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Prevalence and determinants of misreporting of energy intake among Latin American populations: results from ELANS study

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Underreporting and overreporting of energy intake (EI) have been recognized as potential sources of bias. Dietary data mainly rely on proxy respondents, but little is known about the determinants of misreporting of EI among Latin American (LA) populations. This study was conducted using data from the multicenter Latin American Study of Nutrition and Health that consisted of information about sociodemographics, physical activity, and dietary intake from 9218 individuals aged 15 to 65 years who were living in urban areas in 8 LA countries (Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Peru, and Venezuela). Goldberg methodology was applied to classify the participants into categories of overreporter (OR), plausible reporter (PR), or underreporter (UR) of EI. Associations between

Abbreviations: BMI, body mass index; CI, confidence interval; CV, coefficient of variation; EE, energy expenditure; EI, energy intake; ELANS, Estudio Latinoamericano de Nutrición y Salud/Latin American Study of Nutrition and Health; HELENA, Healthy Lifestyle in Europe by Nutrition in Adolescents; LA, Latin American; NHANES, National Health and Nutrition Examination Survey; OR, overreporter; PAL, physical activity level; PR, plausible reporter; SEL, socioeconomic level; TEE, total energy expenditure; UR, under reporter; 24HR, 24-hour dietary recall.

A full list of the ELANS study group members is available at the end of the article.

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1. Introduction

The reliability of the assessment of dietary intake can be affected by several factors. One of the main sources of error is misreporting, characterized by implausible energy intake (EI), which encompasses both underreporting and overreporting [1,2]. Misreporting has been identified worldwide [3-6] and is highly prevalent (around 30% of the sample) independently of the method used (24-hour recall, estimated, or weighed food record) for data collection [1]. Underreporting of food intake is more frequently observed in epidemiological studies, especially in developed countries, and it is more common in middle-aged participants [7-9] and is strongly determined by sex and body mass index (BMI), which is particularly problematic for studies focused on associations between diet and obesity [10]. Overreporting is equally concerning and is also determined by several factors, being more common in younger subjects of normal to low BMI [7,8,11].

Different methods for identifying misreporters have been proposed. Several studies have found that excluding implausible reporters through the use of such methods affects the magnitude and/or direction of diet-health relations, especially the association between obesity and fat, sugar, and fiber consumption [1,12-14]. For that reason, intentional dietary misreporting represents a major task in studies that monitor dietary intake at the population level [15].

We hypothesized that sociodemographic indicators, physical activity, and nutritional status are factors potentially associated with the prevalence of underreporting and overreporting of energy intake. Therefore, the objectives of the present study were to estimate the prevalence of underreporting and overreporting of energy intake among LA populations and to evaluate the factors associated with misreporting of EI by country and for the overall population.

2. Methods and materials

2.1. Participants

The Latin American Study of Nutrition and Health/*Estudio Latinoamericano de Nutrición y Salud* (ELANS) is a multicenter household and cross-sectional survey. ELANS aims to assess food and beverage intake, nutritional status, and physical activity in a nationally representative sample of 8 Latin American (LA) countries (Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Peru, and Venezuela). Roughly 80% to 90% of the population in these countries reside in urban areas, and our study participants were from these urban regions only. This regional focus provided homogeneous samples that are preferred because they typically provide a stronger test of a theory. Of 10 134 eligible participants who were initially assessed in the first visit, 9680 participants had 2 complete visits, and 9218 participants satisfied the analysis of inconsistencies or partially missing data (Fig. 1). The sampling size was calculated with a confidence level of 95% and a maximum error of 3.49%. A survey design effect of 1.75 was estimated based on guidance from the US National Center for Health Statistics. The minimum sample sizes required per strata (socioeconomic status, age group, and sex) was performed for each country. The complete design, protocol, and methodology of ELANS have been described elsewhere [16]. However, in the next sections, dietary intake and physical activity level (PAL) data are detailed.

2.2. Dietary assessment

Dietary data were obtained using 2 nonconsecutive 24-hour dietary recall (24HR) sessions following the multiple pass method [17], which provided detailed information of all food and beverages, including water and alcoholic beverages, recipes, and supplements, consumed over the 24 hours prior to the interview. Reported intakes were quantified in household measures using a photographic album containing the most common household utensils and size portions adapted to each country. This information was transformed into grams and milliliters of food by trained nutritionists and then analyzed using the Nutrition Data System for Research software, version 2012 (Minnesota University, MN, USA). The software is based on the US Department of Agriculture composition table, so local foods were matched with US Department of Agriculture food using a standardized procedure described in detail elsewhere [18]. The software transformed the grams and milliliters of each food or recipe into energy, macronutrients, and micronutrients.

