






Obesity and diet contents of protein and fat are associated with underreport of energy at pregnancy


Maria Beatriz Trindade de Castro ¹
 <https://orcid.org/0000-0001-6618-4007>


Camilla Medeiros Macedo da Rocha ⁵
 <https://orcid.org/0000-0003-1720-3560>


Camila Benaim ²
 <https://orcid.org/0000-0001-8822-062X>

Ana Amélia Freitas-Vilela ⁶
 <https://orcid.org/0000-0002-1122-3846>

Ilana Eshriqui ³
 <https://orcid.org/0000-0001-7010-919X>

Gilberto Kac ⁷
 <https://orcid.org/0000-0001-8603-9077>

Thatiana de Jesus Pereira Pinto ⁴
 <https://orcid.org/0000-0002-0957-3118>

Ana Beatriz Franco-Sena ⁸
 <https://orcid.org/0000-0002-4196-1268>

¹⁻³ Department of Social and Applied Nutrition. Institute of Nutrition Josué de Castro. Federal University of Rio de Janeiro. Av. Carlos chagas Filho, 373. Bloco J. 2º andar. Ilha do Governador. Rio de Janeiro, RJ, Brazil. CEP: 21.941-901. Email: mbtcastro@gmail.com

² National School of Public Health. Oswaldo Cruz Foundation. Rio de Janeiro, RJ, Brazil.

⁵ School of Nutrition. Federal University of Rio de Janeiro. Campus UFRJ-Macaé. Macaé, RJ, Brazil.

⁶ Special Academic Unit of Health Sciences. Goiás Federal University. Jataí, GO, Brazil.

⁸ Department of Social Nutrition. Fluminense Federal University. Niterói, RJ, Brazil.

Abstract

Objectives: to evaluate the association of pre-pregnancy and current body mass index and the density of dietary macronutrients on underreporting of energy intake at pregnancy.

Methods: cross-sectional analysis of 327 postpartum women from the city of Mesquita, in Rio de Janeiro. A food frequency questionnaire was administered at maternity ward having the last six months of the pregnancy as the time frame. Energy balance was considered as the outcome, and it was calculated as the division of energy intake by basal metabolic rate (underreport <1.35). Multivariate logistic regression was applied to test the associations between body mass index (pre-gestational and postpartum) on energy balance (underreport or not). Dietary density of protein (4th quartile), carbohydrate (1st quartile) and fat intake (1st quartile) were tested.

Results: mean energy intake was 2,894 kcal and near of 25% of the women were considered as underreported during pregnancy. Obese women had higher chance (OR=1.90; CI95%=1.09-3.33) of being underreported at pregnancy. Underreported women presented greater chance of report dietary intake with higher contents of protein (OR=2.37; CI95%=1.37-4.09) and lower density of fat (OR=.81; CI95%=1.04-3.15).

Conclusion: underreported pregnant women had higher chance of report great and lower amounts of protein and fat dietary densities.

Keywords Pregnancy, Body mass index, Underreporting, Obesity, Energy intake



Introduction

Underreporting of dietary intake is common in nutritional epidemiological studies, even when different methods such as food frequency questionnaires, 24-hour recalls, and food records are used to assess the food consumption.¹⁻⁵ There is no the better method to assess dietary intake that is most accurate as it is dependent on the aim of your assessment, foods, nutrients, dietary patterns among others aims.

