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Energy misreporting is more prevalent for those of lower socio-economic status and is associated with lower reported intake of discretionary foods

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Abstract

The role of socio-economic status (SES) on the misreporting of food and energy intakes is not well understood with disagreement in the literature. The aim of this study was to examine the associations between low energy reporting, dietary quality and SES in a representative sample of adults. Dietary data were collected using 2 d of 24-h recalls for 6114 adults aged 19 years and over, participating in the Australian National Nutrition and Physical Activity Survey 2011–2012. Low energy reporters (LER) and plausible reporters (PR) were identified. Discretionary food intake was used as a proxy indicator of diet quality. SES was determined using area-level SES and educational attainment. Regression analysis was applied to examine the effects of LER and SES on diet quality, adjusting for potential confounders. LER was more common in populations of lower SES than higher SES (area-level OR 1·46 (95 % CI 1·06, 2·00); education OR 1·64 (95 % CI 1·28, 2·09). LER and SES were independently associated with diet quality, with LER reporting lower percentage energy from discretionary foods compared with PR (27·4 *v.* 34·2, $P < 0·001$), and those of lower area-level SES and education reporting lower diet quality compared with those of higher SES (33·7 *v.* 31·2, $P < 0·001$; and 33·5 *v.* 29·6, $P < 0·001$, respectively). No interaction effect was found between LER and SES, indicating percentage energy in discretionary foods was not differentially misreported across the SES areas (0·3078) or education ($P = 0·7078$). In conclusion, LER and higher SES were associated with better diet quality.

Key words: **Energy misreporting: Reporting bias: Dietary assessment: Socio-economic factors: Diet surveys**

Populations from lower socio-economic status (SES) backgrounds are in the unfortunate position of experiencing greater risk of non-communicable diseases such as depression, type 2 diabetes, CVD and obesity[1–4]. Poorer diet quality, along with other lifestyle factors such as physical inactivity, is key risk factors that cluster in lower SES groups[5]. Measuring dietary patterns of populations from lower socio-economic backgrounds is therefore essential for examining diet–disease relationships and developing effective interventions to improve health. Assessment of diet predominantly relies on self-reported food intake, and the quality of the data collected relies on the accuracy of the reported intake by the participants. Misreporting of food and energy intake (EI), particularly low energy reporting, is a well-documented source of error in dietary assessment[6–9]. If the degree of misreporting in large nutritional surveys is random and evenly distributed within the population and not specific to certain types of foods, it may reduce power but not prove too problematic if sample size is sufficiently large[10]. However, when systematic error is present, associations between nutrition and health can be distorted or misrepresented[10].

The socio-demographic characteristics of misreporting have been frequently described, and greater rates of low energy reporting have recurrently been observed in overweight and obese individuals compared with individuals in the healthy weight range[7,8]. Other correlates of low energy reporting such as sex, smoking status, age, dietary restraint and physical activity have also been described, though less consistently across studies[8,11]. The direction of the effect of SES on reported EI has varied between studies[8], and some studies report that populations of lower SES or education are more likely to misreport[6,9,12,13], while other studies have reported that higher SES is associated with greater misreporting presumably due to greater health or diet consciousness and social desirability bias[14,15].

Given the increasing emphasis on foods and diet quality rather than the effect of single nutrients on health, understanding how diet quality is affected by low energy reporting has become increasingly relevant to nutrition research[16], but little research has been undertaken in this area[17,18]. Some studies indicate that certain foods are disproportionately misreported and those that are perceived to be less healthy, that is energy-dense, nutrient-

Abbreviations: %E, percentage energy; EI, energy intake; LER, low energy reporter; PR, plausible reporter; SES, socio-economic status.

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poor discretionary foods such as cakes or confectionery, are under-reported, while healthier foods such as fruits and vegetables are more accurately reported[12,19]. However, other studies have found that all foods are misreported without discrimination between healthy and unhealthier foods[18,20]. To our knowledge, the effects of misreporting of foods between different SES groups are yet to be investigated.