2.3. Nutritional status

Anthropometric measurements of body weight; height; and waist, hip, and neck circumferences were obtained according to standardized procedures [18]. Among the adolescents (15-19 years old), nutritional status was assessed according to age and sex using the cutoff points from the World Health Organization [19] for BMI-for-age in which the adolescents were classified as underweight (BMI for age < –2 SD), normal weight (–2 SD ≥ BMI for age ≤ 1 SD), overweight (1 SD > BMI for age ≤ 2 SD), and obese (BMI for age > 2 SD) categories. The BMI of adults and the elderly (older than 19 years) was categorized as underweight (<18.5 kg/m^2), normal weight (18.5-24.9 kg/m^2), overweight (25-29.9 kg/m^2), and obese (≥30.0 kg/m^2) [20].

2.4. Physical activity

An adapted version of the Mexican International Physical Activity Questionnaire–long was used to assess the levels of physical activity as well as the sedentary habits of all participants of the ELANS. More details are available in a

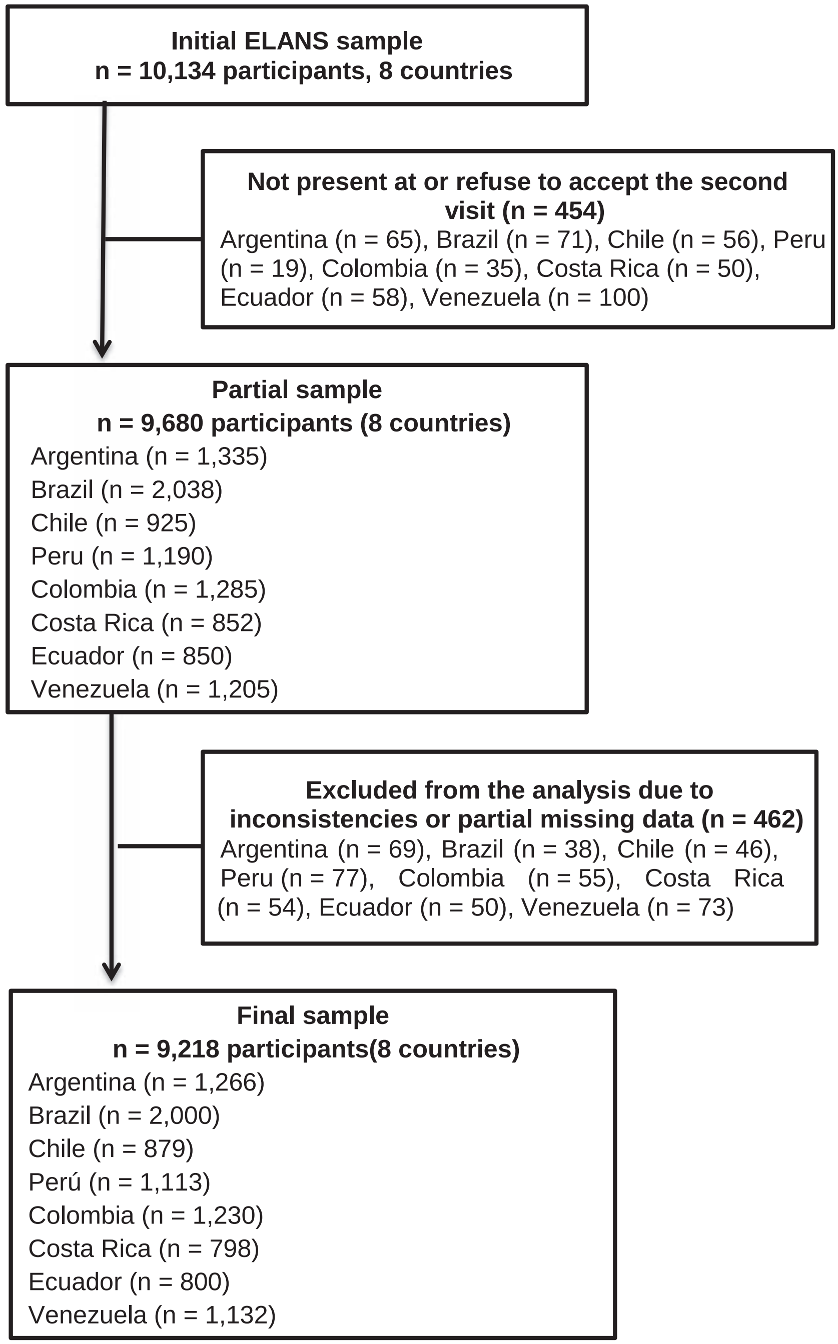

Fig. 1 – Flow diagram of the study participants.

previous publication [16]. In the present study, the information collected by the International Physical Activity Questionnaire was used to predict the total energy expenditure (TEE) in physical activities for each participant. The TEE was estimated from their age, height, weight, and overall activity level using a predictive equation developed by the Institute of Medicine [21,22]. Briefly, the level of activity for each participant was calculated as a function of the participant's basal energy expenditure (EE) and body weight and the duration and metabolic equivalent task score of each activity. The ΔPAL for each participant was determined by adding up all individual PALs reported. Finally, the TEE was predicted based on Dietary Reference Intakes equations and then used to identify the misreporters of EI, as described below. It should be highlighted that this approach has been used before, including population-based ones such as the National Health and Nutrition Examination Survey (NHANES) [23].

2.5. *Misreporting of energy intake*

In 1991, Goldberg et al [24] suggested the first approach that aimed to identify plausible reporter (PR), as well as underreporter (UR) and overreporter (OR). This methodology estimated a confidence interval (CI) for PAL that was