Although the food record is considered the most accurate method to estimate usual dietary intake, all of them have methodological limitations that could bias or misclassify the reporters and confound the direction of the associations.¹⁻³ Memory bias, random and systematic dietary intake variation, seasonal variation, the perception of the food size portion and food items list are some of issues that must be considered.²⁻⁵ Body mass index (BMI) has been reported as the main predictor of underreporting. Most of the studies on this topic have been conducted with adults and verified that the relation of BMI with underreport may be stronger in women than men.¹⁻³

Few studies have been conducted during the gestational period and have described the association between BMI and dietary intake underreporting among pregnant women.⁶⁻⁹ Obese pregnant women tend to misinterpret the dietary intake, and most of the times omitting or underreporting higher portions sizes when compared to lower BMI, and, depression, and diet behavior could be considered as independent predictors.^{6,7}

Studies have shown a wide variation in the prevalence of energy underreporting during pregnancy.⁶⁻⁹ Also, the increasing prevalence of underreporting of energy intake over pregnancy is not a consensus.^{6,7,9} McGowan and McAuliffe⁸ evaluated 248 healthy Irish pregnant women and verified that 44% were potential underreporters, while 10.9% were classified as definite underreporters. Winkvist *et al.*⁹ conducted a longitudinal study with pregnant women from Indonesia and showed prevalence of 29.7%, 16.2% and 17.6% of underreporting in the first, second and third trimesters, respectively. According to Moran *et al.*⁶ 38.0% and 59.7% of pregnant women were classified as under-reporters of energy intake at study entry and at 36 gestational weeks, respectively.

Dietary intake during pregnancy should be evaluated with attention because insufficient or high energy and inadequate nutrient intakes may have deleterious effect on maternal weight gain and consequently on gestational outcome.¹⁰⁻¹² Additionally, underreporting pregnant women seem to be less compliant with maternal dietary

recommendations⁸ what can be harmful to the adequate gestational development. Literature has shown that specific macronutrients as protein and fat, and other nutrients as calcium or food items are often underreported.^{1,8,12} It was observed that adult underreported tend to report lower intake of fat^{8,13} and sweets¹³ and higher consumption of protein⁸. A better understanding of the proportion of underreporting of “healthy food”, as fruits and vegetables, and the diet density of the nutrients is required.

Considering that few studies were conducted during pregnancy and the importance of the adequate nutrition assessment during this period to achieve desirable maternal and fetal outcomes, it is important to investigate the maternal characteristics, as well as the dietary factors, that are possibly associated with nutritional underreporting among pregnant women. This way may allow better screening for underreporting women, and it may be possible to minimize bias in future studies adjusting by confounders co-variables. Thus, the aim of the present study was to evaluate the association of pre-pregnancy BMI and the macronutrients dietary densities on underreport of energy intake.

Methods

This is a cross-sectional study with 327 mothers who gave birth to their children in the maternity ward of Leonel de Moura Brizola Municipal Hospital (HMLMB) in Mesquita, that is a county in the State of Rio de Janeiro. This study is part of a larger project entitled ‘Effect of nutritional, socio-demographic and reproductive determinants in postpartum weight variation and comorbidities development’. Women who gave birth between February 2009 and February 2011 were invited to participate according to the following eligibility criteria: being aged between 18 and 45 years, presenting single pregnancy and without pre-existing chronic diseases, except for obesity. Of the 338 recruited women, 334 (98.8%) accepted to participate and 7 (2.1%) were excluded from the analysis because their reported energy intake was above 6,000 kcal, which was considered implausible.^{14,15}

Structured questionnaires were administered in the maternity ward in the first week after delivery in order to obtain information on sociodemographic conditions. Trained nutritionists were responsible for data collection and the anthropometric measurements, which were conducted in accordance to the Lohman protocol.¹⁶ Information on the following socio-demographic variables was collected: age (years), schooling (years), family income (US\$), skin color (black and brown or white and other), married or stable union (yes or no) and parity (number of births).