The aim of this study was to examine the associations between low energy reporting, dietary quality and SES in a representative sample of adults. Specifically, (a) whether low energy reporting is affected by SES, and (b) if diet quality is differentially reported according to low energy reporters (LER) status and SES.

Material and methods

2011–2012 National Nutrition and Physical Activity Survey

Data from the 2011–2012 National Nutrition and Physical Activity Survey were obtained with permission from the Australian Bureau of Statistics. This survey collected detailed self-reported information on the dietary intake and physical activity of over 12 000 adults and children (2 years of age and older) across Australia. The scope of the survey included usual residents of private dwellings in urban and rural areas of Australia, covering approximately 97 % of people living in Australia, using a multi-stage, probability sampling design[21]. Trained Australian Bureau of Statistics interviewers collected information from one adult and one child (where applicable) of each sampled private dwelling, at least one of whom was 18 years or over, by a face-to-face, computer-assisted personal interview and by a computer-assisted telephone interview for the second interview[21]. Interviews were conducted at least 8 d apart, 7 d/week over a 12-month period, and complied with the Census and Statistics Act of 1905[21]. Ethics approval was obtained from the Australian Government Department of Health and Ageing's Departmental Ethics Committee[21]. The response rate for the computer-assisted personal interview was 77·0 % of eligible households, with 63·6 % of these respondents also participating in the subsequent computer-assisted telephone interview to provide a second day of nutrition data[21].

Two 24-h recalls were collected (at computer-assisted personal interview and computer-assisted telephone interview) for adults aged 19 years and over using the Automated Multiple-Pass Method[21]. This is a five-pass method developed by the United States Department of Agriculture and adapted to the Australian food supply that records all food and beverages consumed on the day before the interview. It comprises several techniques to help participants recall their dietary intake, thus reducing the occurrence of under-reporting in nutrition surveys. A Food Model Booklet was provided to assist in the estimation of portion sizes. The AUSNUT 2011–2013 nutrient database, created by Food Standards Australia New Zealand specifically for the survey, was used to convert foods and beverages into energy and food groups[21,22]. Dietary data were averaged across the 2 d of recall to calculate mean estimates of energy and food intakes.

Energy reporting status

Participants were categorised as LER or plausible reporters (PR). The Goldberg method uses the BMR (using the Schofield equations for individuals based on weight, age and sex) and the ratio of reported EI:BMR to estimate the amount of energy available for activity. The EI:BMR ratio is then compared with a physical activity level. As no measure of physical activity level was available, a physical activity level of 1·55 was assumed to indicate the minimum energy requirement for a normally active but sedentary population. Goldberg *et al.* calculated the lower 95 % confidence limit based on 2 d of dietary intake, allowing for day-to-day variation in EI and errors in calculation of EI:BMR, as 0·96. Individuals with reported EI below this cut-off were classified as LER, and those at or above the cut-off were classified PR.

An alternative method of identifying LER was applied using energy prediction equations[23]. This method and results are described in online Supplementary material and provide similar findings as reported with the application of the Goldberg method.

Selection of food types

Foods from the five food groups were included in the analysis: (1) fruit; (2) vegetables; (3) grains and cereals foods (total, refined grains and wholegrains); (4) milk, yogurt, cheese and non-dairy alternatives (total, high fat (>10 %), moderate fat (4–10 %) and low fat (<4 %)) and (5) meat and alternatives (total, red meat, poultry, fish, seafood, eggs, and nuts and seeds). The number of serves of each food group consumed by each participant was calculated using the Australian Health Survey–Australian Dietary Guidelines database, which contains the standard serve sizes of foods in each food group[24].