Table 1 – Coefficients of variation for energy intake for ELANS population and according to age group, sex and country [a]

	Overall (15-65 y old)			15-19 y old			20-34 y old			35-49 y old			50-65 y old		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
Argentina	32.87	32.70	33.01	36.05	35.10	37.41	31.36	31.68	31.09	33.97	33.50	34.31	31.90	31.31	32.30
Brazil	32.94	33.48	32.46	35.53	36.34	34.28	32.87	33.78	31.96	33.35	33.86	32.89	30.89	29.00	31.95
Chile	30.46	29.94	30.95	31.57	30.68	32.53	31.84	30.75	32.91	28.27	28.43	28.13	30.30	29.89	30.65
Colombia	32.40	32.54	32.26	32.37	32.40	32.34	32.56	32.52	32.60	30.52	28.40	32.38	34.15	36.89	31.63
Costa Rica	33.56	33.84	33.28	34.18	31.76	36.89	33.11	33.66	32.49	33.35	35.21	31.36	34.23	33.88	34.43
Ecuador	30.66	30.90	30.43	28.08	27.07	29.33	32.10	32.60	31.55	29.23	30.40	28.12	31.85	31.34	32.20
Peru	26.18	26.47	25.93	26.60	27.92	24.93	25.65	26.60	24.80	27.22	25.43	28.65	25.47	26.17	24.92
Venezuela	28.51	27.59	29.37	26.86	26.97	26.73	28.53	26.14	30.71	30.17	31.32	29.01	27.03	24.59	28.71
ELANS	31.21 [a]	29.92	32.56	31.82	31.75	31.91	31.07	31.19	30.95	31.27	31.32	31.22	30.99	30.81	31.11

[a] Coefficients of variation for energy intake used to assess the energy reporting status.

based on 3 coefficients of variation (CVs): EI (CV_{WEI}), basal metabolic rate (CV_{WEI}), and PAL (CV_{WPAL}) of their population. Since that time, several procedures for identifying misreporting of EI have been used around the world, some of them based on CIs, ratios between EI and TEE, and cutoffs. In the present study, misreporting of EI was calculated based on the methodology used by McCrory et al [25], according to the following equation:

$$SD = \sqrt{\frac{CV^2 wEI}{d} + CV^2 wpTEE + CV^2 pTEE}$$

In the above equation, CV_{WEI} is the within-subject CV in EI over the number of days of diet assessment (d), CV_{wpTEE} is the CV measuring the TEE by the doubly labeled water method, and CV_{pTEE} is the CV for predicting the TEE. In the present study, the CV_{WEI} (31.2%) was estimated based on both 24HRs, so the number of days (d) was 2. To verify whether there are differences not only between the countries but also between age groups and sex, the CV_{WEI} was estimated for the total population as well as for each country, according to age group and sex (Table 1). CV_{wpTEE} was set to 8.2%, as estimated from doubly labeled water measurements [26], and CV_{pTEE} was 17.7%, as estimated from predicted equations of TEE [27].