The outcome of the present study was energy balance (EB). This variable was calculated dividing energy intake (EI) by basal metabolic rate (BMR). The BMR calculation was based on the Harris-Benedict equation that considers weight (kg), height (cm) and age (years).¹⁷ Values of EB lower than 1.35 were used to classify dietary underreporting among population.¹⁸

Dietary intake was obtained through the application of a Food Frequency Questionnaire (FFQ) with 81 food items in the maternity ward, having the last six months as time frame of pregnancy. The FFQ was previously validated by Sichieri and Everhart.¹⁹ The FFQ had portions described as household measures according to Pinheiro *et al.*²⁰ and nine frequencies of consumption that ranged from: never or almost never; one to three times per month; once a week; two to four times a week; five or six times a week; once a day; two or three times a day; more than three times a day. Afterwards, the information was converted to daily frequencies using a program developed by Sichieri²¹ in the statistical package Statistical Analysis System version 9.3. The Brazilian Food Composition Table²² was used as the main nutritional composition database for the conversion of food into macronutrients (protein, fat and carbohydrate and energy. The density of the dietary intake (grams/energy) was calculated for each macronutrient and, then, a binary variable was created considering the quartile of the intake: density of protein (4th quartile versus others); density of carbohydrate (1st quartile versus others); and density of fat (1st quartile versus others).

Pre-pregnancy weight (PPW), pre-pregnancy body mass index (PPBMI), current body mass index (BMI) at immediate postpartum and gestational weight gain (GWG) were the anthropometric variables assessed. The information of PPW was obtained from the prenatal card, if measured before the 13th gestational week. If not available, it was self-reported. Postpartum weight (kg) and height (m) were measured at the maternity ward in the first week after the delivery using a Tanita[®] digital scale (Tanita Inner Scan, Tanita Corporation of America, Inc., Illinois, USA and Altura Exata[®] portable stadiometer, respectively. For the anthropometric measurements, the participants used light clothing and had their shoes removed. PPBMI and current BMI were calculated by the formula: BMI= weight (kg)/height (m²). BMI ≥ 25 kg/m² and BMI ≥ 30 kg/m² were adopted as the cutoff points for classifying overweight and obesity in the pre-pregnancy period.²³ The current BMI considered the cutoff point just to classify as obese women (or no).

Initially, nutritional status (PPBMI, BMI, PPW and GWG), energy intake (kcal), macronutrients dietary

densities (protein, carbohydrate and fat, and socio-demographic characteristics [maternal age (years), parity (n), schooling (years), family income (us dollar), civil status (married and stable union or single and others) and skin color (Black and Brown or White and others) of the 327 postpartum women were compared according to EB status (≥ 1.35 or < 1.35) using Student's t-Test to compare means or chi squared test for proportions. Secondly, all the variables were stratified according PPBMI (≥ 25 kg/m²) or not and BE (\geq or < 1.35 status).

Multiple logistic regression model was used to estimate the effect of PPBMI [obese (1) or no obese (0); overweight (1) or no overweight (0)] on EB [≥ 1.35 (1) or < 1.35 (0)]. The adjustment of the model considered the background available in the scientific literature and the covariates that were represented as confounders (ancestor of the outcome and exposure by the DAGitty methodology (version 3.0). The multiple models for each predictor were adjusted for maternal age and skin color. All analyzes were conducted in SAS.

The present study was approved by the Research Ethics Committees of the Institute of Social Medicine of UERJ (Protocol number: CAAE - 0178.0.314.000-10). The context, procedures and objectives of the study were explained to the pregnant women and the ones who accepted to voluntarily participate gave their informed consent after all clarifications were made. Methodology was compliant with STROBE guidelines.²⁴

Results

Pregnant women assessed at postpartum presented mean (SD) PPBMI of 23.6 kg/m² (4.64) and maternal age of 24.8 (5.53) years old. Of the 327 women assessed, 83 (25.4%) were classified as underreported, and these women reported greater amounts (Figure 1) of protein dietary density [42.3 g/kcal (7.80) versus 38.8 g/kcal (8.28); $p=0.001$] and lower contents of fat density [25.2g/kcal (5.67) versus 27.0g/kcal (6.30); $p=0.021$] than pregnant who did not underreport (Table 1).

Furthermore, underreported overweight women reported higher contents of protein intake ($p=0.002$) than women without excess of weight and with EB ≥ 1.35 (Table 2).