Intake of discretionary foods, defined as foods and beverages high in added sugars, saturated fat, Na and/or alcohol, was also assessed, with one serve being equivalent to 600 kJ (total; cakes, muffins, cookies and pastries; pizza and burgers; fried potatoes; beer; savoury snack foods and crackers; confectionery and ice cream; sugar; sugar-sweetened beverages; beer; and wine). The proportion of energy derived from discretionary foods as a proportion of total energy (%E from discretionary food) was assessed for each participant and used as an indicator of diet quality.

Socio-economic status and co-variates

SES was defined by area-level and individual level. An area-level index of relative socio-economic disadvantage (SEIFA) was based on postcode for variables such as income, educational attainment, unemployment and dwellings without motor vehicles and represents an average of all people living in an area[25]. Participants were categorised into three groups: low (quintile 1), middle (quintiles 2–4) and high (quintile 5). Individual level SES was represented by educational attainment[26] categorised into three groups: no tertiary education qualification; college or vocational qualification; and university qualification. Weight and height measures were taken to one decimal point, by trained Australian Bureau of Statistics staff during the household interview using digital scales and a portable stadiometer[21].

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Statistical analysis

Collinearity between SEIFA and education was assessed using a correlation matrix in SAS, and no correlation was >0·3 and therefore no high correlations observed. Crude and multiple logistic regression was used to calculate the OR of being classified as a LER for different socio-demographic variables including age group (18–50 years; 51–70 years and 71+ years); sex (male and female); BMI category (underweight <18·5 kg/m^2; normal ≥18·5 kg/m^2 to <25·0 kg/m^2; overweight ≥25·0 to <30·0 kg/m^2; and obese ≥ 30·0 kg/m^2); SEIFA; education; geographic area; whether on a low-energy or weight-loss diet and country of birth.

Multiple linear regression was used to determine the relationship between %E from discretionary food and energy reporting status (LER or PR), SEIFA and educational attainment and adjusted for age (continuous), BMI (continuous), country of birth and whether on a low-energy or weight-loss diet. To determine if there was effect modification between SES and energy reporting status, interaction terms were applied between SEIFA and energy reporting status (LER or PR) and educational attainment and energy reporting status.

Differences in proportions of LER and PR that reported consuming different food groups were determined with Pearson's χ^2 test. Mean differences in per consumer intake and in %E from discretionary food were determined between LER and PR using ANCOVA, adjusted for BMI (continuous), age (continuous), sex, and country of birth, SEIFA and education and differences between groups were assessed with Bonferroni *post hoc* tests. All outcome distributions were checked for normality. All analyses were conducted in SAS® version 9.4: SAS Institute Inc.[27]. To account for selection probability and the clustered survey design, person-specific weights were applied to compute point estimates and replicate weights (the Jackknife group delete one method) were used to compute standard errors[21]. Significant differences were considered as those $P < 0·05$.

Results

Socio-demographics of plausible reporter and low energy reporter

The final sample consisted of those participants who had completed 2 d of dietary recalls and provided height and weight data (*n* 5421). The mean age was 45·9 (SE 0·09) years. About 23·0 % of participants were classified as LER using the Goldberg cut-offs. The socio-demographic characteristics of participants classified as LER and PR and the OR for different socio-demographic variables and LER are shown in Table 1. The characteristics associated with LER were similar in the unadjusted and adjusted multivariate models. The odds of being classified as a LER differed by groups, with participants of lower education attainment being more likely to be classified as a LER than those with university education, in both the crude and adjusted model (Table 1). Being classed as overweight or obese, and being on a low-energy or weight-loss diet were also associated with higher odds of being classified as a LER compared with their counterparts (Table 1).

Differences in percentage energy from discretionary food by energy reporting status

Regression analysis showed that LER, SEIFA and educational attainment were all associated with reported %E from discretionary foods (Table 2). The %E from discretionary foods was lower for LER than PR (27·4 % (26·5–28·4) *v.* 34·2 % (33·7–34·7), $P < 0·0001$). As an indicator of SES, educational attainment showed a slight stronger effect than SEIFA but both indicators showed higher SES was associated with lower %E from discretionary foods. Testing for effect modification using interaction terms (energy reporting status and SEIFA, $P = 0·3078$ or energy reporting status and educational attainment, $P = 0·7078$) revealed no significant effect modification. Fig. 1 demonstrates the same gradient in %E for LER and PR according to educational attainment.

