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Meal Frequency but Not Snack Frequency Is Associated with Micronutrient Intakes and Overall Diet Quality in Australian Men and Women[1–3]

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Abstract

Background: Skipping breakfast is associated with poorer diet quality among adults, but evidence of associations for other eating patterns [e.g., eating occasion (EO), meal, or snack frequency] is equivocal. An understanding of how eating patterns are associated with diet quality is needed to inform population-level dietary recommendations.

Objective: We aimed in this cross-sectional study to determine the relation between frequency of meals, snacks, and all EOs with nutrient intakes and diet quality in a representative sample of Australian adults.

Methods: Dietary data for 5242 adults aged ≥19 y collected via two 24-h recalls during the 2011–2012 National Nutrition and Physical Activity Survey were analyzed. EO, meal, and snack frequency was calculated. Adherence to recommendations for healthy eating was assessed with the use of the 2013 Dietary Guidelines Index (DGI) and its subcomponents. Linear regression, adjusted for covariates and energy misreporting, was used to examine associations between eating patterns, energy-adjusted nutrient intakes, and the DGI-2013.

Results: The frequency of meals, but not of snacks, was positively associated with micronutrient intakes, overall diet quality [men: β = 5.6 (95% CI: 3.9, 7.3); women: β = 4.1 (95% CI: 2.2, 5.9); $P < 0.001$], and DGI-2013 component scores for cereals, lean meat and alternatives, and alcohol intake ($P < 0.05$). A higher frequency of all EOs, meals, and snacks was positively associated with DGI-2013 scores for food variety, fruits, and dairy foods ($P < 0.05$). Conversely, a higher snack frequency was associated with a lower compliance with guidelines for discretionary foods and added sugars among men ($P < 0.05$).

Conclusions: These findings suggest that meal frequency is an important determinant of nutrient intakes and diet quality in Australian adults. Inconsistent associations for snack frequency suggest that the quality of snack choices is variable. More research examining the dietary profiles of eating patterns and their relations with diet quality is needed to inform the development of meal-based guidelines and messages that encourage healthy eating. *J Nutr* doi: 10.3945/jn.116.234070.

Keywords: diet quality, eating occasion frequency, eating patterns, meals, nutrients, snacks

Introduction

The important role that diet plays in preventing noncommunicable diseases (e.g., cardiovascular disease and some cancers) is well documented (1). Despite this, the diets of many Australian adults fail to meet national recommendations for intakes of core foods and key nutrients (2, 3). Current dietary advice is framed around the amount and types of food populations should consume rather than through a consideration of eating patterns (4). Eating patterns describe how people eat at the level of an eating occasion (EO)[4] and may include a range of indicators such as frequency, timing and skipping of meals, and frequency and timing of snacks (5).

Epidemiologic evidence suggests that skipping breakfast is associated with obesity (6), other cardiovascular disease risk

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[3] Supplemental Tables 1–3 are available from the "Online Supporting Material" link in the online posting of the article and from the same link in the online table of contents at http://jn.nutrition.org.
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[4] Abbreviations used: ABS, Australian Bureau of Statistics; ADG, Australian Dietary Guideline; DGI, Dietary Guidelines Index; EI, energy intake; EO, eating occasion; HEI, Healthy Eating Index; NNPAS, National Nutrition and Physical Activity Survey; PA, physical activity; PAL, physical activity level; pTEE, predicted total energy expenditure; rEI, reported energy intake.

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factors (7–9), and lower intakes of micronutrients (5) among adults. However, evidence of associations with macronutrients and other eating patterns (e.g., meal, snack, and total EO frequency) is equivocal or limited (5). To date, most studies that have examined relations between eating patterns and nutrient intakes have focused on either the frequency of total EOs or snacks (5), whereas only a few to our knowledge have considered meal frequency (10, 11).

Similarly, little research among adults has examined the relation between eating patterns other than breakfast skipping and measures of overall diet quality (5). Diet quality refers to the quality of a person's overall food intake and may be measured by how well one adheres to national dietary guidelines, usually by applying a predefined diet-quality score (12). Whereas breakfast skipping has been associated with poor diet quality, the evidence for other eating patterns and associations with other eating pattern indicators is lacking (5). Studies on EO, meal, and/or snack frequency and diet quality are dominated by the use of questionnaire-based assessments of eating patterns, which lack data on their relative validity (13–16). Furthermore, few of these studies used a comprehensive measure of dietary assessment (e.g., 24-h recalls) (10, 11, 17), of which only 2 examined both meal and snack frequency (10, 11).

There are 2 important methodologic issues to consider when investigating the relation between eating patterns, nutrient intakes, and diet quality. First, to our knowledge, there is no standard definition of an EO; some studies allow participants to self-identify EO (including meals and snacks), whereas others use time of day (5, 18). Second, most studies have not allowed for energy misreporting, although both eating frequency and food and nutrient intakes have been positively associated with total energy intake (EI) (19, 20). There is also evidence that those who underreport EI also underreport their EO frequency (21, 22). Unless adjusted for, energy misreporting may therefore affect the reported relation between eating patterns and food and nutrient intakes.

A better understanding of the differential impact that meals and snacks have on diet quality could inform the development of practical meal-based communication strategies to help populations follow dietary guidelines and achieve the recommended daily intakes of foods and nutrients (4). Therefore, the aim of this study was to determine the relation between the frequency of meals, snacks, and all EOs with energy-adjusted nutrient intakes and overall diet quality in a nationally representative sample of Australian adults.

Methods

Study population

This study was a secondary analysis of dietary data from NNPAS (National Nutrition and Physical Activity Survey) 2011–2012 (23). Conducted by the Australian Bureau of Statistics (ABS), NNPAS was a cross-sectional, nationally representative survey of noninstitutionalized persons aged ≥2 y. Of the 12,153 survey respondents (77% response rate), 9338 were adults aged ≥19 y. The survey methodology, which has been described in detail previously, included a multistage probability sampling design (23). Therefore, person-specific weights, adjusted for the probability of selection, were used to provide estimates relating to the whole population. The Census and Statistics Act 1905 provides ethics approval for the ABS to conduct household interview components of the health survey (23).

Dietary assessment

Dietary intake was assessed by two 24-h recalls (USDA automated multiple 5-pass method) (24) conducted ~9 d apart. Both dietary recalls were completed by 6053 (65%) of the 9338 adult respondents. Respondents were asked to recall the type of EO and the time when that EO commenced. The EO response options included breakfast, brunch, lunch, dinner or supper, snack, morning tea, afternoon tea, drink or beverage, extended consumption, other, and do not know. Foods and beverages were coded, and nutrient and EIs were calculated from the Australian Supplement and Nutrient Database 2011–2013 (25). Dietary information was averaged across the 2 d of recall to calculate mean estimates of energy and nutrient intakes, diet quality scores, and eating patterns.