According to the multiple logistic models, current obese (BMI ≥ 30 kg/m²) women (OR=1.90; CI95%=1.09-3.33; $p=0.024$) had higher chance of being classified as underreported. It was shown in the Table 3, that underreported women presented greater risk of report higher density of protein (OR=2.37; CI95%=1.37-4.09; $p=0.002$) and lower density of fat intake (OR=1.81; CI95%=1.04-3.15; $p=0.036$).

Table 1

Mean (SD) and frequencies (%) of nutritional status, dietary intake and socio-demographics variables of the 327 postpartum women according to energy balance, Mesquita - Rio de Janeiro, Brazil, 2009-2011.

Variables	Total	Energy Balance [‡]		p ^a
		1,35 (n=244)	<1,35 (n=83)	
x̄ (SD)				
PPW ^{‡‡} (kg)	61.1 (12.8)	58.9 (10.5)	61.7 (13.4)	0.071
PPBMI [‡] (kg/m ²)	23.6 (4.64)	23.1 (3.83)	23.7 (4.8)	0.320
Current BMI ^{‡‡} (kg/m ²)	26.9 (4.91)	26.3 (4.00)	27.0 (5.13)	0.233
GWG ^{‡‡‡} (kg)	12.8 (6.32)	12.7 (6.29)	12.8 (6.34)	0.940
Energy (kcal)	2,894 (1,081)	4,460 (532)	2,467 (707)	<0.001
Protein (g/kcal)	41.6 (8.02)	38.8 (8.28)	42.3 (7.80)	0.001
Carbohydrate (g/kcal)	154 (17.9)	154 (20.7)	154 (17.2)	0.990
Fat (g/kcal)	25.6 (5.85)	27.0 (6.30)	25.2 (5.67)	0.021
Age (years)	24.8 (5.53)	26.2 (5.83)	24.5 (5.39)	0.023
Parity (n)	2.3 (1.36)	2.4 (1.25)	2.2 (1.39)	0.205
Schooling (years)	8.7 (3.06)	8.4 (3.06)	8.8 (3.06)	0.450
Family income (US\$)	338 (211)	306 (168)	346 (220)	0.133
Variables	N (%)		N (%)	p ^b
Skin color				0.623
Black or mixed	274 (83.8)	60 (85.7)	214 (83.3)	
White	53 (16.2)	10 (14.3)	43 (16.7)	
Married or stable union				0.450
Yes	240 (73.6)	54 (77.1)	186 (72.7)	
No	86 (26.4)	16 (22.9)	70 (27.3)	

[‡]Energy Balance (EB): Energy Intake (EI)/Basal Metabolic Rate (BMR); ^{‡‡}Pre-pregnancy weight; ^{‡‡‡}Pre-pregnancy body mass index; ^{‡‡‡‡}Current body mass index; ^{‡‡‡‡‡}Gestational weight gain; ^ap refers to t-Student test; ^bp refers to chi-square test.

Table 2

Mean (SD) and frequencies (%) of nutritional status, dietary intake and socio-demographics variables of the 327 women according to Pre-Pregnancy Body Mass Index (PPBMI) on Energy Balance.