Differences in food intake by energy reporting status

The differences between LER and PR for the mean intake reported by consumers of different foods and the proportion of consumers of different foods are shown in Table 3. LER reported smaller portions of five food group foods and discretionary foods with the exception of fish and seafood, and eggs. Similarly, the proportion of participants reporting consuming foods from the five food groups and discretionary foods was lower for LER compared with PR except for lean meat and alternatives, fish and seafood, legumes and beans, poultry, eggs and low-fat dairy products which were not significantly different (Table 3).

LER tended to report lower intake of five food group foods that may have been perceived to be less healthy; for example, LER reported fewer serves of medium and high fat dairy products than PR and were 38·1 and 29·9 % lower than PR, respectively, compared with low-fat dairy products, which was only 17·4 % lower; red meat serves were reported 25·9 % less by LER compared with PR, whereas the differences in the serves of fish (−1·9 %) and eggs (−8·8 %) were negligible and/or not significantly different (Table 3).

Discussion

In our analysis of a nationally representative nutrition survey, low energy reporting was more prevalent for groups living in lower-SES areas and in those without a university education. Compared with PR, adults classified as LER reported less frequent consumption of all foods (five food group foods and discretionary foods). However, LER reported better diet quality shown by a lower %E from discretionary foods which contributed 26·6 % of energy for LER, compared with 35·4 % for PR. This relationship was not modified by area-level SES or educational attainment, with populations from the lowest-SES backgrounds having poorer diet quality.

Our findings that low energy reporting is more common in groups living in lower-SES areas or with lower educational attainment are largely consistent with other studies that used large, representative samples of the population and collected dietary data with 24-h recalls[7,28–30]. This has been attributed to having fewer skills needed to complete dietary assessments accurately and/or less time invested into diet or health[8].

Table 1. Risk of being a low energy reporter (LER) (*n* 1289) compared with a plausible reporter (PR) (*n* 4132) for different socio-demographic groups in the Australian National Nutrition and Physical Activity Survey 2011–2012*
(Odds ratios and 95 % confidence intervals)