The SD was calculated according to the equation above. Misreporting was estimated based on a cutoff of ±1.5 SD for reported energy intake (on the first 24HR) and the predicted TEE (EI/TEE). To calculate the relation EI/TEE, only the EI reported on the first 24HR was used in this approach [28,29]. Therefore, underreporting was defined as <−1.5 SD and overreporting as >+1.5 SD.

2.6. Sociodemographics

A sociodemographic questionnaire was applied to collect information about sex (male and female); age group (adolescents [15-19 years old], younger adults [20-34 years], adults [35-49 years] and older adults [50-65 years]); marital status (single, married or living with a partner, widowed, or divorced); socioeconomic status (low, medium, or high); education level (none, basic, secondary, or higher); and race/ethnicity (white, nonwhite, or no answer).

2.7. Ethics

The ELANS protocol was approved by the Western Institutional Review Board (#20140605) and registered at Clinical Trials (#NCT02226627). It was also approved by a local ethics committee at country level. All participants gave their informed consent before participating in the survey.

2.8. Statistical analyses

Odds ratio, P value, and 95% CI for the risk of being classified as an UR of EI, compared with being a PR, an OR, or an acceptable reporter, were estimated using logistic regression (Table 2). For continuous variables, the Kruskal-Wallis test demonstrated differences among the 3 groups of energy report classification and the consumption of total EI, macronutrients (as a percentage of energy), and anthropometric measures (Table 3). To evaluate the impact of using the energy report classification on the relation between EI and its associated factors, 2 multiple linear regression models were developed: in model 1, the energy report classification variable was not included in the analysis, and in model 2, it was (Table 4). All analyses were carried out using SPSS software (version 22.0; SPSS Inc, Chicago, IL, USA). $P < .05$ was considered statistically significant.

3. Results

The study population (N = 9218) was classified as URs, PRs, and ORs of EI in which the percentages were 12.10%, 73.82%, and 14.08%, respectively. Table 2 shows the odds ratios, P values, and 95% CIs for the risk of being an UR or OR compared with a PR, according to sociodemographic characteristics, PAL, and nutritional status. A higher risk of being an UR was associated with female sex, Ecuadorians (compared with Peruvians), being overweight or obese, and being older ($P < .05$). On the other hand, a lower risk of being an UR was associated with more years of education (compared with no education), nonwhite (compared with white), Colombians and Costa Ricans (compared with Peru), and insufficient activity ($P < .05$).

A higher risk of being an OR compared with a PR was associated with being single, of low economic level (compared with high), being nonwhite (compared with white),