Eating patterns

The mean total frequency of all EOs, meals, and snacks were calculated after applying the following definitions, which were informed by previous research and have been described previously (18). An EO was defined as any occasion during which a food or beverage was consumed that contained a minimum energy content of 210 kJ (50 kcal) and was separated in time from the preceding and succeeding EO by 15 min. Although to our knowledge there is no standard research definition of an EO, previous research has demonstrated that this definition more strongly predicts total EI and measures of adiposity than applying EO definitions with no energy criterion (18, 26) or differing time intervals (18). Meals and snacks were assigned based on participant self-reporting. There is currently no consensus on which approach is best for classifying meals and snacks (5), with little difference found in predicting total EI and food and/or beverage intake based on either self-reporting or time-of-day methods (18). EOs reported as breakfast, brunch, lunch, and dinner or supper were considered meals, and EOs reported as snacks, morning tea, afternoon tea, and beverages or breaks were considered snacks. EOs reported as extended consumption or as other or do not know were only classified as a meal or snack if they occurred within 15 min of a preceding meal or snack EO, respectively (18, 27). Participants were divided into categories of daily frequency of all EOs (1–3, 4–5, or ≥6), meals (1–2 or ≥3), and snacks (0–1, 2–3, or ≥4) based on the sample distribution.

Nutrients

Mean total dietary intakes of carbohydrates, sugars, total fat, SFAs, MUFAs, PUFAs, protein, dietary fiber, folate, β-carotene, sodium, potassium, calcium, iron, and iodine were calculated for each participant. The selection of these nutrients was based on a consideration of nutrients that play an important role in preventing health-related conditions reflected in disease burden (e.g., cardiovascular disease, hypertension, osteoporosis, iron-deficient anemia, iodine deficiency) according to the Australian Dietary Guidelines (ADGs) and Nutrient Reference Values (4, 28). All nutrient intakes were adjusted for total EI with the use of the residual method by regressing nutrient intakes on total EIs (20, 29).

Diet quality

Overall diet quality was assessed with the use of the 2013 version of the Dietary Guidelines Index (DGI). DGI-2013 is a food-based index designed to measure compliance with the most recent ADGs and has been described in detail previously (30–32). Briefly, DGI-2013 comprises 13 components, with each component scored proportionally (possible range from 0 to 10) to reflect the level of compliance for meeting an ADG (e.g., a score of 10 indicates the participant fully met the recommendation). Seven of the 13 components assess the adequacy of the diet (e.g., food variety, vegetables, fruits, cereals, dairy and alternatives, lean meat and alternatives, and fluid intake), whereas the remaining 6 components assess the moderation of dietary intake (e.g., discretionary foods, saturated fat, salt, added sugar and alcohol, and moderate intakes of unsaturated fat). The scores for each component were summed to give a total score out of 130, with a higher score reflecting better diet quality.

Covariates

Sociodemographics. Age was categorized as 19–30, 31–50, 51–70, and >70 y, consistent with the categories used in the Nutrient Reference Values (28). Educational status was categorized as low (completed some high school or less), medium (completed high school and/or certificate or diploma), or high (having a tertiary qualification). Income deciles of participants' weekly gross household income was determined by the ABS by taking into account the number of persons living in the household (23). The reference ranges in Australian dollars/wk were as follows: decile 1, <333; decile 2, 333–398; decile 3, 399–502; decile 4, 503–638; decile 5, 639–795; decile 6, 796–958; decile 7, 956–1151; decile 8, 1152–1437; decile 9, 1438–1917; and decile 10, ≥1918. Country of birth was categorized by the ABS as Australia, other main English-speaking countries, and all other countries (23).

Health characteristics. Smoking status was self-reported and categorized as current daily smoker, current weekly smoker, current monthly smoker, ex-smoker, and never smoked. Physical activity (PA) in the last week was assessed with the use of questions from the Active Australia Survey (frequency and total duration of walking for ≥10 min for recreation or transport, vigorous PA or exercise, and other moderate PA or exercise) (33). Total duration of physical activity was computed, with time spent in vigorous PA multiplied by 2 to reflect the higher energy cost (33). Participants were categorized as meeting PA guidelines (participated for ≥150 min and 5 sessions of PA) or not meeting PA guidelines (did not participate for ≥150 mins and 5 sessions of PA), which are consistent with recommendations for the Active Australia Survey (33). Participants reported how much time they spent in sedentary behavior in the past week. Sedentary behavior was defined as time spent sitting or lying down at work, during transport, or during leisure activities (23). Total minutes spent in sedentary behavior in the past week was calculated. Participants reported whether they were currently dieting and whether they ate more or less than usual on the day of each 24-h recall. Mean daily alcohol intake (g/d) was calculated from the 2 d of 24-h recall for each participant.

Energy misreporting. Energy misreporting was assessed with the use of the ratio of reported EI to predicted total energy expenditure (pTEE) method [reported energy intake (rEI):pTEE] developed by Huang et al. (34) This method uses the sex- and age-specific equations from the Institute of Medicine's *Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein and Amino Acids* to calculate pTEE (35). For this study, the equations used to calculate pTEE were those suitable for use in populations with a range of weight statuses and required information on participant age, height, and PA level (PAL). The equations for men and women were pTEE = 864 – [9.72 × age (y)] + PA × [14.2 × weight (kg) + 503 × height (m)] and pTEE = 387 – [7.31 × age (y)] + PA × [10.9 × weight (kg) + 660.7 × height (m)], respectively. Height (cm) and weight (kg) were measured to 1 decimal point with a portable stadiometer and digital scales, respectively, by trained ABS staff (23). Consistent with previous research (34, 36), a low-active PAL (e.g., ≥1.4 and <1.6) was assumed because of a lack of an objective measure of PA. Participants were identified as plausible reporters, underreporters, or overreporters of EI with the use of the following equation to calculate the ±1-SD cutoff for rEI:pTEE: $\pm 1SD = \sqrt{CV_{rEI}^2/d + CV_{pTEE}^2 + CV_{mTEE}^2}$ (34, 37). The values in this equation were 34.5% for CV_{rEI} (value specific to the NNPAS dataset); 2 for d (number of 24-h recall days); 19.2% for CV_{pTEE} (value specific to the NNPAS data set); 8.2% for CV_{mTEE} (38), where $_mTEE$ is the technical error of measuring total energy expenditure with the use of the doubly labeled water technique and biological variation. With the use of this equation, the ±1-SD cutoffs for the agreement between rEI and pTEE was ±0.32.

Analytic sample

Of the 6053 adults aged ≥19 y who completed two 24-h recalls, participants who were pregnant, breastfeeding, or undertaking shift work within the past 4 mo were excluded (n = 687). Participants were also excluded if they reported no EI during a 24-h recall (n = 8) or had EOs that could not be identified as a meal or a snack (e.g., EOs reported as do not know or other) or did not report the time at which an EO commenced (n = 116). Of the final sample of 2402 men and 2840 women, 919 had missing data on covariates (income and rEI:pTEE), leaving a sample of 2053 men and 2270 women available for the regression analysis.