Variables	EB [‡] ≥ 1.35		EB [‡] < 1.35		p ^a
	PPBMI [‡] < 25 (N=173)	PPBMI [‡] ≥ 25 (N=71)	PPBMI [‡] < 25 (N=51)	PPBMI [‡] ≥ 25 (N=32)	
x̄ (SD)					
PPW ^{‡‡} (kg)	54.0 (7.17) ^{ab}	73.2 (8.94) ^{acd}	55.5 (7.32) ^c	79.3 (12.3) ^{bd}	<0.001
Current BMI [‡] (kg/m ²)	24.5 (3.44)	31.3 (3.92)	25.0 (3.47)	32.8 (4.01)	<0.001
GWG ^{‡‡} (kg)	12.7 (5.70)	11.1 (6.36) ^a	14.6 (6.18) ^a	14.3 (8.53)	0.016
Energy (kcal)	3,250 (882) ^{ab}	3,461 (921) ^{cd}	1,594 (475) ^{ac}	1,786 (456) ^{bd}	<0.001
Protein (g/kcal)	40.5 (7.59) ^a	41.2 (8.10) ^b	42.8 (8.98)	46.1 (6.96) ^{ab}	0.002
Carbohydrate (g/kcal)	154 (17.6)	153 (17.7)	156 (20.1)	150 (17.2)	0.522
Fat (g/kcal)	26.0 (5.75)	26.2 (5.63)	23.7 (6.40)	24.8 (5.51)	0.064
Age (years)	24.2 (5.34)	26.1 (5.48)	24.6 (6.15)	25.9 (5.19)	0.055
Parity (n)	2.4 (1.47)	2.1 (1.14)	2.0 (1.22)	2.4 (1.41)	0.238
Schooling (years)	8.27 (2.99)	9.2 (3.11)	8.9 (3.01)	9.4 (3.12)	0.093
Family income (US\$)	327 (201)	364 (241)	334 (213)	343 (192)	0.720
Variables	N (%)				p ^b
Skin color					0.982*
Black or mixed	143 (82.7)	61 (85.9)	42 (82.4)	28 (87.5)	
White or others	30 (17.3)	10 (14.1)	09 (17.1)	04 (12.5)	
Civil status					0.875*
Married or stable union	123 (71.1)	56 (78.9)	34 (67.3)	27 (87.1)	
Single and others	50 (28.9)	15 (21.1)	17 (33.3)	04 (12.9)	

[‡]Energy Balance (EB): Energy Intake (EI)/ Basal Metabolic Rate (BMR). ^{‡‡}Pre-pregnant weight; ^{‡‡‡}Current body mass index; ^{‡‡‡‡}Gestational weight gain; ^ap refers to ANOVA; ^bp refers to chi-square test. There is a significant difference between equal superscripts (p<0.05). *Mantel-Haenszel Chi-square.

Table 3

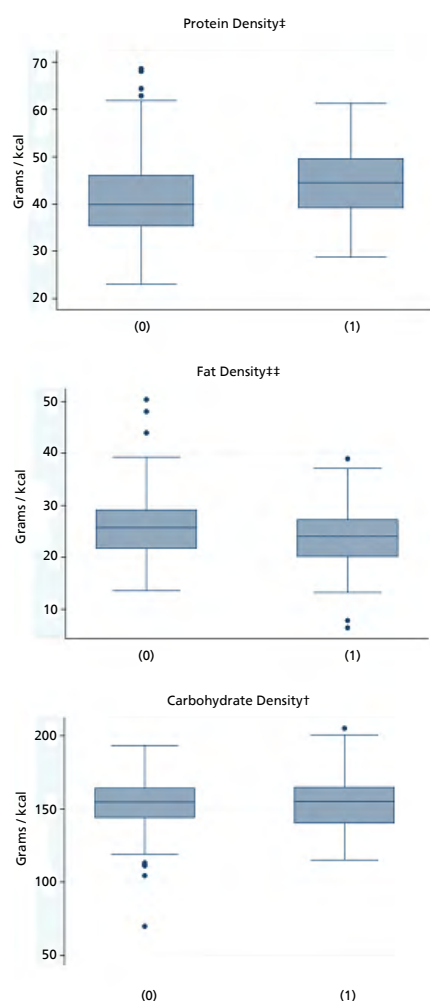
Univariate and multiple logistic regression† of pre-pregnancy and current nutritional status and the density of macronutrients‡ dietary intake (Protein, Fat and Carbohydrate) on energy balance§.