			LER		Crude			Multivariate‡		
Demographics	*n*	%	%	SE	OR	95 % CI	*P*†	OR	95 % CI	*P*†
Age										
18–50 years	2908	53·6	22·1	1·3	1·01	0·76, 1·36		1·32	0·96, 1·80	
51–70 years	1786	32·9	25·2	1·5	1·21	0·89, 1·65		1·25	0·90, 1·73	
71+ years	727	13·4	21·7	2·4	1·00	Ref	0·2314	1·00	Ref	0·2231
Sex										
Male	2571	47·4	22·4	1·2	1·00	Ref		1·00	Ref	
Female	2850	52·6	23·4	1·3	1·05	0·88, 1·26	0·5957	1·10	0·90, 1·36	0·3469
BMI										
Underweight (<18·5 kg/m^2)	78	7·3	7·3	3·6	0·49	0·14, 1·71		0·47	0·14, 1·59	
Normal (≥18·5–25·0 kg/m^2)	1842	34·2	13·9	1·2	1·00	Ref		1·00	Ref	
Overweight (≥25·0–30·0 kg/m^2)	1974	36·6	20·3	1·2	1·58	1·30, 1·93		1·64	1·33, 2·02	
Obese (≥30·0 kg/m^2)	1497	27·8	40·5	2·3	4·22	3·24, 5·51	<0·0001	4·30	3·22, 5·75	<0·0001
SEIFA										
Lowest (quintile 1)	999	18·4	25·2	1·8	1·46	1·06, 2·00		1·21	0·88, 1·68	
Middle (quintiles 2–4)	3113	57·4	23·9	1·3	1·36	1·03, 1·79		1·29	0·99, 1·68	
Highest (quintile 5)	1309	24·1	18·8	1·9	1·00	Ref	0·0542	1·00	Ref	0·1784
Educational attainment										
No tertiary education	2011	37·8	25·0	1·5	1·59	1·29, 1·97		1·64	1·28, 2·09	
Vocational education	1851	34·7	25·4	1·4	1·62	1·30, 2·03		1·60	1·23, 2·07	
University education	1465	27·5	17·3	1·3	1·00	Ref	<0·0001	1·00	Ref	0·0004
Country of birth										
Australia	3850	71·0	22·6	1·2	1·00	Ref		1·00	Ref	
Other English-speaking countries	683	12·6	22·4	2·3	0·99	0·71, 1·38		0·94	0·69, 1·28	
Other	888	16·4	24·7	2·2	1·12	0·87, 1·45	0·6096	1·23	0·93, 1·64	0·2517
Geographic area										
Major cities	3461	63·8	23·5	1·1	0·94	0·68, 1·28		1·21	0·85, 1·72	
Inner regional	1079	19·9	20·3	2·4	0·78	0·53, 1·13		0·83	0·56, 1·23	
Other	881	16·3	24·7	2·6	1·00	Ref	0·3742	1·00	Ref	0·0425
Whether on a weight-loss diet										
No	5068	93·5	21·9	1·0	0·43	0·30, 0·60		0·55	0·38, 0·81	
Yes	353	6·5	39·7	3·9	1·00	Ref	<0·0001	1·00	Ref	0·0030

Ref, reference; SEIFA, socio-economic index for area.
* All estimates are weighted.
† *P* values derived from logistic regression.
‡ Multivariate model adjusted for all variables in column.

Table 2. Linear regression for discretionary food (DF) intake (% energy (%E)) by energy-reporting status for different groups in the Australian National Nutrition and Physical Activity Survey*

	Discretionary food (%E)							
	Model 1		Model 2a		Model 2b		Model 2c	
Demographic	B	*P*	B	*P*	B	*P*	B	*P*
Energy reporting status								
LER	−6·26		−6·85		−6·63		−6·81	
PR	0	<0·0001	0	<0·0001	0	<0·0001	0·00	<0·0001
SEIFA								
Lowest (quintile 1)	2·79		2·38		3·15			
Middle (quintiles 2–3)	1·58		1·25		1·72			
Highest (quintile 5)	0	0·0326	0	0·0499	0	0·0078		
Educational attainment								
No tertiary education	3·71		2·99				3·35	
Vocational education	4·07		3·08				3·37	
University education	0	<0·0001	0	0·001			0	0·0002

LER, low energy reporters; PR, plausible reporters; SEIFA, socio-economic index for area.
* Model 1: univariate model. Model 2a adjusted for age, sex, BMI, country of birth, low-energy or weight-loss diet, energy reporting status, SEIFA and educational attainment. Model 2b adjusted for age, sex, BMI, country of birth, low-energy or weight-loss diet, energy reporting status and educational attainment. Model 2c adjusted for age, sex, BMI, country of birth, low-energy or weight-loss diet, energy reporting status and SEIFA. There was no significant effect modification between energy reporting status and SEIFA (*P* = 0·3078) or educational attainment (*P* = 0·7078), and the interaction terms were removed from the models. All estimates are weighted.