Statistical methods

All statistical analyses were conducted with the use of Stata version 13.1 (StataCorp LP) and stratified by sex. After examining the distribution of the data, all nutrient data were log-transformed to improve normality. Descriptive statistics for nutrient and diet-quality variables were presented as weighted means (95% CIs). Geometric means (95% CIs) were calculated for all log-transformed nutrient variables by applying the appropriate back-transformation (e.g., exponentiated). The F-test (with Bonferroni correction across >2 categories) was used to determine differences in nutrient intakes and diet quality (total and component scores) between categories of EO, meal, and snack frequency. Differences in mean values for EI, eating patterns, and DGI-2013 scores between categories of energy misreporting were also assessed with the use of an F-test with Bonferroni correction. For all analyses, person-specific weights and replicate weights (jackknife group delete-1 method) were applied to compute point estimates and jackknife SEs to account for selection probability and the clustered survey design, respectively. The weighting, benchmark, and estimation procedures for NNPAS have been described in detail previously (23). Bonferroni correction was used to account for multiple testing across >2 categories of EO and snack frequencies.

Multiple linear regression (Wald test of association) was used to test for associations between eating patterns (EO, meal, and snack frequency) and EI, energy-adjusted nutrient intakes, and DGI-2013 and its components. Potential covariates were identified based on their hypothesized relation with both dependent and independent variables and the published literature. Bivariate analyses (Pearson's chi-squared test for categorical variables and an F-test for continuous variables) were subsequently employed to determine the final model. Models were adjusted for age group, educational status, income, country of birth, meeting PA guidelines, sedentary behavior, smoking status, alcohol intake (continuous except for DGI-2013 scores), dieting, and whether ate more or less than usual. All models were checked for issues of multicollinearity and appropriate model fit with the use of regression diagnostics. Models were also adjusted for energy misreporting with the use of the rEI:pTEE variable, a statistical approach used in previous research (10, 39, 40). This approach was chosen because research suggests the exclusion of energy misreporters may introduce selection bias because of differences in observed characteristics between plausible and nonplausible reporters of EIs (26, 34, 41). For all analyses, $P < 0.05$ was considered statistically significant.

Results

For both men and women and among all age groups, most participants reported consuming 4 or 5 EOs (range: 56–60%) and ≥3 meals/d (range: 62–89%). After examining potential covariates, significant associations with categories of EO, meal, and snack frequency were found for age, smoking status, and alcohol intake (**Supplemental Tables 1** and **2**). Educational status (men only), income (men only), country of birth (women only), whether ate more or less than usual, and alcohol were significantly associated with categories of meal frequency, whereas snack frequency was associated with meeting PA guidelines (women only) and sedentary time (men only) (Supplemental Tables 1 and 2).

Tables 1 and **2** present energy-adjusted nutrient intakes and diet-quality scores by categories of eating patterns for men and women. Mean intakes for energy increased across increasing categories of EO, meal, and snack frequency. Therefore, all nutrient analyses were conducted with the use of energy-adjusted nutrient intakes. Nutrient intakes for protein, fiber, and all micronutrients examined were considerably higher among men and women consuming ≥3 meals/d than those who consumed <3. Intakes of total sugars, calcium, and potassium increased across increasing categories of EO and snack frequencies. Results were less consistent for DGI-2013 and its component scores. Among both sexes, those who consumed ≥3 meals/d had a higher DGI-2013 and component scores for food variety, vegetables, fruits, dairy foods and alternatives, cereals, and lean meat and alternatives. Higher DGI-2013 and

TABLE 1 Energy-adjusted nutrient intakes by categories of daily EO, meal, and snack frequency among Australian men and women[1]

