\geq 19$  years ( $n$  9341) from the 2011–12 National Nutrition and Physical Activity Survey

Rank	Q1 (low consumer)		Q2		Q3		Q4 (high consumer)	
	Sub-major food group	Contribution to total energy intake (%)	Sub-major food group	Contribution to total energy intake (%)	Sub-major food group	Contribution to total energy intake (%)	Sub-major food group	Contribution to total energy intake (%)
1.	Sugar, honey and syrups	1.1	Wines	2.4	Cakes, muffins, scones, cake-type desserts	3.7	Pastries	6.2
2.	Sweet biscuits	0.7	Sweet biscuits	1.8	Wines	3.4	Cakes, muffins, scones, cake-type desserts	5.5
3.	Processed meat	0.5	Sugar, honey and syrups	1.6	Pastries	3.0	Wines	4.5
4.	Salad dressings	0.4	Cakes, muffins, scones, cake-type desserts	1.6	Beers	2.4	Beers	4.3
5.	Chocolate and chocolate-based confectionery	0.4	Chocolate and chocolate-based confectionery	1.3	Soft drinks, and flavoured mineral waters	2.1	Soft drinks, and flavoured mineral waters	3.2

Q, quartile.

energy intake in well-controlled laboratory studies<sup>(41–44)</sup>. Beverages may be of particular concern among high DF consumers. Three of the leading five food group contributors to DF energy intake among adults in the third and fourth quartiles of DF intake were beverages, compared with low DF consumers, who had no beverages in the leading five DF contributors. It has been demonstrated that beverages have a relatively low satiety value in comparison to solid foods<sup>(45–47)</sup>. Experimental evidence has shown that a reduction in portion size leads to a reduction in energy intake<sup>(48)</sup>, including for discretionary foods<sup>(49)</sup>, even when there is no change to the total quantity of food offered<sup>(50)</sup>. Strategies to reduce DF consumption should therefore consider interventions that reduce portion size, such as the use of visual cues, labelling, reducing the size of packaging and plate size<sup>(51)</sup>. Selecting discretionary foods that are generally consumed in smaller portions, such as sugar, honey and syrups in coffee or tea, or processed meat in a sandwich, instead of those consumed in larger portions, such as cakes, muffins, scones, cake-type desserts or pastries, may also help to reduce total DF energy intake, since it may be more difficult to have smaller portions of the latter foods, such as a quarter of a piece of cake or half a muffin. Given that there is high variability in the manufacturer-declared serving sizes for DF in Australia<sup>(52)</sup>, and that inaccurate estimation of standard dietary servings and portion sizes may also contribute to excess consumption<sup>(53)</sup>, reference guidelines or regulatory policy concerning the development and labelling of serving sizes for DF should also be considered.

We found that dinner, lunch, snack and beverage/drink were the four leading EO that contributed to DF energy intake, with dinner and lunch combined

contributing almost half of daily DF energy intake. Few studies have previously investigated the contribution of EO to DF energy intake<sup>(54)</sup>. In Mexico, the proportion of energy that products high in saturated fat and/or high in added sugar contributed was higher at mid-afternoon snacks and lower at lunch and brunch, while the proportion of energy from sugar-sweetened beverages was higher during mid-morning snacks<sup>(55)</sup>. In Australia, an analysis of the 2011–12 NNPAS reported that a higher frequency of snacks (self-reported by participants), but not main meals, was associated with a lower compliance to the Dietary Guidelines Index for discretionary foods<sup>(56)</sup>. In our analysis, the REO snack contributed a high percentage of DF energy, but morning tea, afternoon tea and supper, which traditionally are also snacking occasions, did not. With more than half of all EO containing DF, encouraging adults to have EO free of DF may help to reduce its consumption.

Targeting high-DF EO with the provision of core foods may also be an effective means for reducing DF intake at these meal times, since the substitution of discretionary with core foods has been shown to reduce energy intake<sup>(49)</sup>. In a crossover trial that incorporated vegetables in place of other ingredients within a recipe to lower the energy density of the entire meal, intake of vegetables increased and reduced the total energy intake over the day, without changes to satiety<sup>(57)</sup>. In a national nutrition campaign in the UK, the promotion of ‘smart swaps’, or the replacement of discretionary foods with core foods, was associated with a change in purchase habits towards healthier products<sup>(58)</sup>.

Wines was the top food group at dinner and beers the top at beverage/drink that contributed to DF energy

intake. The high energy contribution from alcohol is consistent with data that show alcohol consumption in Australia is among the highest in the world<sup>(59)</sup>. Alcohol is a top source of discretionary energy and, unlike other discretionary foods, can be an addictive drug<sup>(60)</sup>; since it is not necessary to meet nutritional needs, its reduction should be a top public health priority. The high contribution of alcoholic beverages to total DF energy intake reinforces the need for DF-reducing strategies to specifically target a reduction in alcohol intake.

