Food insecurity in pregnant women is associated with social determinants and nutritional outcomes: a systematic review and meta-analysis

Associação entre insegurança alimentar, determinantes sociais e desfechos nutricionais em mulheres grávidas: revisão e metanálise

Abstract The association between FI, social determinants, and nutritional outcomes for pregnant women are analyzed. A systematic review was conducted through a search of articles in five electronic databases. Social determinants (race, education, participation in social programs) and nutritional status (pre-gestational BMI, gestational weight gain, anemia) were analyzed in relation to the FI situation. For each article, the frequency of food insecurity was collected in order to calculate the summary measure, prevalence ratio (PR). 26 articles were selected. An elevated occurrence of FI was associated with black pregnant women (PR: 1.83, 95% CI 1.08-3.10), participation in social protection programs (PR = 1.43, 1.02-2.01), and with low education levels on the part of pregnant women (PR = 2.73, 1.68-4.43). FI increased the chances of being overweight (PR = 1.57, 95% CI = 1.29-1.91) and obese (PR = 1.47, 95% CI = 1.15-1.87) in pregnant women, as well as excessive weight gain (PR = 1.42, 95% CI = 1.10-1.82) and inadequate weight gain (PR = 1.47; 95% CI = 1.09-1.97) during pregnancy. Anemia was not associated with FI. Social inequities are associated with food and nutritional insecurity in pregnant women.

Key words Food and nutritional security, Pregnant women, Social determinants of health

Resumo O estudo objetiva analisar a associação entre insegurança alimentar, determinantes sociais e estado nutricional de mulheres gestantes por meio de uma revisão sistemática e metanálise. As buscas de artigos ocorreram em cinco bases eletrônicas. Determinantes sociais (raça, escolaridade, participação em programa social) e estado nutricional (IMC pré-gestacional, ganho de peso gestacional, anemia) foram analisados em relação à situação de IA. Em cada estudo, a frequência de insegurança alimentar foi coletada para calcular a medida sumário- razão de prevalência (RP) e seu intervalo de confiança de 95%(IC95%). Foram selecionados 26 artigos. Observou-se elevada ocorrência de IA em gestantes pretas (RP:1,83; IC 95% 1.08-3.10), naquelas com participação em programas de proteção social (PR = 1.43, 95% CI = 1.02-2.01) e com baixo nível de escolaridade (RP = 2.73; IC 95% = 1.68-4.43). O fato de a gestante possuir companheiro protegou contra IA (RP = 0.61; IC 95%= 0.40-0.95). Anemia não foi associada à IA. Iniquidades sociais estão associadas à insegurança alimentar e nutricional em gestantes.

Palavras-chave Determinantes sociais da saúde, Mulheres grávidas, Segurança alimentar e nutricional

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Introduction

Food insecurity (FI) is a significant risk factor that can influence the physical health of both the pregnant woman and her child, directly compromising the nutritional state and serum profile of micronutrients, such as iron\textsuperscript{1,2}. It may also trigger a series of stressful events in the family environment due to the difficulty in obtaining food, provoking a deterioration in maternal mental health and consequent development of anxiety and depression, and also leading to negative repercussions with regard to childcare\textsuperscript{3}.

FI consists of the violation of the human right to adequate food (HRAF). In other words, the lack of adequate food, both from a quantitative and qualitative perspective, can deny one the right to life\textsuperscript{4}. The light and moderate forms of FI involve concern or uncertainty with regard to food access and inadequate food quality, and quantitative reduction of food among adults and children and/or a rupture in food standards resulting from the lack of food, respectively. Serious FI, in addition to these aspects, is marked by the presence of hunger, where someone may spend an entire day without eating due to lack of money with which to purchase food\textsuperscript{5}.

FI status worldwide has shown some improvements in recent years. The number of people experiencing FI globally decreased from 18.6\% to 12.5\% between 1990-92 and 2010-12, and dropped from 23.2\% to 14.9\% in developing countries, indicating the possibility of hitting the Millennium Development Goal (MDG) target, should all adequate and appropriate actions be taken\textsuperscript{6}.

Adequate food for women, especially during the gestational phase, is a critical factor for improved health and quality of life. It contributes to a reduction in gestational complications and maternal and neonatal mortality; to nutritional status and adequate maternal weight gain; to normal levels of micronutrient serum concentrations, such as iron; and to satisfactory obstetric results, such as adequate birth weight and gestational age at birth\textsuperscript{7-10}.