	EO frequency			Meal frequency		Snack frequency		
	1–3 times	4–5 times	≥6 times	1–2 times	≥3 times	0–1 times	2–3 times	≥4 times
Men								
Energy, MJ/d	6.7 (6.4, 7.1)[a]	8.7 (8.5, 8.9)[b]	10.7 (10.5, 11.0)[c]	8.6 (8.3, 8.8)[a]	9.3 (9.1, 9.5)[b]	8.0 (7.8, 8.3)[a]	9.3 (9.1, 9.5)[b]	10.2 (9.8, 10.5)[c]
Carbohydrates, g/d	219 (211, 228)[a]	229 (225, 232)[a]	237 (232, 241)[b]	225 (219, 230)[a]	233 (230, 236)[b]	228 (223, 234)	232 (228, 236)	231 (225, 236)
Total sugars, g/d	75 (68, 82)[a]	89 (86, 92)[b]	109 (106, 113)[c]	92 (88, 97)[a]	94 (92, 97)[b]	85 (81, 89)[a]	95 (92, 98)[b]	103 (98, 108)[c]
Protein, g/d	100 (94, 106)	97 (95, 99)	95 (93, 98)	92 (90, 95)[a]	98 (97, 100)[b]	99 (97, 102)[a]	96 (94, 99)[a,b]	94 (92, 97)[b]
Fat, g/d	74 (70, 77)	74 (72, 75)	72 (70, 94)	73 (71, 76)	73 (72, 74)	74 (73, 75)	72 (70, 74)	73 (71, 75)
SFAs, g/d	26 (25, 28)	27 (26, 27)	27 (26, 28)	27 (26, 29)	27 (26, 27)	27 (26, 28)	27 (26, 27)	27 (27, 28)
MUFAs, g/d	29 (27, 30)[a]	28 (28, 29)[a]	27 (26, 28)[b]	28 (27, 29)	28 (27, 28)	29 (28, 29)[a]	28 (27, 28)[a,b]	28 (27, 28)[b]
PUFAs, g/d	11 (10, 12)	11 (10, 11)	10 (10, 11)	10 (9, 10)[a]	11 (11, 11)[b]	11 (11, 11)[a]	10 (10, 11)[a,b]	10 (10, 11)[b]
Fiber, g/d	20 (18, 21)[a]	22 (22, 23)[b]	23 (23, 24)[c]	19 (18, 20)[a]	24 (23, 24)[b]	22 (21, 23)	23 (22, 23)	23 (22, 23)
Folate, μg/d	496 (444, 554)[a]	616 (595, 638)[b]	633 (610, 658)[c]	509 (483, 535)[a]	652 (634, 669)[b]	600 (569, 632)	616 (595, 638)	606 (580, 633)
Vitamin C, mg/d	70 (60, 83)[a]	81 (77, 85)[b]	94 (88, 101)[c]	74 (68, 81)[a]	88 (83, 93)[b]	76 (69, 83)[a]	88 (83, 94)[b]	89 (82, 95)[b]
β-Carotene, mg/d	1.7 (1.4, 2.1)[a]	2.3 (2.1, 2.3)[b]	2.2 (2.1, 2.4)[b]	1.7 (1.5, 1.9)[a]	2.3 (2.2, 2.5)[b]	2.1 (1.9, 2.3)	2.3 (2.1, 2.5)	2.0 (1.9, 2.2)
Calcium, mg/d	612 (564, 665)[a]	729 (707, 753)[b]	789 (759, 820)[c]	677 (642, 714)[a]	759 (739, 779)[b]	693 (663, 724)[a]	738 (708, 770)[b]	783 (756, 811)[c]
Iron, mg/d	11 (10, 11)[a]	12 (11, 12)[b]	12 (11, 12)[c]	10 (10, 10)[a]	12 (12, 12)[b]	12 (11, 12)	12 (11, 12)	11 (11, 12)
Iodine, μg/d	148 (134, 163)[a]	168 (164, 173)[b]	178 (172, 184)[c]	156 (149, 163)[a]	174 (170, 179)[b]	164 (158, 171)	170 (164, 177)	173 (167, 178)
Sodium, g/d	2.3 (2.1, 2.5)[a]	2.5 (2.5, 2.6)[b]	2.3 (2.2, 2.4)[a]	2.4 (2320, 2554)	2.4 (2.4, 2.5)	2.5 (2.4, 2.6)[a]	2.4 (2.3, 2.4)[b]	2.4 (2.3, 2.4)[b]
Potassium, g/d	2.8 (2.6, 2.9)[a]	3.0 (2.9, 3.0)[b]	3.1 (3.0, 3.2)[c]	2.8 (2.7, 2.9)[a]	3.0 (3.0, 3.2)[b]	2.9 (2.8, 3.0)[a]	3.0 (3.0, 3.1)[b]	3.0 (3.0, 3.1)[b]
Women								
Energy, MJ/d	4.7 (4.4, 5.0)[a]	6.6 (6.5, 6.7)[b]	8.3 (8.1, 8.4)[c]	6.0 (5.8, 6.2)[a]	7.2 (7.0, 7.3)[b]	6.0 (5.8, 6.2)[a]	6.9 (6.8, 7.1)[b]	7.7 (7.5, 8.0)[c]
Carbohydrates, g/d	164 (155, 173)[a]	172 (169, 175)[a]	181 (178, 184)[b]	172 (167, 176)	175 (173, 177)	172 (168, 177)	174 (171, 177)	176 (173, 180)
Total sugars, g/d	63 (58, 68)[a]	74 (72, 77)[b]	86 (84, 89)[c]	77 (73, 81)	77 (75, 78)	68 (65, 72)[a]	78 (75, 80)[b]	83 (80, 85)[c]
Protein, g/d	74 (70, 77)[a]	74 (73, 75)[a]	71 (70, 73)[b]	69 (67, 70)[a]	74 (73, 75)[b]	75 (73, 77)[a]	73 (72, 75)	71 (69, 73)[b]
Fat, g/d	58 (54, 61)	58 (56, 58)	56 (55, 57)	58 (57, 60)[a]	56 (56, 57)[b]	57 (55, 58)	58 (57, 59)	56 (55, 57)
SFAs, g/d	20 (18, 22)	20 (20, 21)	20 (20, 21)	21 (20, 22)[a]	20 (20, 21)[b]	20 (19, 21)	21 (20, 21)	20 (20, 21)
MUFAs, g/d	22 (21, 24)	22 (21, 22)	21 (21, 22)	22 (22, 23)[a]	21 (21, 22)[b]	22 (21, 22)	22 (22, 22)[a]	21 (20, 22)[b]
PUFAs, g/d	9 (8, 10)	9 (8, 9)	8 (8, 9)	9 (8, 9)	9 (8, 9)	9 (8, 9)	9 (8, 9)	9 (8, 9)
Fiber, g/d	16 (15, 18)[a]	19 (19, 20)[b]	20 (20, 21)[c]	16 (16, 17)[a]	20 (20, 21)[b]	18 (17, 19)[a]	20 (19, 20)[b]	20 (19, 20)[b]
Folate, μg/d	421 (381, 465)[a]	477 (463, 491)[b]	514 (498, 530)[c]	398 (375, 423)[a]	509 (499, 519)[b]	476 (456, 497)	483 (471, 497)	489 (471, 507)
Vitamin C, mg/d	53 (42, 68)[a]	69 (66, 72)[a]	78 (73, 83)[b]	57 (52, 63)[a]	74 (71, 77)[b]	65 (59, 72)[a]	70 (67, 74)	74 (69, 79)[b]
β-Carotene, mg/d	1.4 (1.1, 1.9)[a]	2.1 (2.0, 2.2)[b]	2.2 (2.0, 2.3)[b]	1.6 (1.4, 1.8)[a]	2.2 (2.1, 2.3)[b]	1.9 (1.7, 2.1)	2.1 (1.9, 2.3)	2.1 (1.9, 2.3)
Calcium, mg/d	560 (508, 618)[a]	647 (631, 663)[b]	712 (688, 737)[c]	594 (561, 565)[a]	677 (662, 692)[b]	622 (592, 654)[a]	656 (636, 676)[a]	694 (669, 720)[b]
Iron, mg/d	8 (8, 9)[a]	9 (9, 9)[a]	9 (9, 9)[b]	8 (8, 9)[a]	9 (9, 9)[b]	9 (9, 9)	9 (9, 9)	9 (9, 9)
Iodine, μg/d	125 (118, 133)[a]	135 (133, 138)[b]	143 (139, 148)[c]	128 (122, 133)[a]	140 (137, 143)[b]	134 (129, 140)	136 (133, 139)	140 (135, 145)
Sodium, g/d	1.9 (1.8, 2.0)	1.9 (1.8, 1.9)[a]	1.8 (1.7, 1.8)[b]	1.9 (1.8, 2.0)	1.8 (1.8, 1.9)	1.9 (1.9, 2.0)[a]	1.8 (1.8, 1.9)	1.8 (1.7, 1.8)[b]
Potassium, g/d	2.3 (21.4, 2.4)[a]	2.4 (2.4, 2.5)[b]	2.6 (2.5, 2.6)[c]	2.3 (2.2, 2.3)[a]	2.6 (2.5, 2.6)[b]	2.4 (2.3, 2.5)[a]	2.5 (2.4, 2.5)	2.6 (2.5, 2.6)[b]

[1] Values are weighted geometric means (95% CIs), n = 2402 men and 2840 women. An F-test with Bonferroni correction was used for pairwise comparisons between frequency categories within each eating pattern (EO, meal, and snack frequency). Different superscript letters indicate significant differences between frequency categories within eating patterns, $P < 0.01$. EO, eating occasion.

component scores for food variety, fruits, and dairy foods and alternatives but lower component scores for discretionary foods, added sugar, and unsaturated fats were observed in those with a higher EO and snack frequency.

Differences in EI, eating patterns, and DGI-2013 component scores were found between plausible reporters and underreporters of total EI. The weighted percentages of participants classified as having plausible EIs (rEI:pTEE) within the calculated ±1-SD range of 0.68 to 1.32 was 68% . The percentages of under- and overreporters were 25% and 7%, respectively. Compared with plausible energy reporters, underreporters had substantially lower mean values of EIs and frequency of reported EOs, meals, and snacks (**Supplemental Table 3**). They also had substantially higher mean DGI-2013 component scores for unsaturated fats, discretionary foods, added sugar, and alcohol. Mean component scores were considerably lower for food variety, vegetables, fruits, grains, and dairy and alternatives. No significant differences were observed for overall DGI-2013 scores.