Variables	OR	p	CI95%
Univariate			
PPBMI (obesity ≥ 30 kg/m ²)	1.92	0.109	0.87; 4.25
PPBMI (overweight ≥ 25 kg/m ²)	1.53	0.110	0.91; 2.58
Current BMI (obesity ≥ 30 kg/m ²)	1.92	0.022	1.10; 3.35
Current BMI (obesity ≥ 25 kg/m ²)	1.43	0.175	0.85; 2.40
Protein (4 th quartile)	2.37	0.002	1.38; 4.09
Carbohydrate (1 st quartile)	1.53	0.130	0.88; 2.66
Fat (1 st quartile)	1.79	0.036	1.04; 3.109
Multiple			
PPBMI (obesity ≥ 30 kg/m ²)	1.89	0.119	0.85; 4.21
PPBMI (overweight ≥ 25 kg/m ²)	1.51	0.125	0.89; 2.56
Current BMI (obesity ≥ 30 kg/m ²)	1.90	0.024	1.09; 3.33
Current BMI (obesity ≥ 25 kg/m ²)	1.41	0.195	0.84; 2.39
Protein (4 th quartile)	2.37	0.002	1.37; 4.09
Carbohydrate (1 st quartile)	1.52	0.139	0.87; 2.65
Fat (1 st quartile)	1.81	0.036	1.04; 3.15

†Multiple model for each predictor variable (PPBMI, current BMI, Protein, Carbohydrate and Fat) was adjusted by maternal age skin color, schooling and civil status; ‡Density of macronutrients intake (grams/energy): protein (4th quartile versus others); carbohydrate (1st quartile versus others) and fat (1st quartile versus others); §EB = energy intake/energy expenditure. EB \geq 1.35 (coded as 0) or EB $<$ 1.35 (coded as 1).

Figure 1

Distribution of macronutrient dietary density between underreported (1) and non-underreported (0).



† $p=0.001$; ‡ $p=0.021$; ‡ $p=0.989$.

Discussion

The main finding of the current study is that underreported pregnant women tend to report greater and lower density of protein and fat, respectively. Also, current obese women had higher chance of being classified as underreported women when compared to normal weight counterparts. Approximately twenty-five percent of the study subjects were classified as under-reporters and among them, more than one third was classified with excess of weight.

According to the scientific literature, the BMI seems to be the most consistent predictor of underreported intake,^{25,26} although actual age, income and schooling²⁶ are also commonly cited as important ones. In a sample of 248 pregnant women studied by McGowan & McAuliffe,⁸ the total prevalence of underreporting was up to 45%. This study results shows a higher prevalence of underreporting with increasing BMI, in line with our results. Winkvist *et al.*⁹ assessed dietary intake of pregnant women performing six repeated 24-hour diet recalls in each gestational trimester and authors found a decreasing prevalence of underreporting from the first to the third gestational trimesters. However, the authors did not stratify their analysis according to BMI. The differences in the proportions of underreporting in studies with pregnant women may be due to the different cut-off points used to define this outcome that has been frequently used in literature.

Previous studies have described associations between nutritional status and underreporting of dietary intake. Energy underreporting varies as a function of pre-pregnancy BMI and among obese pregnant women.^{6,7} According Ravelli and Schoeller,²⁷ obese people are more likely

to underreporting energy intake by 7% more than those with adequate BMI. Authors mentioned the association of underreporting and individual's concerned weight.

More specifically, during pregnancy, a cohort study⁸ evaluated 248 Irish women between 12 and 20 weeks of gestation and identified that the higher category of BMI (≥ 25 kg/m²) was associated with higher odds of energy underreporting (OR=4.40; CI95%=2.48;7.67) compared to normal weight women (< 25 kg/m²). In the study of Winkvist *et al.*,⁹ early pregnancy BMI was significantly associated with higher risk of being an under-reporter in all pregnancy trimester. The results of these previous studies conducted with adult samples and with pregnant women are in line with our findings, that showed an inverse association between PPBMI and EB.