Food insecurity in pregnant women is related to the social health determinants. This is because social inequities lead to disparities in health and nutrition\textsuperscript{11-12}, especially during the gestational phase. In this sense, social determinants such as race, education level, and the existence of social protection policies have a determinative effect on the condition of food security.

On the other hand, no meta-analyses were found in the epidemiological literature about the association between food insecurity, social determinants, and nutritional outcomes among pregnant women. It is therefore important to aggregate and systematize information about FI and its relationship to social determinants and nutritional state, in order to provide information that will support future studies and public policies that promote and guarantee women’s food and nutritional security (FNS). The current study was designed with this objective in mind.

Methods

Registration and protocol

A systematic review and meta-analysis were carried out, following PRISMA standards\textsuperscript{13}, in order to answer the following key question: “What is the association between food insecurity and social and nutritional determinants in pregnant women, when compared against women who have food security?” To answer this question, the scientific literature related to the interface between FNS and gestational health was reviewed and the protocol for this systematic review was registered in PROSPERO.

Search strategy

Two researchers (MP and FD) independently searched the Medline/PubMed, Web of Science, Scopus, Science Direct, and Lilacs databases between April 2016 and July 2017 using search terms “food and nutritional insecurity” combined with “pregnant women”, “pregnancy”, and “women’s health” (Chart 1). The publications were located based on the combination of these search terms and the key question. The reference list of relevant articles was then manually searched to identify additional articles.

Articles in Portuguese, English, and Spanish published from 2000 that used a validated food security assessment tool were screened. The published papers were managed using the Mendeley\textsuperscript{®} program.

Eligibility criteria

The inclusion and exclusion criteria used are highlighted in Chart 2. Publications identified in the databases were selected independently by two reviewers (MP and FD) using forms containing the eligibility criteria for the studies. Publications
were screened based on their titles and abstracts. If they met the selection criteria, they were then selected for a full-text review. Following the review, articles about which opinions diverged were selected by a consensus reached between the reviewers.

**Data extraction process**

The articles selected were read in their entirety and the following information was extracted and recorded using a specially designed form: publication and design objective of the study, sample size, age of participants, time pe-
period when the study was conducted, instrument/method used to evaluate food insecurity, location, and outcome(s) investigated.

Data on the prevalence of food security and insecurity for pregnant women were collected for each result of interest. For the results related to social determinants, data was collected for the following groups: race/color (black, non-black), education level (> high school, < high school), marital status (married, unmarried), and participation in social programs (yes, no). Nutritional results data was collected for the following groups: anemic (yes, no), pre-gestational BMI, overweight (yes, no), obese (yes, no), and weight gain during pregnancy, categorized as either inadequate (yes, no) or excessive (yes, no).

**Assessing bias risk**

Bias risk was assessed according to the Research Triangle Institute Item Bank (RTI-Item Bank)\(^\text{14}\). The RTI-Item Bank contains items for evaluating observational studies, seven of which are applicable to the studies included in this review. This tool considers uniform inclusion/exclusion criteria, appropriate sample selection, valid assessment of inclusion/exclusion, and valid assessment of outcome (Chart 3). Domain details for each tool are available elsewhere\(^\text{14}\). If a study obtained one or more negative responses, it was considered to have a high bias risk. If one or more “partially” or “cannot be determined” outcomes were observed, the study was considered to have a moderate bias risk. Low bias risk was defined for cases where all study questions had a positive response.

**Statistical analysis**

The prevalence ratio (PR) was used to summarize the meta-analysis and the results are presented in a Forest Plot chart. PR and its respective confidence interval (95% CI) were obtained following the fixed or random effects model, depending on the heterogeneity between the studies\(^\text{15}\). The heterogeneity and inconsistency of the measures were identified using the Cochran-Q statistical test. Where heterogeneity was confirmed, the random effects model analysis was performed with inverse variance, weighted by the results of the individual studies\(^\text{15}\). The inconsistency test (I\(^2\) > 50%) was used as an indicator of elevated heterogeneity\(^\text{15}\).