Table 2 – Proportion and risk of being a misreporter of energy intake

Characteristic	PR, n (%)	UR, n (%)	OR1	95% CI	OR, n (%)	OR2	95% CI
Total sample (N = 9218)	**6805 (73.82)**	**1115 (12.09)**			**1298 (14.08)**		
Sex							
Male	3293 (74.69)	499 (11.32)	1.00		617 (13.99)	1.00	
Female	3512 (73.03)	616 (12.81)	1.16 *	1.02-1.31	681 (14.16)	1.03	0.92-1.17
Age by group, y							
15-19	858 (70.16)	108 (8.83)	1.00		257 (21.01)	1.00	
20-34	2555 (73.44)	417 (11.99)	1.30 *	1.04-1.62	507 (14.57)	0.66 **	0.56-0.78
35-49	1970 (74.99)	344 (13.09)	1.39 *	1.10-1.75	313 (11.91)	0.53 **	0.44-0.64
50-65	1422 (75.28)	246 (13.02)	1.38 *	1.08-1.75	221 (11.7)	0.52 **	0.43-0.63
Marital status							
Single	2809 (71.8)	471 (12.04)	1.00		632 (16.16)	1.00	
Marriage or living with a partner	3316 (75.48)	520 (11.84)	0.94	0.82-1.07	557 (12.68)	0.75 **	0.66-0.85
Widowed	174 (74.04)	37 (15.74)	1.27	0.88-1.83	24 (10.21)	0.61 *	0.40-0.95
Divorce	506 (74.63)	87 (12.83)	1.03	0.80-1.31	85 (12.54)	0.75 *	0.58-0.95
SEL							
High	673 (76.48)	100 (11.36)	1.00		107 (12.16)	1.00	
Middle	2616 (73.86)	452 (12.76)	1.16	0.92-1.47	474 (13.38)	1.14	0.91-1.43
Low	3516 (73.31)	563 (11.74)	1.08	0.86-1.35	717 (14.95)	1.28 *	1.03-1.60
Educational level							
None	74 (69.16)	22 (20.56)	1.00		11 (10.28)	1.00	
Basic education	4002 (72.29)	717 (12.95)	0.60 *	0.37-0.98	817 (14.76)	1.37	0.73-2.60
Secondary education	2064 (76.53)	277 (10.27)	0.45 **	0.28-0.74	356 (13.20)	1.16	0.61-2.21
Higher education	665 (75.74)	99 (11.28)	0.50 *	0.30-0.84	114 (12.98)	1.15	0.59-2.24
Race/ethnicity							
White	2365 (73.54)	459 (14.27)	1.00		392 (12.19)	1.00	
Nonwhite	4023 (74.14)	582 (10.73)	0.75 **	0.65-0.85	821 (15.13)	1.23 **	1.08-1.40
Do not answer	417 (72.40)	74 (12.85)	0.91	0.70-1.19	85 (14.76)	1.23	0.95-1.59
Physical activity							
Physically active	3357 (72.41)	589 (12.70)	1.00		690 (14.88)	1.00	
Insufficiently active	3164 (75.41)	476 (11.34)	0.86 *	0.75-0.98	556 (13.25)	0.85 *	0.76-0.97
Nutritional status							
Normal weight	2543 (74.36)	235 (6.87)	1.00		642 (18.77)	1.00	
Underweight	184 (60.13)	13 (4.25)	0.76	0.43-1.36	109 (35.62)	2.35 **	1.82-3.02
Over weight	2388 (75.40)	422 (13.32)	1.91 **	1.61-2.26	357 (11.27)	0.59 **	0.51-0.68
Obese	1690 (73.00)	445 (19.22)	2.85 **	2.40-3.38	180 (7.78)	0.42 **	0.35-0.50
Country							
Peru	905 (81.31)	79 (7.10)	1.00		129 (11.59)	1.00	
Argentina	925 (73.06)	166 (13.11)	1.04	0.80-1.37	175 (13.82)	0.87	0.68-1.12
Brazil	1486 (74.30)	256 (12.80)	1.00	0.78-1.29	258 (12.90)	0.80	0.63-1.01
Chile	643 (73.15)	115 (13.08)	1.04	0.78-1.39	121 (13.77)	0.87	0.66-1.14
Colombia	885 (71.95)	70 (5.69)	0.51 **	0.37-0.69	275 (22.36)	0.66 **	0.50-0.86
Costa Rica	545 (68.30)	195 (24.44)	0.46 **	0.33-0.64	58 (7.27)	1.43 **	1.13-1.81
Ecuador	576 (72.00)	99 (12.38)	2.08 **	1.59-2.72	125 (15.63)	0.49 **	0.35-0.68
Venezuela	840 (74.20)	135 (11.93)	0.94	0.71-1.24	157 (13.87)	0.86	0.67-1.11

OR1: odds ratio PR vs UR.
OR2: odds ratio PR vs OR.
* $P < .01$.
** $P < .05$.

underweight (compared with normal weight), and Costa Rican (compared with Peruvian) ($P < .05$). On the other hand, a lower risk of being an OR was associated with being overweight or obese (compared with normal weight), Colombians and Ecuadorians (compared with Peruvians), and older ($P < .05$)

As shown in Table 3, UR had significantly higher weight, waist circumference, neck circumference, and BMI ($P < .001$) than OR and PR. As expected, UR consumed less energy. In relation to the dietary variables, UR had less total EI and fewer energy coming from fats and more from protein. The opposite scenario was found for OR who had higher fat intake (% kcal), lower protein (% kcal), and total energy. Carbohydrate (% kcal) did not differ among the 3 groups.