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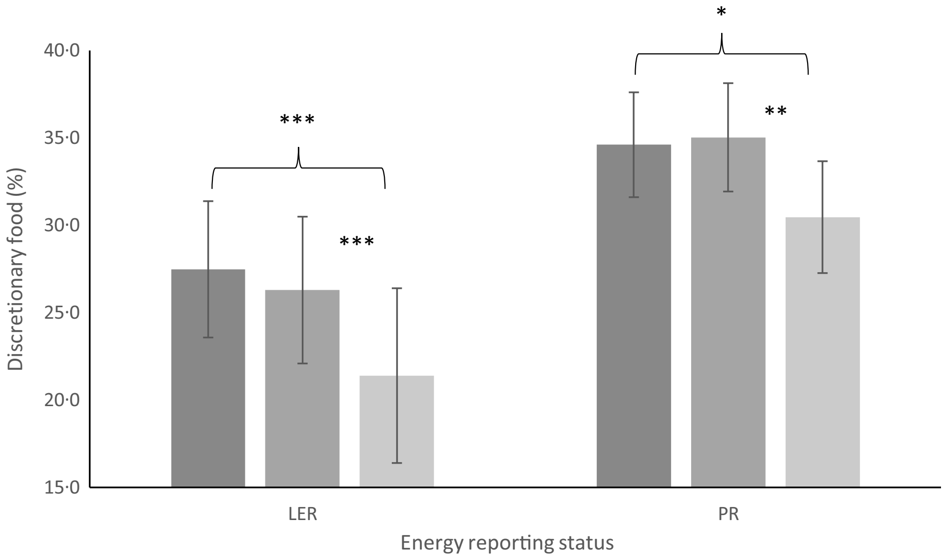

Fig. 1. Percentage energy (%E) from discretionary food by highest tertiary education attainment for plausible reporters (PR) and low energy reporters (LER). Mean differences determined with ANCOVA and Bonferroni *post hoc* tests; means were adjusted for BMI, age, sex, country of birth, low-energy or weight-loss diets and socio-economic index for area (SEIFA). **P* < 0·05, ***P* < 0·01, ****P* < 0·0001. All estimates are weighted. ■, No tertiary education; ■, vocational education; ■, university education.

Table 3. Mean intake of foods and food groups per consumer for plausible reporters (PR) and low energy reporters (LER)
(Mean values and 95 % confidence intervals; proportions and standard errors)

	Mean per consumer						Proportion of consumers				
	LER		PR				LER		PR		
Food and food groups (serves)†	Mean	95 % CI	Mean	95 % CI	*P*‡	%Df§	%	SE	%	SE	*P**
Vegetables and legumes	2·7	2·6, 2·9	3·6	3·5, 3·8	<0·0001	24·3	96·9	1·0	99·3	0·2	<0·0001
Fruit	1·5	1·4, 1·6	2·0	1·9, 2·1	<0·0001	23·0	81·0	1·6	87·2	0·8	0·0003
Milk and alternatives	1·1	1·0, 1·1	1·6	1·6, 1·7	<0·0001	35·3	93·8	1·0	97·7	0·3	<0·0001
Higher-fat dairy products, >10 % fat	0·4	0·4, 0·5	0·6	0·6, 0·7	<0·0001	29·9	36·3	1·7	46·5	1·3	<0·0001
Medium-fat dairy products, 4–10 % fat	0·5	0·4, 0·6	0·8	0·8, 0·9	<0·0001	38·1	50·4	1·8	66·7	1·0	<0·0001
Lower-fat dairy products, <4 % fat	0·7	0·6, 0·8	0·9	0·8, 0·9	<0·0001	17·4	46·5	2·2	46·1	1·3	0·8897
Grains and cereals	3·2	3·0, 3·4	4·8	4·7, 4·9	<0·0001	33·6	98·3	0·6	99·8	0·1	0·0002
Refined grains	2·2	2·0, 2·3	3·1	3·0, 3·3	<0·0001	31·0	78·8	1·8	83·2	0·7	0·0124
Wholegrains	1·6	1·5, 1·7	2·3	2·1, 2·4	<0·0001	28·7	53·7	1·8	67·0	1·2	<0·0001
Meat and alternatives	1·7	1·6, 1·8	2·5	2·4, 2·5	<0·0001	32·4	98·1	0·5	98·9	0·2	0·1491
Red meat	1·0	0·9, 1·1	1·4	1·3, 1·5	<0·0001	25·9	43·3	2·2	53·5	1·3	0·0002
Poultry	0·8	0·7, 0·9	1·1	1·0, 1·2	<0·0001	25·1	36·5	2·5	38·7	1·1	0·4428
Fish and seafood	0·5	0·5, 0·6	0·6	0·5, 0·6	0·7222	1·9	20·8	1·7	21·8	1·0	0·572
Eggs	0·3	0·2, 0·3	0·3	0·3, 0·3	0·0472	8·8	22·2	1·8	27·1	1·0	0·0241
Nuts and seeds	0·4	0·3, 0·5	0·6	0·6, 0·7	<0·0001	33·4	19·2	1·5	27·0	1·0	0·0002
Legumes and beans	0·4	0·3, 0·5	0·5	0·5, 0·6	0·0011	27·1	9·6	1·2	11·8	0·8	0·1445
Discretionary foods	1·9	1·7, 2·4	5·0	4·8, 5·2	<0·0001	61·2	100	0·0	100	0·0	N/A