In all analyses, a p-value of less than 0.05 was considered statistically significant. Statistical analysis was performed using the Stata 13 program (Stata Corp, College Station, TX, USA) and the PR was obtained using the metan command.

**Results**

**Identification and characteristics of eligible studies**

An initial search generated a list of 4382 publications in the selected databases, 271 of which were duplicates. After screening, 124 articles were assessed for eligibility and 98 were excluded because they did not meet the inclusion criteria. Therefore, 26 studies\(^\text{1,10,16-39}\) were eligible for inclusion in the systematic review and 11 were eligible for the meta-analyses (Figure 1).

**Chart 3. RTI Item Bank use in the Present Systematic Review.**

| Uniform inclusion/exclusion criteria: |
|--------------------------------------|
| 1. Does the article clearly state its own inclusion/exclusion criteria (i.e., does not require the reader to infer)? |
| 2. Did the study apply inclusion/exclusion criteria uniformly to all comparison groups of the study? |
| 3. Was the strategy for recruiting participants into the study the same across study groups/ of the study? |
| **Appropriate sample selection:** |
| 4. Is the sample appropriate? |
| **Valid assessment of inclusion/exclusion:** |
| 5. Are the inclusion/exclusion criteria measured using valid and reliable measures? |
| **Valid assessment of outcome:** |
| 6. Are outcomes assessed using valid and reliable measures, implemented consistently across all study participants? |
| 7. Were the important confounding and effect modifying variables taken into account in the design and/or analysis (e.g., through matching, stratification, interaction terms, multivariate analysis, or other statistical adjustment)? |
The studies were published between 2006 and 2017, and the majority (10) of them was conducted in the United States (USA). A majority (14) used an epidemiological study design of a cross-sectional type, 7 articles used cohorts, 2 used intervention, and 2 used case control. Most of the studies used the Household Food Security Survey Module (HFSSM) as an instrument for evaluating the household food insecurity situation for women and pregnant women (Chart 2). Regarding the methodological quality of the studies analyzed, most (65%) were found to have a high bias risk (Figure 2; Table 1), mainly because the final study sample was truly representative of the target population.

FI was considered as an exposure variable in most of the studies (18) and the outcomes investigated were: anemia, anthropometric nutritional status, congenital birth defects, mental health, gestational complications (diabetes, hypertension), food consumption, and other outcomes. In four of the investigations, FI was studied as an outcome (Chart 4).

The relationship of social determinants to food insecurity for pregnant women

In Figure 3, the social determinants that increased exposure to food insecurity in pregnant women were considered in 7 studies. It was observed that black pregnant women had an 83% higher occurrence of FI compared to non-blacks (PR = 1.83; 95% CI = 1.08-3.10; Figure 3.1). A similar tendency was found for participation in social protection programs (PR = 1.43; 95% CI = 1.02-2.01; Figure 3.2), and for low education level (PR = 2.73; 95% CI = 1.68-4.43; Figure 3.3). It was also found that married pregnant women had protection against food insecurity (PR = 0.61; 95% CI = 0.40-0.95; Figure 3.4). The results of the inconsistency test showed a high heterogeneity among the analyzed studies (p = 0.00). Therefore, the random effects model
Chart 4. Characteristics of studies included in the quantitative synthesis.

