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DIETARY INTAKE MISREPORT: WHAT WE KNOW

PLAUSIBILIDADE DAS DECLARAÇÕES DE CONSUMO ALIMENTAR: O QUE SABEMOS

A.R.
ARTIGO DE REVISÃO

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ABSTRACT
Nutritional epidemiological studies are essential to the development of appropriate public health programs and food policies. However, the relation between nutrient intake and health outcomes might be affected by dietary intake misreport. The purpose of this study was to review the phenomenon of dietary intake misreport, including the existing evaluation methods, its implications, its prevalence and its associated factors. A bibliographic research was carried out. The reference method for studying dietary misreport is Doubly Labelled Water, by comparison of reported energy intake with total energy expenditure. Since it presents limitations of use in large epidemiological studies, alternative methods were described, some of which are univariate and others are multivariate. Few studies take into account under- and over-reporters and those who account differ on the way of identifying misreporters, which makes interpretations and comparisons difficult. Regardless the method, in each study, a consideration should be addressed to misreport prevalence, misreporters' characteristics and how under and over-report affects nutrient analysis.

KEYWORDS
Energy intake, Food consumption, Misreport, Nutritional epidemiology

RESUMO
Os estudos epidemiológicos na área da nutrição são essenciais ao desenvolvimento de programas de saúde pública e de políticas alimentares apropriadas. No entanto, a relação entre a ingestão nutricional e os resultados de saúde pode ser afetada pelas declarações incorretas do consumo alimentar. O objetivo deste trabalho foi rever a temática das declarações não plausíveis do consumo alimentar, incluindo os métodos existentes para identificação destes casos, as suas implicações, a prevalência e os fatores associados. Foi realizada uma revisão da literatura. O método de referência para identificar declarações não plausíveis da ingestão energética é a Água Duplamente Marcada, que permite a comparação da ingestão energética reportada com o gasto energético. Por apresentar limitações de uso em estudos epidemiológicos de grande dimensão, alguns métodos alternativos tem sido descritos, onde se incluem modelos univariados e multivariados. As sub e sobre-declarações são identificadas por poucos estudos sendo que os que as apresentam diferem na metodologia, o que dificulta interpretações e comparações. Independentemente do método usado para avaliar a plausibilidade das declarações, em cada estudo deve ser endereçada uma consideração à prevalência, características dos declaradores não plausíveis e à forma como afetam a análise da ingestão dos nutrientes.

PALAVRAS-CHAVE
Ingestão energética, Consumo alimentar, Declarações não plausíveis, Epidemiologia nutricional

INTRODUÇÃO

Nutritional epidemiological studies, including surveys and analytical studies, are essential tools to identify the nutritional needs of the population and also the dietary determinants of health. The development of public health programs and food policies is facilitated by the existence of this valuable information (1). The biggest challenge is measuring accurately what people eat and drink. Self-reported dietary intake data is often used in population-based studies to evaluate food consumption and nutrient intake because of its cost-effectiveness. Additionally, self-reported data provides information that is not possible to be obtained from a comprehensive set of biomarkers, such as food consumption, food behaviours, and eating patterns (1). Therefore, the study of misreporting through nutritional intake biomarkers in urine or in blood can be useful, complementing the information from dietary reports, being used, for example, for calibration of the measurement error (2).

Dietary misreport: definition and implications

Dietary misreports refers to non-plausible food reports who are generally identified considering individual energy intake (EI), a global indicator of food intake. EI under or over-report is considered to be present when reported EI is substantially lower or higher than the individual expected value. Misreports can be intentional by voluntary omission of foods consumed or may result from incomplete recordkeeping on the part of the subject due to one or many factors, such as memory lapses, erroneous estimation of portion sizes eaten and "unconscious" omission of certain eating occasion or item (3).

EI misreport persists across all self-reported methods of assessing food and nutrient intake. However, it is known that Automated Self-Administered 24-hour dietary recalls and 4-d food records provided the best estimates, minimizing misreport (4).

Under-report affects the estimation of EI and consequently other nutrients, may constituting a bias on the associations between food/nutrient intake and disease assessed in epidemiological studies (5, 6). Under-report seems to be more of a concern for specific food items which are most likely to be socially undesirable. Those who under-report present a lower contribution from lipids and carbohydrates but not from protein, suggesting a bias towards fat, carbohydrates or even alcohol (7). This might be due to the lower report of foods such as butter, potato chips, sugars and confectionery/pastry products, or less reporting of the amounts consumed in these types of products (8). Consequently, due to misreporting, nutrient inadequacies and the associations between nutrient intake and disease could be distorted(6, 9). Also, the exposure estimation to chemical or microbiological hazards from food might be affected (10).