Multiple linear regression models were used to study the factors associated with EI (Table 4). In the first model, in which the energy reporting status was not considered, total EI was significantly lower among older females who were insufficiently active and had excess weight ($P < .05$). In the second model, the multiple linear regression was adjusted for energy reporting status (classified as URs, PRs, or ORs). The result was similar to model 1, with the exception of the nutritional status. As expected, in model 2, daily EI was higher among those participants with excess weight (BMI >25).

4. Discussion

The objectives of the present study were to estimate the prevalence of UR and OR of EI among LA populations and to evaluate the associated factors with misreporting of EI by country and for the overall population. Several large population surveys have assessed misreporting of EI [2,11,30] and its correlations with sociodemographic and nutritional variables. To our knowledge, however, this is the first study assessing misreporting of EI and associated factors in a large, multicultural LA sample. We accept our working hypothesis that sociodemographic characteristics, PAL, and nutritional status are factors potentially associated with the prevalence of UR and OR of EI. In brief, we found UR to be significantly more frequent in females; older groups; those with no education; and those who are white, physically active, overweight or obese, and living in Costa Rica. On the other hand, the percentage of OR is higher in younger groups; single individuals; and those who are of lower socioeconomic level (SEL), nonwhite, physically active, under or at normal weight, and living in Colombia.

It has been previously postulated in the literature that no matter the effort to assure data accuracy, participants are expected to report a misperception of their food and beverage intake for different reasons, including forgetfulness, social desirability, self-image dissatisfaction, or fear of being negatively judged, among others [31].

In the current study, it was found that 26.17% of the respondents reported an implausible EI (12.09% UR and 14.08% OR) based on their BMI, whereas Murakami and Livingstone [11], using data from the NHANES 2003-2012 (n = 19 693 adults), reported a 25.5% UR and 1.4% OR in US population. Other studies have observed a high prevalence of misreporting. Lutomski et al [31] (n = 7521 Irish adults) found a prevalence of 33% of UR and 12% of OR; the Canadian Community Health Survey (n = 16 190, 12 years and older) reported the same prevalence of UR (33%) and 10% of OR; and the Healthy Lifestyle in Europe by Nutrition in Adolescents (HELENA) study (n = 1512 adolescents) found 33% of UR and 15.6% of OR [30]. The little variation on prevalence of misreporting among studies could be explained by the use of different methodologies to assess dietary intake or by the criteria used to estimate cutoff values to evaluate misreporting, besides the inner characteristics of the population under study.

Results from other studies are consistent with our findings, according to sex [7,10,11]. Studies have reported a higher prevalence of UR of EI among women, for example, the Korean National Health Study [33] (n = 15 133 adults) reported that 23% of women and 14.4% of men were UR. In the case of adolescents, the HELENA study cited earlier reported that the percentage of UR was higher for girls (35.7%) than for boys (30.4%) [30]. Our findings are consistent with this tendency: women tend to UR 16% more than do men. According to Scagliusi et al [34], this behavior may reflect social desirability, which is a person's tendency to provide the most socially desirable response to keep pace with perceived cultural norms regardless of its being true or not [34]. It has been found that people, especially women, who score higher on the social desirability scale are more likely to underreport fat intake and total EI [35-37].

The inverse association between increasing age and PR has been consistently demonstrated [6,8,38,39]. Using the NHANES data, Murakami and Livingstone [11] reported that older age was associated with UR of EI, while young people are more likely to engage in OR. Among adults, the Korean National Health Study reported that it was middle-aged people who underreport the most [33].

Misreporting is frequently found in younger populations [39-44]. A longitudinal study performed with only girls measured EI and EE at ages 10, 12, and 15 years. The results showed that, as they aged, subjects reported their EI less accurately. The average accuracy dropped from 88% when the girls were 10 years old to 68% when the girls were 15 years old. It is important to note that, in this particular study, this behavior was independent of BMI [40]. Adolescents, despite being more capable to report their own dietary intake, are usually less motivated and cooperative than younger children, which decreases their compliance and increases reporting errors [41,42]. Also, teenagers eat outside of the home more frequently than their younger peers, and this adds a factor of not knowing all the ingredients and portion sizes of their meals [39].