| Authors | Design/ country of origin | Sample | Evaluation of food insecurity (FI) | Exposure(s) | Outcome |
|---------|---------------------------|--------|------------------------------------|-------------|---------|
| Park and Eicher-Miller, 2014<sup>1</sup> | Cross-sectional, United States | 1,045 pregnant females | HFSSM | FI | Iron deficiency anemia (ID) |
| Carmichael et al., 2007<sup>2</sup> | Case-control, Los Angeles, San Francisco, and Santa Clara, United States | 1,189 case mothers and 695 control mothers | HFSSM-6SF | FI | Congenital defects |
| Hromi-Fiedler et al., 2011<sup>3</sup> | Cross-sectional, Hartford, Connecticut, United States | 135 low income pregnant Latinas, 25.24 years (SD = 5.65) | HFSSM | Household food insecurity | prenatal depressive symptoms-EPDS |
| Laraia et al., 2006<sup>4</sup> | Cohort, University of North Carolina Hospitals, United States | 606 pregnant women, 16–45 years | HFSSM | Economic / demographic and psychosocial predictors | FI |
| Laraia et al., 2010<sup>5</sup> | Cohort, United States | 810 pregnant women, 27.3 years (DP =5.5) | CSFM | FI | Gestational complications |
| Laraia et al., 2013<sup>6</sup> | Cohort, North Carolina, United States | 1041 pregnant women, 29.3 years (DP = 5.5) | CSFM | FI/ food restriction / pregestational weight retention | Gestational weight gain |
| López-Sáleme et al., 2012<sup>7</sup> | Cross-sectional, Cartagena, Colombia | 413 pregnant women | ELCSA | FI | Gestational nutritional status |
| Quintero Tabares et al., 2010<sup>8</sup> | Cross-sectional, Pereira, Colombia | 150 pregnant women, median 17 years | ELCSA | - | - |
| Stevens et al., 2017<sup>9</sup> | Cross-sectional, northern Bangladesh. | 288 pregnant women, 25.3 (SD = 5.7) | HFIAS | Seasonality | Household food security, dietary diversity and nutritional status |
| Tsai et al., 2016<sup>10</sup> | Longitudinal, three-year cluster-randomized trial, Cape Town, South Africa | 1238 pregnant women | HFIAS | FI | Depression symptom severity |
| Zapata-López and Restrepo-Mesa, 2013<sup>11</sup> | Cross-sectional, Medellín, Colombia | 294 pregnant teenager, 17.3 years (DP: 1.5) | ELCSA | Socio-economic / food safety / health factors | Anthropometric measures |
| Gamba et al., 2016<sup>12</sup> | Cross-sectional study, United States | 1158 pregnant women ≤ 20- >30 | HFSSM | Household food security status | Diet quality |

it continues
Chart 4. Characteristics of studies included in the quantitative synthesis.

| Authors                  | Design/ country of origin                  | Sample                                                                 | Evaluation of food insecurity (FI) | Exposure(s)                                   | Outcome                                      |
|--------------------------|--------------------------------------------|------------------------------------------------------------------------|-----------------------------------|-----------------------------------------------|----------------------------------------------|
| Eaton et al., 2014        | Prospective cohort, Cape Town, South Africa | 95 pregnant women 29.85 (SD = 9.73)                                    | HFSSM                             | Alcohol Use                                   | Food Insecurity                              |
| Hojaji et al., 2015       | Cross-sectional study, Tehran.             | 700 mothers 29 (SD = 5)                                                | HFSSM                             | Household food security                       | Pregnancy complications                      |
| Jebena et al., 2015       | Cross-sectional, Oromia Regional State, southwest Ethiopia | 2,987 pregnant women 25.5 (SD = 4.9)                                  | HFIAS                             | Household food security                       | Mental distress                              |
| Laraia et al., 2015       | Prospective cohort, North Carolina         | 688 pregnant women 28.26 (SD = 6.22)                                  | CFSM                              | Household food security                       | Mental distress                              |
| Morales et al., 2016      | Retrospective analysis, Chelsea, Massachusetts | 1.295 pregnant women (aged ≥18 y)                                     | Food access variables             | FI                                            | Cardiovascular Health                        |
| Na et al., 2016           | Cluster-randomized, northwestern Bangladesh |                                                                       | HFSSM                             | HFI                                           | Maternal diet                                |
| Natamba et al., 2014      | Mixed-methods, cross-sectional, northern Uganda | 403 pregnant women, 24.7 (SD = 5)                                    | Food insecurity access scale      | -                                             | -                                           |
| Oliveira et al., 2017     | Cross-sectional, Maceió, Brazil            | 428 pregnant women, 23.9 (SD = 6)                                     | EBIA                              | -                                             | Anemia                                       |
| Power et al., 2017        | Cohort, Bradford                           | 1593 women, 27.66 (5.6)                                                | HFSSM.                             | FI and some demographic and socioeconomic characteristics | Planned and unplanned pregnancy            |
| Rasty et al., 2015        | Case-control study, Falavarjan, Isfahan    | 200 women with unplanned pregnancy (cases) and 200 women with planned pregnancy | HFSSM                             | FI                                            | -                                           |
| Yadeegari et al., 2017    | Cross sectional, Rasht (Iran).             | 420 pregnant women, 27.6 (SD = 5.8)                                   | HFSSM                             | -                                             | -                                           |
| Demétrio et al., 2017     | Cross sectional, Santo Antonio de Jesus, Brazil | 245 pregnant women                                                    | HFSSM–6SF                         | Food Insecurity, Prenatal Care               | Anemia                                       |
| Marano et al., 2014       | Cross-sectional, Rio de Janeiro, Brazil    | 1,535 women in the first trimester of pregnancy, 13 - 45 years         | EBIA                              | Socio-economic / demographic / obstetric / FI factors | Pregestational anthropometric nutritional status |
| Heberlein et al., 2016    | Prospective cohort, United States          | 248 pregnant women 23.6 (4.9)                                          | HFSSM–6SF                         | Prenatal care in late pregnancy and early postpartum | Psychosocial outcomes among food-insecure |