Energy intake misreport identification methods

Total energy expenditure assessed by Doubly Labelled Water (DLW) has become the reference for the evaluation of dietary assessment methods (11). Thus, it has been used to validate EI estimated by diet recalls, food records or diet history. This method, accurate and non-invasive, assumes that EI equals total energy expenditure (TEE) when body weight is stable. In this context, TEE can be considered a biomarker of EI and DLW. Since DLW needs a sophisticated laboratory and analytical back-up entailing high costs, this method is not amply used in epidemiological studies (12). Nonetheless, some studies have identified considerable bias towards underestimation of EI by comparing with DLW(13-15).

Alternative approaches to detect EI misreports have been described. Are included crude methods which detect implausible reports if they are below or above fixed values or detecting if they are extremes of a range of intake. Other methods are multivariate applying individual cut offs that account for errors associated with within-participant variation in EI and in TEE.

1. Willett method

A simple univariate method proposed by Willett (16) excludes arbitrary energy values under 500 or 800 Kcal/day and above 3500 or 4000 kcal/day for women or men, respectively.

2. Interquartile amplitude range Method

This method is based on outliers detection by interquartile amplitude range of the EI distribution (17). On this model, moderate and severe outliers, that is values that fell outside the interval delimited by the 25th percentile minus 1.5 or 3 times the interquartile range and the 75th percentile plus 1.5 or 3 times the interquartile range, are identified.

Regarding to multivariate models, the energy requirement predicted by equations is usually used for comparison.

3. Goldberg method

The most well studied method to account for EI misreport is the Goldberg method (18), adapted later by Black (19). Goldberg et al. uses fundamental principles of energy physiology to calculate the range for which reported EI is plausible as a valid measure of food intake. This method compares the ratio of reported EI to predicted basal metabolic rate (BMR) with physical activity level (PAL) multiplied by a correcting factor (for sample size, for the number of reported days and for the variation of EI (23%), pBMR (8.5%) and for PAL (15%)). Schofield equations are used for the BMR estimation (20). A fixed average value can be assumed for PAL or it can be assessed individually through physical activity questionnaires (21). Participants are defined as under, plausible or over-reporters whether individual ratio of EI:BMR is below, within or above the 95% or 99% confidence limits calculated, respectively (corresponding to 2 or 3 standard deviation (SD))(16). Reports are plausible if they are between the results of these equations:

$$rEI{:}pBMR < PAL\ x\ exp\left[SDmin \times \frac{S/100}{\sqrt{n}}\right]$$

$$rEI{:}pBMR > PAL\ x\ exp\left[SDmax \times \frac{S/100}{\sqrt{n}}\right],\ onde{:}$$

$$S = \sqrt{\frac{CVwEI^2}{d} + CVwB^2 + CVtP^2} \qquad (8, 19)$$

rEI: reported Energy Intake
pBMR: predicted Basal Metabolic Rate
PAL: Physical Activity Level
SDmin: minimum Standard Deviation (-2 or -3 for the 95% or 99% lower confidence limit)
SDmax: maximum Standard Deviation (+2 or +3 for the 95% or 99% upper confidence limit)
n: number of subjects included in each defined group
S: factor that takes account of the variation in energy intake, BMR and PAL
CVwEI: within-subject variation in energy intake (23.0%)
d: number of days of diet assessment
CVwB: within-subject variation in repeated BMR measurements or the precision of estimated BMR compared with measured BMR. This includes both measurement error and variation with time on repeated BMR measurements (8.5%)
CVtP: total variation in PAL (15.0%)

4. Predicted Total Energy Expenditure (pTEE) method

The pTEE method relies on prediction equations for energy requirements derived from a meta-analysis of using DLW (22). This method compares EI:pTEE ratio with 1, 1.5 or 2SD cut offs (23, 24) as described below. Reports are plausible if they are between the results of these equations:

$$rEI{:}pTEE < SDmin\ x \sqrt{\frac{CVrEI^2}{d} + CVpER^2 + CVmTEE^2}$$

$$rEI{:}pTEE > SDmax\ x \sqrt{\frac{CVrEI^2}{d} + CVpER^2 + CVmTEE^2} \qquad (23, 24)$$

rEI: reported Energy Intake
pTEE: Total Energy Expenditure
SDmin: minimum Standard Deviation (-1, -1.5 or -2)
SDmax: maximum Standard Deviation (+1, +1.5 or +2)
CVrEI: within-subject coefficient of variation in energy intake (23.0%)
d: number of days of energy intake measurement
CVpER: within-subject coefficient of variation in predicted Energy Requirement (17.7%)
CVmTEE: coefficient of variation in measurement Total Energy Requirement (8.2%)

There are few comparative studies of existing methods reason why no method is recommended in relation to another. Mendez et al. (25) analysed the associations between dietary exposures and obesity in the frame of European Prospective Investigation Into Cancer and Nutrition using the Willet and the Goldberg method. Stronger associations between dietary exposures and obesity that were more consistent with expectations were found accounting for misreporters identified by the Goldberg method. Rhee et al. (26) replicated this work in the frame of Nurses' Health Study, in which they found similar correlations between diet and blood biomarkers applying the two methods.