The tendency of misreporting in adolescents, however, is not consistent throughout the literature. For example, the HELENA study [30] showed no association with age and misreporting, whereas a study with Slovenian adolescents showed that this age group is more likely to UR [42]. Similar results were seen among a young population in the United States, but it was dependent on BMI [43]. African American preadolescents, according to Hare et al [44], are also more likely to UR when they have a higher BMI. In Japanese children, UR was observed with an older age (15-year-olds) [8]. In our study, adolescents UR less frequently than adults and showed the highest percentage of OR. This may be due to cultural differences because other studies mentioned earlier were not performed in LA; however, further investigations are needed to confirm the reasons for the variability of results with this specific younger population.

Marital status is an important demographic variable that can determine misreporting because it often describes living arrangement. Living alone, for example, has been associated with a higher tendency of misreporting [33,45]. By contrast, married individuals tend to report their EI more accurately because their living arrangement is usually more stable and their meal patterns more consistent and therefore easier to report [46]. In concordance with the literature, in the present study, single individuals OR more than any other living arrangement category.

Previous studies have reported socioeconomic status and educational level as determinants of misreporting [1]. Although the existing literature is inconclusive, some studies reported no significant association [38,44,46,47], whereas others reported a positive association with either low [8] or higher education levels [48]. In our study, we found a higher risk of being UR among those with a lower educational level and a higher risk of being OR in individuals with low SEL. It has been observed that poor literacy skills might account for

Table 3 – Anthropometric measurements and energy and macronutrients, according to energy reporting status [a]

	All participants	URs	PRs	ORs	
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	P[a]
Anthropometric measurements					
Body weight (kg)	71.77 ± 16.36	79.15 ± 18.05	71.78 ± 15.89	65.35 ± 14.41	<.001
Waist circumference (cm)	88.26 ± 14.31	94.32 ± 14.62	88.27 ± 14.04	82.94 ± 13.29	<.001
Neck circumference (cm)	35.61 ± 4.07	36.69 ± 4.32	35.61 ± 4.02	34.67 ± 3.92	<.001
BMI (kg/m^2)	26.91 ± 5.61	29.52 ± 6.17	26.9 ± 5.44	24.68 ± 5.01	<.001
Energy and macronutrients intake					
Total energy (kcal)	8339.26 ± 2598,14	5570.16 ± 1428.63	8177.38 ± 2003.84	11566.63 ± 2828.34	<.001
Fat (% kcal)	29.62 ± 5.78	29.13 ± 5.72	29.51 ± 5.72	30.63 ± 6.03	<.001
Protein (% kcal)	16.03 ± 3.01	16.98 ± 3.5	16.07 ± 2.95	14.99 ± 2.52	<.001
Carbohydrate (% kcal)	54.35 ± 7	53.89 ± 7.45	54.42 ± 6.93	54.38 ± 6.97	.202

[a] Kruskal-Wallis test.

the higher misreporting in less-educated groups. However, several studies have indicated an association of misreporting, mainly as UR, with higher educational level, potentially due to higher awareness for socially desirable responding that may also be associated with high socioeconomic status [1,30]. It should be mentioned that, usually, educational level has been related to SEL; however, this analysis was not performed in the current study.

We observed higher UR and lower OR among whites when compared to nonwhites. These results are consistent with those found in the US population [11] and in older African Americans [48]. It has been proposed that this could be related to a more relaxed attitude toward body weight, which would account for a lower incidence of misreporting. However, other studies did not find differences in UR among ethnic groups [49].

Our study shows that there were more UR and OR among physically active subjects than insufficiently active individuals. The literature is still weak about the effect of PAL on the risk of both OR and UR of EI. Perhaps, it could be more important to evaluate the type of activity (low, moderate, and high) as well as time spent being sedentary. Also, self-reported physical activity tends to have errors; therefore, misreporting of both EI and EE should also be taken into consideration in nutrition surveys [35,50]. Macdiarmid and Blundell [15] state that self-reported estimates of physical activity have little or no relationship with underreporting of EI; however, other studies have demonstrated otherwise [31,44]. A study conducted with African American girls, where physical activity was assessed by an accelerometer, showed that the PRs had significantly higher levels of moderate to vigorous physical activity and higher average total activity counts per minute [44]. On the other hand, in our study, more misreporting (either UR or OR) was found among self-reported physically active than among insufficiently active participants.

It has been reported in the literature that the UR of EI is more common among obese or overweight people than among those of normal weight and that OR is more common among underweight participants [11,32,33,51,52]. In our study, the probability of UR increased with overweight and obese subjects, and on the contrary, underweight subjects showed a higher probability of OR, which is consistent with previous studies. As pointed out by other authors [1,29], this could be explained by social desirability bias, a denial or poor ability to report dietary intake, or a tendency to provide socially desirable answers.