Food insecurity (FI), HFSSM Six-Item Short Form (HFSSM-6SF), Household Food Security Survey Module (HFSSM), Latin American and Caribbean Food Security Scale (ELCSA), Food and Nutrition Technical Assistance Project’s Household Food Insecurity Access Scale (HFIAS); Brazilian Household Food Insecurity Measurement Scale (EBIA).
Figure 2. Risk of bias – Summary of all studies.

Table 1. Risk bias assessment using RTI Item Bank for the studies included in the meta-analysis.

| Authors                  | Question Numbers | Overall Judgment on Risk of Bias |
|--------------------------|-------------------|---------------------------------|
| Carmichael et al., 2007  | +     +     +     -     +     +     +   | High                            |
| Hromi-Fiedler et al., 2011 | +     +     +     -     ?     +     +   | High                            |
| Laraia et al., 2006      | +     +     +     -     +     +     +   | High                            |
| Laraia et al., 2010      | +     +     +     -     +     +     +   | High                            |
| Laraia et al., 2013      | ?     +     +     -     +     +     +   | High                            |
| López-Sáleme et al., 2012 | -     +     +     +     +     +     -   | High                            |
| Marano et al., 2014      | +     +     +     -     +     +     +   | High                            |
| Park et al., 2014        | -     +     +     +     +     +     +   | High                            |
| Quintero et al., 2010    | +     +     +     -     +     -     -   | High                            |
| Stevens et al., 2016     | +     +     +     +     +     +     +   | High                            |
| Tsai et al., 2016        | +     +     +     +     +     +     +   | Low                             |
| Zapata-López et al., 2013 | +     +     +     +     +     +     +   | Low                             |
| Gambda et al., 2016      | +     +     +     +     +     +     +   | Low                             |
| Eaton et al., 2014       | ?     +     +     +     +     +     -   | High                            |
| Heberlein et al., 2016   | +     +     +     _     +     +     +   | High                            |
| Hojaji et al., 2015      | +     +     +     _     +     +     +   | High                            |
| Jebena et al., 2015      | +     +     +     +     +     +     +   | Low                             |
| Laraia et al., 2015      | +     +     +     +     +     +     +   | Low                             |
| Morales et al., 2016     | +     +     +     +     -     -     -   | High                            |
| Na et al., 2016          | +     +     +     +     +     +     +   | High                            |
| Natamba et al., 2014     | +     +     +     ?     +     +     +   | Moderate                        |
| Oliveira et al., 2017    | +     +     +     +     +     +     +   | Low                             |
| Power et al., 2017       | +     +     +     +     +     +     +   | Low                             |
| Rasty et al., 2015       | +     +     +     -     +     +     +   | High                            |
| Yadegari et al., 2017    | +     +     +     +     +     +     -   | High                            |
| Demetrio et al., 2017    | +     +     +     +     +     +     +   | Low                             |

Key: + = low risk of bias; – = high risk of bias; ? = unclear risk of bias.
Food insecurity in pregnant women and nutritional outcomes

As shown in Figure 4, food insecurity was considered to be an exposure factor for the occurrence of adverse nutritional outcomes in 7 studies. Food insecurity in the pre-gestational phase was associated with obesity (PR = 1.47, 95% CI = 1.15-1.87; Figure 4.1) and overweight (PR = 1.57, 95% CI = 1.29-1.91; Figure 4.2). During gestation, food insecurity increased the occurrence of both excessive weight gain (PR = 1.42, 95% CI = 1.10-1.82; Figure 4.3) and inadequate weight gain (PR = 1.47, 95% CI = 1.09-1.97; Figure 4.4). FI did not have a statistically significant association with anemia during pregnancy (PR = 1.28, 95% CI = 0.89-1.84; Figure 4.5).