We found that foods and beverages that were top sources of discretionary energy were not necessarily the top sources of the nutrients total sugars, saturated fat and Na. For example: wines, pastries and beers were among the leading contributors to DF energy but not to total sugars intake; and sugar, honey and syrups was among the leading contributors to total sugars intake but not DF energy intake. It should be noted, however, that these outcomes may have differed if added sugars had been analysed instead of total sugars although, by definition, total sugars from discretionary foods are mostly added. These findings suggest that it is a combination of portion size and the type of food that influences discretionary energy intake, and hence a focus on individual nutrients alone is unlikely to target the leading contributors to total DF energy intake in the diet of Australian adults. Our data strengthen the case for interventions aimed at reducing DF consumption that focus on targeted EO and whole diets rather than on singular nutrients of concern.

Compared with low consumers, high consumers were more likely to report lower physical activity, be a current smoker and have a lower usual fruit intake. The clustering of high DF intake with other less healthy lifestyle behaviours, such as lower physical activity and greater fast-food intake, has been previously reported in the USA<sup>(11)</sup>. Data from the National Health and Nutrition Examination Survey (NHANES) also reported that a high intake of energy-dense, nutrient-poor foods was associated with a low intake of core foods<sup>(4)</sup>. Interventions that appreciate these interrelationships may be more effective than interventions aimed at reducing DF alone.

Consistent with our finding, there is a large body of evidence that reports an association between lower SES and poorer diet quality<sup>(61)</sup>, including in Australia<sup>(62)</sup>, but these findings are not uniform across countries. High DF intake has been associated with a higher SES in Mexico<sup>(27)</sup> and a lower DF intake has been associated with lower income earners in the USA<sup>(4)</sup>. Since the relationship between diet quality and SES may differ according to the culture and economic status of the country, it is important to have population-specific data to best inform local intervention policies aimed at reducing DF intake. In Australia females of low SES reported that the perceived high cost of healthy food and a lack of time were important barriers for healthy eating<sup>(63)</sup>. Yet, it has been shown

that healthy diets can be more affordable than current (less healthy) diets in Australia<sup>(64)</sup> and that an education-based intervention on food affordability improves perceptions of healthy food affordability in Australian mothers<sup>(65)</sup>. Reducing the perception of the high cost and time commitments associated with healthy eating may be particularly important for reducing DF intake.

With respect to adiposity-related measures, we found a clear and consistent relationship with DF consumption and waist circumference, but not BMI. There is a large body of evidence that waist circumference independent of BMI is a significant predictor of chronic diseases<sup>(66–69)</sup>. An association between DF or its components and waist circumference, but not BMI, has been reported previously. An analysis of the 1988–1994 NHANES reported that high waist circumference but not BMI was associated with the amount of daily energy intake from energy-dense, nutrient-poor foods in men<sup>(4)</sup>. An increase in waist circumference but not BMI was also associated with increasing frequency of sugar-sweetened beverage intake in a study of US adults<sup>(70)</sup>. A number of prospective studies that measured increases in waist circumference adjusted for BMI have also reported an association with poorer diet quality<sup>(71–74)</sup>. Increased waist circumference without changes to BMI may be a marker of increased visceral fat, and it has been suggested that some aspects of poor diet quality, such as high glycaemic index, may causally encourage greater visceral fat storage<sup>(72,75)</sup>. It is also possible that our observed associations are due to confounding factors or under-reporting. In our study, low DF consumers were more likely to meet recommendations for physical activity, for example, which generally reduces abdominal fat<sup>(76)</sup>. We also found a substantially higher proportion of under-reporting among the lowest consumers of DF (33%) compared with the highest consumers of DF (13%). This may be explained in part by a proportion of low DF consumers actively dieting and purposely reducing total energy and DF intake, and not under-reporting as predicted by EI:BMR. Overweight and obese individuals are more likely to under-report than lean individuals<sup>(77)</sup> and DF are more likely to be under-reported than other foods<sup>(78,79)</sup>. Intervention studies are required to better understand the possible causal effects between different DF and the different measures of adiposity.

A particular strength of the present study is the use of a large, nationally representative sample of the Australian adult population. The data are cross-sectional and causal effects cannot be determined from the observed associations. Dietary intake was derived from a single day of 24 h recall and is not indicative of usual intakes. Two-thirds of respondents in the NNPAS provided two days of recall; however, in order to maximise the sample size only day 1 of recall was used. Evidence of under-reporting of energy intake in the survey implies that total DF intake could be

even higher than reported. Since under-reporting is generally higher in females and overweight and obese respondents<sup>(77)</sup>, under-reporting may have also impacted the observed associations between DF intake and other variables, such as sex, waist circumference and BMI.

## Conclusions

In summary, the current results showed intakes of DF well above the maximum recommended levels stipulated by the Australian Dietary Guidelines, with the average per capita intake equivalent to five DF servings daily. The leading contributors to total DF energy intake were generally DF food groups consumed in large portion sizes, close or equal to three DF servings, the maximum DF energy limit recommended for an entire day. Dinner and lunch were the leading contributors to DF energy intake of all EO and contributed almost half of all DF energy intake, followed by the REO snack and beverage/drink. Addressing high DF intake by targeting the DF consumed in large portion sizes, particularly at dinner and lunch, may help to inform more strategic and evidenced-based DF-reducing interventions, for which the need is compelling.

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## Supplementary material

To view supplementary material for this article, please visit <https://doi.org/10.1017/S1368980018003361>

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