Results from the linear regression showed that the frequency of meals, snacks, and EOs were associated with nutrient intakes (**Table 3**). After adjusting for confounders, including energy misreporting, positive associations were found between meal frequency and energy-adjusted intakes of protein, fiber, folate, iron, iodine, calcium, vitamin C, and potassium (men only). Snack frequency and all EOs were associated with substantially higher intakes of carbohydrates, total sugars, protein (women only), and calcium. Among men only, a higher snack frequency was positively associated with SFA, and among women, a higher EO frequency was inversely associated with sodium intake.

Table 4 presents the adjusted associations between eating patterns and DGI-2013 and its component scores. In both men and women, the frequency of all EOs and meals, but not snacks, were positively associated with DGI-2013, with larger effect sizes observed for associations with meal frequency. A higher frequency of all EOs, meals, and snacks were associated with DGI-2013 scores for food variety, fruits, and dairy foods and

TABLE 2 Diet quality scores by categories of daily EO, meal, and snack frequency among Australian men and women[1]

	EO frequency			Meal frequency		Snack frequency		
	1–3 times	4–5 times	≥6 times	1–2 times	≥3 times	0–1 times	2–3 times	≥4 times
Men								
DGI-2013[2]	75.6 (73.1, 78.1)[a]	79.0 (77.9, 80.2)[a]	80.9 (79.8, 82.1)[b]	72.8 (71.2, 74.3)[a]	82.0 (80.9, 82.9)[b]	78.8 (77.5, 80.1)	79.7 (78.3, 81.1)	79.4 (78.1, 80.6)
DGI-2013 components[3]								
Food variety	2.3 (2.0, 2.6)[a]	3.23 (3.10, 3.35)[b]	3.8 (3.67, 3.9)[c]	2.5 (2.4, 2.7)[a]	3.6 (3.5, 3.7)[b]	2.9 (2.8, 3.1)[a]	3.4 (3.3, 3.6)[b]	3.6 (3.4, 3.8)[b]
Vegetables	4.1 (3.6, 4.5)	4.7 (4.4, 4.9)	4.7 (4.5, 5.0)	4.0 (3.7, 4.3)[a]	4.9 (4.7, 5.1)[b]	4.5 (4.1, 4.8)	4.8 (4.6, 5.1)	4.6 (4.3, 4.8)
Fruit	3.5 (2.8, 4.1)[a]	5.0 (4.7, 5.3)[b]	7.1 (6.8, 7.5)[c]	4.2 (3.7, 4.6)[a]	6.1 (5.8, 6.4)[b]	4.5 (4.2, 4.9)[a]	4.8 (5.5, 6.1)[b]	6.3 (5.9, 6.7)[b]
Grains	4.4 (3.8, 4.9)[a]	5.0 (4.8, 5.2)[a]	5.7 (5.4, 5.9)[b]	4.3 (4.0, 4.5)[a]	5.5 (5.3, 5.7)[b]	4.8 (4.5, 5.1)[a]	5.4 (5.1, 5.6)[b]	5.3 (5.0, 5.6)
Lean meat and alternatives	7.6 (7.1, 8.0)	7.8 (7.6, 8.0)[a]	8.2 (8.0, 8.4)[b]	7.4 (7.2, 7.7)	8.1 (7.9, 8.2)	7.8 (7.6, 8.0)	7.9 (7.7, 8.1)	8.1 (7.8, 8.3)
Dairy foods and alternatives	3.3 (2.7, 3.8)[a]	4.8 (4.6, 5.1)[b]	6.3 (6.0, 6.7)[c]	4.7 (4.4, 5.1)[a]	5.3 (5.1, 5.5)[b]	4.4 (4.0, 4.7)[a]	5.2 (4.9, 5.5)[b]	6.1 (5.8, 6.4)[c]
Fluids	7.6 (7.2, 8.0)[a]	8.0 (7.8, 8.2)[a]	8.4 (8.2, 8.6)[b]	7.9 (7.6, 8.1)	8.2 (8.0, 8.3)	8.0 (7.7, 8.2)	8.0 (7.8, 8.3)	8.3 (8.0, 8.5)
Discretionary foods	4.4 (3.4, 5.3)[a]	2.7 (2.4, 3.0)[b]	1.2 (0.9, 1.5)[c]	2.1 (1.6, 2.5)[a]	2.5 (2.2, 2.8)[a]	3.3 (2.8, 3.8)[a]	2.2 (1.8, 2.6)[b]	1.6 (1.2, 1.9)[b]
Saturated fat	7.2 (6.8, 7.7)[a]	8.0 (7.9, 8.2)[b]	8.1 (7.9, 8.4)[b]	7.7 (7.4, 8.0)	8.1 (7.9, 8.2)	7.6 (7.3, 7.9)	8.1 (7.9, 8.3)	8.2 (7.9, 8.4)
Unsaturated fats	9.6 (9.4, 9.9)[a]	9.2 (9.0, 9.3)[b]	8.6 (8.3, 8.9)[c]	9.3 (9.1, 9.6)[a]	8.9 (8.7, 9.1)[b]	9.3 (9.1, 9.5)[a]	9.0 (8.8, 9.3)	8.6 (8.4, 8.9)[b]
Salt use	6.0 (5.4, 6.6)[a]	5.7 (5.5, 5.9)[a]	5.7 (5.5, 6.0)[a]	5.4 (5.1, 5.7)[a]	5.9 (5.7, 6.1)[b]	5.9 (5.5, 6.3)	5.7 (5.4, 6.0)	5.6 (5.2, 6.0)
Added sugars	7.2 (6.3, 8.2)[a]	6.6 (6.3, 7.0)[a]	5.2 (4.7, 5.7)[b]	5.7 (5.1, 6.2)	6.4 (6.1, 6.7)	7.0 (6.6, 7.5)[a]	6.0 (5.5, 6.4)[b]	5.6 (5.1, 6.1)[b]
Alcohol	8.6 (8.1, 9.1)	8.3 (8.0, 8.5)	7.8 (7.5, 8.2)	7.5 (7.1, 7.9)[a]	8.4 (8.2, 8.6)[b]	8.8 (8.4, 9.1)[a]	8.1 (7.8, 8.4)[b]	7.6 (7.1, 8.0)[b]
Women								
DGI-2013	76.1 (73.8, 78.4)[a]	81.8 (80.9, 82.8)[b]	82.5 (81.1, 83.9)[b]	75.5 (73.9, 77.2)[a]	83.2 (82.4, 84.0)[b]	80.5 (79.1, 82.0)	82.0 (80.9, 83.0)	81.9 (80.6, 83.1)
DGI-2013 components								
Food variety	2.5 (2.3, 2.8)[a]	3.6 (3.4, 3.7)[b]	4.1 (4.0, 4.3)[c]	2.7 (2.6, 2.9)[a]	3.9 (3.8, 4.0)[b]	3.2 (3.1, 3.4)[a]	3.7 (3.5, 3.8)[b]	4.0 (3.8, 4.1)[c]
Vegetables	3.7 (3.1, 4.2)[a]	4.9 (4.7, 5.1)[b]	5.3 (5.1, 5.5)[c]	4.0 (3.7, 4.3)[a]	5.2 (5.0, 5.3)[b]	4.5 (4.1, 4.8)[a]	5.0 (4.8, 5.2)[b]	5.2 (4.9, 5.4)[b]
Fruit	3.1 (2.3, 3.8)[a]	5.4 (5.1, 5.6)[b]	7.0 (6.7, 7.2)[c]	4.2 (3.9, 4.6)[a]	6.1 (5.8, 6.3)[b]	4.6 (4.2, 5.0)[a]	5.7 (5.5, 6.0)[b]	6.5 (6.2, 6.8)[c]
Grains	3.9 (3.4, 4.4)[a]	4.8 (4.6, 5.0)[b]	5.3 (5.1, 5.6)[c]	3.7 (3.4, 4.0)[a]	5.2 (5.1, 5.4)[b]	4.6 (4.3, 4.9)[a]	4.8 (4.6, 5.0)[a]	5.2 (5.0, 5.4)[b]
Lean meat and alternatives	7.2 (6.8, 7.6)[a]	7.9 (7.7, 8.0)[b]	8.3 (8.2, 8.5)[c]	7.2 (7.0, 7.5)[a]	8.2 (8.1, 8.3)[b]	7.7 (7.5, 7.9)[a]	8.0 (7.8, 8.2)	8.2 (8.0, 8.3)[b]
Dairy foods and alternatives	2.5 (2.2, 2.9)[a]	4.1 (3.9, 4.2)[b]	5.3 (5.1, 5.6)[c]	3.7 (3.4, 4.1)[a]	4.5 (4.3, 4.7)[b]	3.6 (3.3, 3.9)[a]	4.3 (4.0, 4.5)[b]	5.0 (4.8, 5.3)[c]
Fluids	8.1 (7.8, 8.5)[a]	8.7 (8.5, 8.8)[b]	8.9 (8.8, 9.1)[b]	8.6 (8.4, 8.9)	8.7 (8.6, 8.8)	8.4 (8.2, 8.6)[a]	8.8 (8.7, 8.9)[b]	8.9 (8.7, 9.0)[b]
Discretionary foods	5.3 (4.4, 6.2)[a]	3.6 (3.3, 3.9)[b]	1.8 (1.4, 2.1)[c]	3.3 (2.7, 3.8)	3.2 (2.9, 3.4)	4.5 (4.0, 5.0)[a]	3.1 (2.8, 3.4)[b]	2.2 (1.9, 2.6)[c]
Saturated fat	7.7 (7.2, 8.3)	8.4 (8.2, 8.5)	8.4 (8.2, 8.6)	8.1 (7.8, 8.5)	8.4 (8.3, 8.5)	8.2 (7.9, 8.4)	8.4 (8.2, 8.6)	8.4 (8.2, 8.6)
Unsaturated fats	9.2 (8.7, 9.8)[a]	8.1 (7.9, 8.4)[b]	6.6 (6.1, 7.1)[c]	8.5 (8.1, 8.9)[a]	7.5 (7.3, 7.8)[b]	8.6 (8.2, 9.1)[a]	7.8 (7.5, 8.1)[b]	6.9 (6.5, 7.3)[c]
Salt use	6.2 (5.7, 6.7)	6.0 (5.8, 6.2)	6.0 (5.7, 6.3)	5.8 (5.4, 6.2)	6.1 (5.9, 6.3)	6.1 (5.8, 6.4)	6.0 (5.8, 6.2)	5.9 (5.6, 6.2)
Added sugars	7.8 (6.9, 8.6)[a]	7.2 (6.9, 7.6)[a]	6.4 (6.0, 6.8)[b]	6.7 (6.1, 7.3)	7.1 (6.8, 7.4)	7.5 (7.0, 8.0)	7.0 (6.6, 7.5)	6.6 (6.2, 7.0)
Alcohol	9.0 (8.3, 9.7)	9.2 (9.0, 9.4)	9.0 (8.8, 9.3)	8.8 (8.4, 9.2)	9.2 (9.1, 9.4)	9.2 (8.8, 9.5)	9.3 (9.1, 9.5)	8.9 (8.6, 9.2)