Df, difference; N/A, not applicable.
* Pearson's χ^2 test. Significant differences were considered at $P < 0.05$.
† One serve of vegetables = 75 g; one serve of fruit = 150 g; one serve of milk and alternatives = 550 kJ; grains and cereals = 500 kJ; meat and alternatives = 500 kJ; one serve of discretionary food = 600 kJ.
‡ ANCOVA for means adjusted for BMI, age, sex, country of birth, low-energy or weight-loss diets and socio-economic index for area (SEIFA).
§ %Df: Percentage difference in number of serves for all foods. All estimates are weighted.

A smaller study that used biomarkers to validate EI found no association between education and misreporting, but cautioned that this may have been due to the limited education range in the sample[31]. Other studies have found that higher SES is associated with greater low energy reporting; in a Canadian study, higher educational attainment was associated with lower EI:BMR ratios[14]. These conflicting results may be due to differences in the dietary assessment method, for example, a FFQ[14] can be prone to over-estimation of the amounts of foods consumed[32]. Greater rates of over-reporting for participants with lower educational attainment have been found in several, but not all, studies that assessed diet with FFQ and it may depend on the specific FFQ used[7,33]. A further study in northern France found a greater prevalence of low energy reporting in 3-d diet diaries in groups of higher socio-professional class[15]. However, a more recent study using 7-d food diaries in a representative sample of the French population found those with the lowest educational attainment misreported to a greater extent than those of higher educational attainment[29]. Overall, these results seem to suggest that lower SES is associated with higher rates of low energy reporting, especially in 24-h recalls, when representative population samples are used.

There was evidence that all foods (healthy and unhealthy) were misreported and both were reported less frequently and smaller amounts by LER. Reasons for misreporting are multi-factorial and can be due to the deliberate misrepresentation of food intake but also due to other errors such as memory lapse and underestimation of portion sizes[8]. Some foods that are recalled during the interview and snacks are more frequently forgotten, which may explain why fruit and nuts were reported by a smaller proportion of LER[34]. Eggs and fish and seafood were not differentially reported between PR and LER, which is consistent with other studies[35] as these foods may be recalled more easily or may be less prone to omission due to social desirability bias.