Inaccurate reporting of EI also affects the macronutrients distribution in the diet [30,53]. We found a higher contribution of proteins (%EI) and lower energy coming from fats among UR compared with PR and OR, as described by Lafay et al [54] and Tomoyasu et al [55]. On the contrary, we found more energy coming from fat and fewer from carbohydrates among OR. The literature has been inconsistent regarding carbohydrates; some studies show significantly higher, and others significantly lower, contribution to EI coming from this macronutrient, whereas others found no statistically significant differences among UR, PR, and OR [1]. We did not find differences in carbohydrate intake when comparing UR with PR.

In brief, the prevalence of UR was higher among older females with no education, who are white, physically active, overweight or obese, and living in Costa Rica. On the other hand, the prevalence of OR was higher among younger, single, low-SEL, nonwhites, who were physically active, underweight or at normal weight, and living in Colombia.

Jessri et al [2] evaluated different methods to handle misreporting in obesity research, concluding that the adjustment for reporting status maintained the statistical power and shifted the association of dietary exposures with obesity to the expected direction. The same scenario was found in our study: when we included the energy report status in the linear model, we observed a positive and significant association between EI and excess weight that was not observed without this adjustment. In addition, this way to handle misreporting allowed for retaining the whole sample in the study without introducing any more bias.

Table 4 – Association between energy intake (kcal) and covariates with and without adjusting by energy reporting status *a, **b

	Model 1[a]				Model 2[b]			
	Univariate		Multivariate		Univariate		Multivariate	
	β	P	β	P	β	P	β	P
Sex								
Male	Reference		Reference		Reference		Reference	
Female	−433.40	<.001	−406.39	<.001	−425.70	<.001	−409.54	<.001
Age, y								
	−8.51	<.001	−6.33	<.001	−6.56	<.001	−5.79	<.001
SEL								
High	Reference		Reference		Reference		Reference	
Middle	−32.93	.159	−34.38	.118	−34.15	.068	−27.92	.100
Low	−37.59	.099	−20.65	.334	−57.90	.002	−35.07	.034
Physical activity								
Insufficiently active	Reference		Reference		Reference		Reference	
Physically active	116.07	<.001	63.23	<.001	111.38	<.001	64.67	<.001
Excess weight								
No	Reference		Reference		Reference		Reference	
Yes	−164.619	<.001	−80.50	<.001	−24.14	.025	56.34	<.001

[a] Model 1: linear regression model excluding the energy intake classification (plausible, overreporting, or underreporting).
[b] Model 2: linear regression model adjusted for energy intake classification (plausible, overreporting, or underreporting).

Like many nutritional surveys, ELANS was subject to misreporting. Identifying the characteristics associated with misreporting and having a mitigation strategy are important. This study contributes to improving our understanding of which factors should be considered when looking at the relationship between EI and nutritional status. The main strength of this study is the sample size, including a national representative sample of 8 LA countries, which enables a detailed analysis of the misreporting of EI.

The current study has several limitations. First, EE was analyzed by a self-reported physical activity questionnaire; therefore, the questionnaire was validated for LA populations [56]. Second, the 24HR dietary recall depends on participants' memory; however, they were obtained following the multiple pass method [17], and to assist the participant in specifying and quantifying foods in household measures, photographic albums (tailored to each country) containing the most common household utensils and size portions were used. Third, it is important to mention that the methodology used in this study did not allow for distinguishing between underreporters from undereaters and overreporters from overeaters.

Future analysis of the ELANS database will be conducted using the energy reporting group of EI as an adjusted variable to improve the ability to estimate population intake and associated factors to support evidence-based public policies in LA populations.

Misreporting is a common error in nutritional surveys, and it responds to several demographic, cultural, and individual factors. The results of the present study highlighted the importance of identifying and characterizing misreporting of EI in a survey database to attenuate or reverse the effect of this bias on the relationship between dietary intake and associated factors. The accuracy of dietary intake reporting is vital because misreporting may alter the epidemiological association of diet-associated diseases and their determinants, which can affect nutritional interventions and public health policies. It is important in every nutritional survey to assess EE to improve the identification of potentially biased findings on energy reporting.

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