[1] Values are weighted means (95% CIs), n = 2402 men and 2840 women. An F-test with Bonferroni correction was used for pairwise comparisons between frequency categories within each eating pattern (EO, meal, and snack frequency). Different superscript letters indicate significant differences between frequency categories within eating patterns, $P <$ 0.01. DGI, Dietary Guidelines Index; EO, eating occasion.
[2] DGI-2013 represents a total diet quality score with a possible range from 0 to 130. Higher scores indicate better overall diet quality.
[3] Values for the DGI-2013 components have a possible score range from 0 to 10. Higher scores indicate better compliance with the Australian Dietary Guidelines.

alternatives. Conversely, a higher EO and snack frequency were inversely associated with DGI-2013 scores for limiting discretionary foods and added sugars (men only). A higher snack frequency was also associated with lower scores for vegetable intakes among men and lower scores for unsaturated fat intakes in women. On the other hand, meal frequency was positively associated with DGI-2013 scores for total cereals, lean meat and alternatives, fluids (men only), and limited alcohol intake.

Discussion

This study examined associations between the frequency of meals, snacks, and all EOs with energy-adjusted nutrient intakes and overall diet quality in a nationally representative sample of Australian adults. To our knowledge, this is one of the few studies among adults to include the frequency of both meals and snacks (not just EO frequency) and to adjust for the effect of energy misreporting when examining the relation between eating patterns and dietary intake (10).

Results from this study suggest that eating patterns are complex and that meals and snacks may have different impacts on dietary intake. For example, in both men and women, meal but not snack frequency was associated with energy-adjusted intakes of protein, fiber, folate, and iron and better overall diet quality, indicated by higher DGI-2013 and component scores for cereals, lean meat and alternatives, and limited alcohol intake.