Whilst all food groups were misreported, the significantly higher degree of under-reporting of discretionary foods suggests some bias towards selective under-reporting. Social desirability is likely to have played a significant role in both the types of foods from the five food groups that were reported, as well as the amounts of discretionary foods[11,36]. For example, there were only small differences in the proportion of LER that reported intake of low-fat dairy products but there were more substantial differences in moderate- and high-fat dairy products between LER and PR. Similarly, the number of serves of wholegrains reported by LER was closer to the number of serves reported by PR, whereas there was a larger difference in the number of serves of refined grains reported. This form of under-reporting is likely an attempt by the participant to avoid disapproval by adhering to what society perceives as 'acceptable dietary behaviour'[36]. These findings are in agreement with previous studies which have found that LER tends to report healthier dietary patterns or lower consumption of discretionary (unhealthy) foods, namely products that are high in added sugar and/or saturated fat, such as biscuits, chips, cakes and confectionery[11,35–38]. Further studies have found that when estimates were adjusted for energy, healthier foods were over-estimated by LER[12,19]. This is consistent with the present results that healthier foods represent a higher proportion of foods reported by LER. However, some studies have found that reported intake of both healthy and unhealthy foods were lower for LER compared with PR, with no apparent bias towards unhealthy foods[18,20,39].

Exclusion of low energy reporter in data analysis

Understanding self-reported dietary intake errors can help to improve the collection of data, and analysis of relationships between nutrition and health. For example, there has been much debate over whether to exclude participants identified as LER when analysing dietary intake data[40,41]. A few studies revealed that the inclusion of LER in their analyses led to weak and/or misleading relationships between obesity and dietary intake, as obese individuals more commonly overeat and under-report foods high in sugar and fat[13,41]. However, if the aim of the study is to obtain information on the food and EI of a nationally representative sample, the exclusion of LER would introduce an alternative source of error – selection bias[40]. This is particularly problematic as low energy reporting is associated with socio-demographic characteristics, including BMI and SES[8]. Future research should include SES as part of their models/analysis when examining dietary associations. Additionally, the excluded LER would include participants who genuinely under-eat for any number of reasons, thus distorting the results. Some participants classified as LER may have genuinely reduced EI and improved their diet quality due to attempted weight loss, and in the present study, 12·3 % of LER reported they were on a low-energy or weight-loss diet compared with 5·1 % of PR. Excluding LER from analysis is therefore likely to over-estimate intake of the population, and some low EI will represent actual intake. It has been recommended to use sensitivity analysis to determine the effect of misreporting and use alternatives to removing participants including adjusting the data analyses for factors linked to low energy reporting or stratifying by LER status, in order to avoid introducing selection bias[40,42]. Adjusting for EI has been shown to improve estimates for macronutrients[40]; however, further research on how this improves estimates for dietary patterns is needed[41].

Limitations and strengths

Two days of 24-h recall were used to assess diet and reported EI which may not reflect usual intake for individuals. As with many self-reported diet measures, measurement errors including social desirability and portion size estimation were not able to be objectively quantified. The Goldberg cut-off used to identify LER in this study is not only able to determine extreme LER[43,44] but has also been validated against doubly-labelled water, the gold standard for total energy expenditure, and shown to be a reasonable approach to characterising low energy reporting for 2 d of recalls[45]. The use of two separate indicators of SES, area-level SEIFA and individual level education, resulting in same results, strengthen the evidence of the association. The findings of the present study may be generalisable to Western populations given the large, nationally representative sample of Australian adults.

Future research would benefit from objectively measuring dietary intake within a variety of free-living settings in order to truly capture what food types and at what times low energy reporting is likely to occur. Recent studies have shown wearable cameras to be a useful, passive measure of dietary assessment, with findings that low energy reporting was most common for snack foods, condiments and beverages[35]. Further evaluation of such technology with larger study populations has the potential to greatly improve the accuracy of dietary assessment.

Conclusions

This study indicates that lower SES is associated with a greater prevalence of low energy reporting. However, there did not appear to be a differential effect of SES on the types of foods that were misreported. Differences in reported food intake were observed between PR and LER and while the amounts and proportions of almost all foods were reported by fewer LER, discretionary foods were disproportionately affected and made a smaller contribution to total energy. These results indicate that

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low energy reporting is likely to over-estimate the diet quality and obscure diet–disease relationships. This will disproportionality effect socio-economically disadvantaged groups and need to be considered when interpreting studies on diet–disease relationships.

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Supplementary material

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