Another important question is the direction of the misreporting and the bias that uncontrolled systematic error could introduce among interpretations and leading to erroneous conclusions. Pregnant women may report their dietary intake in socially and health desirable way as observed by Scagliusi *et al.*²⁸ among 38 healthy women. In our study, it was observed that pregnant women with higher BMI underreported dietary fat intake and overestimated protein intake. This unequal direction of the amounts of macronutrient intake was described later by Johansson *et al.*¹³ They observed that under-reporters reported a significantly higher protein density diet and lower intake of fat among 193 Swedish respondents. As well as our results, no difference was observed between under-reporters or normal reporters in relation to carbohydrate intake. According to Ravelli and Schoeller,²⁷ the protein intake is underreported in a lower percentage than carbohydrate and fat. McGowan and McAuliffe⁸ observed that the mean percentage intake of protein (higher) and fat (lower) were significantly different across energy reporting groups.

The limitations of the present study are mostly related to the study design. Cross-sectional studies do not allow assumptions of temporality once both measures are assessed in a single moment in time. The impossibility of measuring the basal metabolic rate (BMR) or total energy expenditure using gold standard methods such as the double labeled water may also be considered a limitation. On the absence of the gold-standard method, researchers have used the ratio of EI/BMR proposed by Goldberg *et al.*²⁹ and considering values lower than 1.35 to classify underreporting. During pregnancy it is necessary a steady rate between energy intake and expenditure, as lower rates values do not support body weight gain throughout pregnancy. In addition, the recall bias is inherent to retrospective assessment of dietary intake, but we could have minimized it using a validated FFQ.

Despite this drawback, inherent to cross-sectional studies, it is important to highlight that our hypothesis was carefully designed considering previous studies that have already described the temporal plausibility of our main hypothesis. We tried to evaluate social and demographic variables, which may also be potential confounders. Thus, we have selected the confounders based on the biological plausibility and based on DAG arrangement.

Our results were based on valid measures widely used in epidemiological studies, that are feasible to be collected for tracking subgroups in nutritional care. The instrument used to measure dietary intake has been previously validated¹⁹ and other researchers have reported good validity and reproducibility of this method when used during gestational and postpartum periods.¹⁵

The choice of the cutoff point of EB considered the fact of FFQ has the last six months of pregnancy as a time frame. The insufficient EI among this period would be incompatible with GWG during pregnancy. Besides this, according to a review conducted by Livingstone and Black,³⁰ it was showed that the correlation of EI and energy expenditure measured by different dietary assessment could range from 0.76 and to 1.24 using accurate techniques such as doubly labeled water.

Finally, we reight that more studies should be conducted to understand the risk of being underreported at pregnancy. In our study was found that the probability of underreporting is higher as BMI increases and it increases the risk of report diets with high contents of protein and low densities of fat. Methods accounting for under and over self-reported EI with plausible energy requirements, as multiples of resting metabolic rate recommended by Goldberg *et al.*,²⁹ increase the validity of the information excluding from the analyses misreporting people.

In summary, our data corroborate previous studies that evaluated the association between BMI and underreported dietary intake. We identified that this association also occurred when women in the immediate postpartum reported their food intake throughout pregnancy. Also, to be an obese-postpartum women was associated with underreported at pregnancy, pointing out that nutritional status should be considered to identify women that potentially sub-report their gestational food intake. Besides underreporting, it was showed that dietary macronutrients weren't reported in equal way too. To be classified as pregnant under-reporters increased the chance to relate a higher diet protein density.

Authors' contribution

Castro MBT: conceptualized the study and collected the data, performed the statistical analysis and the interpretation of the data, draft and review the manuscript. Franco-Sena

AB: performed the interpretation of the data, draft and review the manuscript. Freitas-Vilela AA, Pinto TJP, Rocha CMM, Benaim C and Eshriqui I: draft and review the manuscript and approved the final version. Kac G: review the manuscript. All authors have approved the final version of the article and declare no conflict of the interest.

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Received on August 13, 2021

Final version presented on November 22, 2022

Approved on February 7, 2023

Associated Editor: Sheila Morais