Few studies, to our knowledge, have examined the separate associations of meals and snacks with diet quality (5). Our findings are consistent with recent research in British adults that found a positive and negative association for meal and snack frequency, respectively, with measures of overall diet quality

TABLE 3 Associations between daily eating patterns and energy-adjusted nutrient intakes among Australian men and women[1]

	Men			Women		
Nutrients	EO frequency	Meal frequency	Snack frequency	EO frequency	Meal frequency	Snack frequency
Carbohydrates, g/d	0.03 (0.02, 0.04)***	0.02 (−0.00, 0.04)	0.01 (0.01, 0.02)***	0.04 (0.02, 0.05)***	0.02 (−0.01, 0.05)	0.02 (0.01, 0.03)**
Total sugars, g/d	0.14 (0.11, 0.16)***	0.04 (−0.01, 0.10)	0.08 (0.06, 0.09)***	0.12 (0.10, 0.14)***	0.00 (−0.05, 0.06)	0.07 (0.05, 0.08)***
Protein, g/d	−0.01 (−0.02, 0.01)	0.04 (0.01, 0.07)**	−0.01 (−0.02, −0.00)*	−0.02 (−0.03, −0.01)**	0.04 (0.01, 0.08)*	−0.02 (−0.03, −0.01)***
Fat, g/d	−0.01 (−0.01, 0.00)	−0.02 (−0.05, 0.01)	0.00 (−0.01, 0.01)	−0.02 (−0.044, −0.01)*	−0.03 (−0.06, 0.00)	−0.00 (−0.01, 0.01)
SFAs, g/d	0.01 (−0.00, 0.03)	−0.03 (−0.07, 0.00)	0.02 (0.00, 0.03)**	−0.00 (−0.02, 0.02)	−0.03 (−0.07, 0.02)	0.01 (−0.01, 0.03)
MUFAs, g/d	0.01 (−0.02, −0.00)*	−0.02 (−0.06, 0.02)	−0.00 (−0.01, 0.01)	−0.03 (−0.05, −0.01)**	−0.03 (−0.06, 0.01)	−0.01 (−0.02, 0.01)
PUFAs, g/d	−0.02 (−0.04, −0.01)	0.04 (−0.02, 0.10)	−0.02 (−0.03, −0.00)*	−0.04 (−0.07, −0.02)**	−0.02 (−0.07, 0.03)	−0.02 (−0.04, 0.00)
Fiber, g/d	0.02 (0.01, 0.04)*	0.12 (0.08, 0.17)***	0.01 (−0.01, 0.02)	0.04 (0.02, 0.05)***	0.11 (0.07, 0.14)***	0.01 (−0.00, 0.02)
Folate, μg/d	0.04 (0.02, 0.06)**	0.14 (0.10, 0.19)***	0.00 (−0.01, 0.02)	0.06 (0.04, 0.08)***	0.16 (0.10, 0.22)***	0.01 (−0.01, 0.02)
Vitamin C, mg/d	0.07 (0.03, 0.11)***	0.09 (−0.02, 0.19)	0.03 (−0.00, 0.07)	0.07 (0.04, 0.11)**	0.15 (0.06, 0.24)**	0.02 (−0.01, 0.04)
β-Carotene, μg/d	0.01 (−0.04, 0.06)	0.15 (0.00, 0.30)*	−0.03 (−0.07, 0.02)	0.00 (−0.05, 0.06)	0.15 (0.03, 0.27)*	−0.00 (−0.04, 0.03)
Calcium, mg/d	0.07 (0.05, 0.09)***	0.06 (0.01, 0.11)*	0.04 (0.02, 0.06)***	0.09 (0.07, 0.11)***	0.10 (0.05, 0.15)***	0.04 (0.02, 0.06)***
Iron, mg/d	0.01 (−0.01, 0.02)	0.12 (0.07, 0.16)***	−0.01 (−0.02, 0.00)	0.02 (0.00, 0.04)*	0.09 (0.04, 0.14)***	−0.00 (−0.02, 0.01)
Iodine, μg/d	0.05 (0.03, 0.07)***	0.07 (0.04, 0.10)***	0.02 (0.00, 0.03)*	0.06 (0.04, 0.07)***	0.08 (0.03, 0.13)**	0.02 (0.01, 0.04)*
Sodium, mg/d	−0.02 (−0.03, 0.00)	−0.01 (−0.05, 0.04)	−0.01 (−0.03, 0.00)	−0.03 (−0.04, −0.01)**	0.04 (0.00, 0.08)*	−0.02 (−0.03, −0.00)*
Potassium, mg/d	0.03 (0.01, 0.04)***	0.05 (0.02, 0.08)**	0.01 (0.00, 0.02)*	0.03 (0.02, 0.04)***	0.05 (0.01, 0.09)*	0.01 (−0.00, 0.02)

[1] Values are β coefficients (95% CIs), $n = 2053$ men and 2270 women. A Wald test of significance was used to adjust for age group, education, income, country of birth, physical activity, total sedentary time, smoking status, alcohol intake, whether currently dieting, whether ate more or less than usual, and the ratio of reported total energy intake to predicted total energy expenditure. Dependent variables are log-transformed nutrient intake data. The format for interpreting the β coefficient estimates is therefore 100 × (coefficient), which corresponds to the percentage change for a 1-unit increase in the eating pattern variable (while holding all other variables constant). $*P < 0.05$, $**P < 0.01$, and $***P < 0.001$. EO, eating occasion.

(10). In the same study, higher meal frequency was associated with higher intakes of vegetables (women only), cereals, and dietary fiber, whereas a higher snack frequency was associated with lower intakes of vegetables, cereals, protein, and dietary fiber but higher intakes of confectionaries.

Another study (13) also reported a positive association between meal frequency and the Canadian Healthy Eating Index (HEI) score among older adults aged 67–84 y, and other studies have reported no association or an inverse association between a snack-dominant eating pattern [e.g., most of EI from snacks (14) or high snack frequency (42)] and micronutrient intakes (42) and overall diet quality (14) compared with a meal-dominant pattern. In obese Swedish men and women, a higher snack frequency was associated with a lower and higher proportion of total EI from protein and fat, respectively, and a higher EI consumption from fatty and sweet discretionary foods (22).

However, not all evidence suggests that meal and snack frequency have opposing effects on diet quality. For example, this study showed that snack frequency was positively associated with calcium intake and DGI-2013 scores for food variety, fruits,

TABLE 4 Associations between daily eating patterns and diet quality scores among Australian men and women[1]