Energy intake misreport: prevalence and determinants

EI misreport seems to be unequally distributed in the population. Nevertheless, literature on misreporters' characteristics from representative samples in each country is still limited (27, 28). A recent systematic literature search (29) identified thirty-seven relevant studies on EI misreport among adults. The percentage of under-reporters was about 30% and the magnitude of EI underestimation was approximately 15%. Over-report occurs much less often than under-report, and for that reason is less studied.

The determinants of EI misreport were reviewed in detail by Livingstone et al. (6) and Poslusna et al. (29) along with other studies that have been addressing interest on this subject. BMI seems to be a consistent determinant, related to energy (30), protein and potassium under-report, so higher BMI was associated with under-report (7). This may lead into the biased conclusion that overweight and obese individuals have less EI compared with their normal-weight counterparts (31). Also, being satisfied with their own appearance reduces the likelihood of under-report, while attitudes such as skipping breakfast increase. Concern about weight gain was associated with over-report (32) and restrained eating has been associated with under-report of EI (33, 34). Besides BMI, age and sex have also effect on misreport. A higher proportion of under-reporters was found among women and older subjects (35). Also, lower education level and lower socio-economic class were associated with under-report (36).

In France, using 7-day food records, the prevalence of under-report in the 2006-2007 National Food Survey (37) was 22.5%, similar between men and women, being positively associated with overweight and protein intake and inversely with age. In women, having lunch at the workplace or at friends/families' homes, having poor perception of the quality of food and living near to the capital, was positively associated with the under-report. In men, it was positively associated with having lost weight recently and negatively with having lunch with coworkers in the canteen and consuming milk and dairy products. Over-report was not measured.

Data from NHANES 2003–2012(35), using 24-hour dietary recall and based on Goldberg method, found 25.1% of EI under-report and 1.4% of over-report. A higher odds of being an EI under-reporter compared with being a plausible reporter was associated with female gender, older age, non-Hispanic blacks (compared with non-Hispanic whites), overweight and obesity. A higher risk of being an over-reporter compared with being a plausible reporter was associated with underweight and current smoking (compared with never smoking).

Recently, Murakami found lower prevalence among Japanese population (27), less than 6.3% and 2.0% of under and over-report, respectively. This large difference from studies previously presented may be related to the energy expenditure predictive formulas developed in Caucasians and under-report may differ from one country to another, as nutritional habits are partly determined by cultural and geographical factors. Anyway, under-report was associated with younger age, overweight and obesity (compared with normal weight), current smoking (compared with never smoking), no alcohol drinking (compared with drinking everyday), and household consisting of a single person (compared with that consisting of two persons). On the other hand, over-report was associated with female gender, normal weight (compared with overweight), and household consisting of a single person.

Interpersonal communication between the subject and the interviewer is also important to mention. EI misreports can be related to social desirability and this may impact self-report by under-report of "unfavourable" and over-report of "favourable" foods(38). An inclusion of social desirability score as a covariate in studies that rely on self-reports of food intake may be useful (39). To minimise the influence of psychological determinants of misreport it is necessary to promote understanding between the researcher and the subject, and to motivate the subject (29).

DISCUSSION AND CONCLUSIONS

Identifying the presence of dietary misreport and its magnitude constitute the beginning of the results interpretation. Considering previous studies that account for EI misreporters, methods are often different which does not allow comparisons in a clear way. There are substantial differences in the prevalence of implausible reporting across alternative methods (25). Although, no method can be elected as the one who should be applied (40, 41). In order to find the best alternative method to DLW, a more comprehensive analysis, ideally resorting to biomarkers, is required. It is important to refer that under-reporters may be classified by real under-eating and/or even by physical activity over-report.

Under and over-reporters should be identified and reported but should not be excluded from the datasets because it introduces unknown bias (42). Misreporters are systematically different from the plausible reporters on lifestyle, nutritional status and chronic disease risk (43). Its use in sensitivity analyzes is recommended. Furthermore, the study of the characteristics of misreporters may help the statistical adjustment and the development of correction factors, allowing the preservation of statistical power and sample representativeness.

Considering that the best method for evaluating misreport is not yet known, the ratio between EI and TEE of the population should be reported (40). This ratio allows readers to ascertain the degree of misreport at a gross level, and better interpret the results. A ratio less than 1 represents EI under-report and the lower this value, greater error it represents.

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