	Men			Women		
	EO frequency	Meal frequency	Snack frequency	EO frequency	Meal frequency	Snack frequency
DGI-2013	1.38 (0.71, 2.05)***	5.60 (3.89, 7.34)***	0.26 (−0.22, 0.75)	1.12 (0.34, 1.90)**	4.11 (2.23, 5.93)***	−0.05 (−0.62, 0.51)
DGI-2013 components						
Food variety	0.27 (0.20, 0.34)***	0.62 (0.44, 0.81)***	0.11 (0.05, 0.18)**	0.23 (0.16, 0.31)***	0.55 (0.39, 0.71)***	0.07 (0.02, 0.14)*
Vegetables	−0.15 (−0.30, 0.01)	0.30 (−0.04, 0.63)	−0.17 (−0.30, −0.04)*	−0.08 (−0.21, 0.05)	0.27 (−0.08, 0.62)	−0.09 (−0.18, 0.01)
Fruit	0.82 (0.64, 1.00)***	1.20 (0.72, 1.68)***	0.42 (0.29, 0.55)***	0.76 (0.59, 0.94)***	0.95 (0.49, 1.40)***	0.32 (0.16, 0.49)***
Grains	0.06 (−0.09, 0.21)	0.52 (0.10, 0.79)**	−0.02 (−0.13, 0.10)	0.08 (−0.08, 0.24)	0.62 (0.30, 0.94)***	−0.03 (−0.14, 0.09)
Lean meat and alternatives	0.11 (−0.02, 0.24)	0.52 (0.22, 0.82)**	−0.01 (−0.11, 0.10)	0.01 (−0.09, 0.11)	0.26 (0.01, 0.52)*	−0.01 (−0.09, 0.07)
Dairy foods and alternatives	0.53 (0.42, 0.65)***	0.35 (0.01, 0.68)*	0.32 (0.20, 0.44)***	0.53 (0.39, 0.67)***	0.42 (0.13, 0.71)**	0.24 (0.12, 0.37)***
Fluids	0.20 (0.08, 0.33)**	0.31 (0.07, 0.54)*	0.10 (−0.01, 0.20)	0.15 (0.06, 0.24)**	0.12 (−0.10, 0.35)	0.03 (−0.07, 0.12)
Discretionary foods	−0.27 (−0.45, −0.08)**	0.47 (0.07, 0.88)*	−0.23 (−0.39, −0.07)**	−0.32 (−0.56, −0.09)**	0.09 (−0.39, 0.58)	−0.23 (−0.42, −0.04)*
Saturated fat	−0.01 (−0.12, 0.14)	0.13 (−0.21, 0.47)	0.04 (−0.07, 0.14)	−0.01 (−0.10, 0.09)	0.02 (−0.25, 0.28)	0.02 (−0.05, 0.09)
Unsaturated fats	−0.01 (−0.13, 0.10)	−0.04 (−0.44, 0.35)	−0.04 (−0.16, 0.08)	−0.34 (−0.61, −0.07)*	−0.13 (−0.66, 0.41)	−0.24 (−0.45, −0.04)*
Salt use	−0.06 (−0.23, 0.11)	0.24 (−0.07, 0.54)	−0.03 (−0.19, 0.12)	0.03 (−0.09, 0.15)	−0.10 (−0.49, 0.28)	−0.08 (−0.20, 0.04)
Added sugars	−0.35 (−0.62, −0.08)*	0.46 (−0.15, 1.08)	−0.26 (−0.47, 0.05)*	−0.27 (−0.53, −0.02)*	0.46 (−0.05, 0.96)	−0.09 (−0.29, 0.11)
Alcohol	0.02 (−0.16, 0.19)	0.65 (0.26, 1.04)**	0.10 (−0.24, 0.05)	0.21 (0.05, 0.36)*	0.43 (0.06, 0.80)*	0.07 (−0.05, 0.20)

[1] Values are β coefficients (95% CIs), $n = 2053$ men and 2270 women. A Wald test of significance was used to adjust for age group, education, income, country of birth, physical activity, total sedentary time, smoking status, alcohol intake, whether currently dieting, whether ate more or less than usual, and ratio of reported total energy intake to predicted total energy expenditure. $*P < 0.05$, $**P < 0.01$, and $***P < 0.001$. DGI, Dietary Guidelines Index; EO, eating occasion.

and dairy and alternatives. Positive associations between snack frequency and HEI scores (17) and intakes of dairy products and micronutrients (e.g., vitamins A, C, and E; magnesium; β-carotene; and potassium) have also been reported in older US adults (43). The conflicting findings for snack frequency may be in part caused by the different approaches across studies used to define a snack as well as different national food consumption patterns (5). This study also examined energy-adjusted nutrients with the use of the residual method, whereas previous research examined nutrient densities (e.g., g/1000 kJ) (10, 22, 42), nutrient intakes as a proportion of total EI (14, 22), or adjusted for overall EI by regression analysis (43). Of these approaches, the residual method is the only one that completely adjusts for the effect of total EI, which may explain some of the variation in findings (20, 44).

Another explanation for the conflicting findings may be that snack patterns are heterogeneous with respect to their nutritional and food profiles. Improving people's snack choices may therefore represent an opportunity for improving overall dietary profiles. In a recent study of US adults that used a cluster analysis approach, Nicklas et al. (45) found 12 distinct snacking patterns with differing food profiles, some healthier than others. Compared with a no-snacks pattern, those with a vegetable or legume, miscellaneous, crackers or salty snacks, or a whole-fruit pattern had substantially higher scores for HEI-2005. In contrast, those with a soft drinks pattern had substantially lower HEI-2005 scores (45). Future research that examines the nutritional and food profiles of different meal and snack patterns and their associations with nutrient intakes and diet quality is therefore needed to better inform population dietary advice in the context of meals and snacks.

A strength of this study is that information on diet quality, nutrient intakes, and eating patterns was based on two 24-h recalls conducted in a large nationally representative sample of adults. This study also examined energy-adjusted nutrients. Because EO frequency and nutrient intakes are both positively associated with total EI, adjusting for EI is required (20). Although this study used an evidence-based approach to define EO (18), there is no consensus on which approach is best to use, and further research with the use of different definitions is warranted (5).

Another strength of this study is that associations between eating patterns, nutrient intakes, and diet quality were adjusted for multiple confounders, including energy misreporting. Energy misreporting may affect how eating patterns are reported because evidence suggests that foods eaten as part of a snack are more likely to be underreported (21, 41). A systematic review also found that approximately one-third of participants in studies with the use of dietary recall methods underreport EI (46). In this study, significant differences in eating patterns, EIs, and DGI-2013 component scores were found between plausible energy reporters and underreporters. This highlights the importance of adjusting for energy misreporting when examining relations between eating patterns, nutrient intakes, and diet quality.

A limitation of this study is that we were not able to assess the day-to-day variability of eating patterns and dietary intakes; more dietary recall days are needed to assess this. Other limitations include the exclusion of participants who were missing information on eating patterns and covariates and the assessment of misreporting that used published equations and assumed a "low-active" PAL to calculate pTEE. Although these equations are validated against measurements of total energy expenditure that used the doubly labeled water method and are shown to be highly accurate (men: $R^2 = 0.82$; women: $R^2 = 0.79$) in Caucasian populations (35), a lack of an objective measure of PA in this study may have led to an over- or underestimation of rEI:pTEE. An objective measure of PA (e.g., accelerometer) is needed to examine energy expenditure more rigorously.

In this cross-sectional study, the frequency of all EOs and meals was positively associated with energy-adjusted nutrient intakes and an index of overall diet quality in a representative sample of Australian men and women. In contrast, findings for associations between snack frequency, energy-adjusted nutrient intakes, and diet quality were mixed; both positive associations (e.g., intakes of calcium and better DGI-2013 scores for fruits and dairy and alternatives) and inverse associations (e.g., better DGI-2013 scores for limited discretionary foods and added sugars) were found.

Overall, the findings suggest that meals are an important determinant of nutrient intake and diet quality. This may in part be due to the structural features of a meal (e.g., routine, presence of others, cultural importance, preparation involved) (47, 48). Snack behaviors, on the other hand, seem to be more variable and may therefore represent a greater opportunity for improving overall dietary profiles. Future studies should consider examining how the nutritional and food profiles of meal and snack patterns influence diet quality to help inform the development of strategies and messages that encourage healthy eating. Relations between eating patterns and health outcomes should also be explored.

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