Discussion

Many social determinants are associated with the food and nutritional security situation during pregnancy. This phase in a woman’s life is a time when psychological and physiological transformations can lead to vulnerability within the context of social inequity, such as poverty and lack of coverage by social policies. The results of this study show that social determinants such as race, participation in social programs, education, and marital status are associated with an increase in the occurrence of FI in pregnant women. On the other hand, FI during the pre-gestational period increased the occurrence of being overweight or obese, and provoked an increase in both excessive and inadequate weight gain during gestation.

Over the past seventeen years (2000-2017), the number of published studies on food and nutritional safety conditions in pregnant women has increased. However, this scientific production is concentrated mostly in North American countries. The need to carry out studies on the subject in countries with different social and ep-
Figure 4. Food insecurity in pregnant women and nutrition outcomes.

idemological contexts is therefore evident, considering the many negative outcomes to women’s health associated with food and nutritional insecurity, especially during the gestational period. It should be emphasized, however, that most of the studies that have been carried out are cross-sectional, making it difficult to assess the repercussions of FI on women’s health and nutrition. In addition, qualitative studies that investigate subjective and socio-cultural issues experienced by women facing FI are scarce. It is therefore necessary that future studies be conducted to consider these aspects.

Household Food Insecurity is correlated to social indicators, specifically related to education, family income, and participation in social protection programs. However, in addition to financial constraints and adverse conditions related to poverty that make families vulnerable to HFI, racial determinants, such as black skin color, are also correlated to the condition of FNI in pregnant women. These
factors contribute to the violation of the right to adequate food, health, education, and housing. Therefore, social and racial inequities reinforce themselves through food and nutritional insecurity, especially when this occurs during gestation.

Social assistance programs targeting poor families may potentially be associated with FI in pregnant women17,25,33,34. This relationship indicates that social protection programs are adequately focused on pregnant women in situations of social inequality, but do not reinforce inequalities.

The present study identified that the relationship between FI and the anthropometric nutritional status of the mother was the object of greatest investigative focus among the surveys18-20,33,38. In most of these studies, FI was associated with excess weight (overweight/obesity)18-20,33,38. This demonstrates the fact that anthropometric nutritional deviations in pregnant women accompanied changes in the nutritional profile of the overall population, marked by the steady increase of obesity and food consumption, with the predominance of densely caloric foods having reduced vitamin, mineral, and antioxidant content, resulting in situations of nutritional insecurity. In this way, poorer families end up purchasing more energy-dense foods, especially in societies where these foods are cheaper40.

This change, characterized by a decrease in the occurrence of malnutrition (or underweight) along with an increase in the prevalence of being overweight and obese, corroborates the phenomena of nutritional transition in underdeveloped and developing countries, as well as in developed countries9,38. The condition of FNI can also be associated with nutritional deficit and thinness. Thus, in contexts of severe or moderate FNI, pregnant women may experience food deprivation and hunger, contributing to thinness and insufficient weight gain during pregnancy.

FI may be especially critical during pregnancy17. This is because nutritional requirements increase due to physiological changes that occur in pregnant women, such as an increase in basal metabolism caused by accelerated synthesis of fetal, placenta, uterine mammary tissues, and maternal reserve, and an increase in the mass of metabolically active tissue and cardio-respiratory work. The effort necessary to prepare food may become more difficult and pregnant women may be obliged to leave work, especially at the end of the pregnancy, leading to financial restrictions. All of these factors can influence nutrition, health conditions, and nutritional status of pregnant women and result in adverse outcomes for the pregnancy17.

It is important to note that some factors that influence maternal food insecurity17, such as the increased effort to prepare food and the “forced” abandonment of work at the end of the pregnancy, do not apply to the reality of women who have a support network during pregnancy, either from the family, or a partner or spouse. It is important to consider that pregnancy is not a phase of life affected only by biological and individual factors, but also by collective – family and socio-cultural factors. Therefore, the occurrence of FI during pregnancy and its repercussions on the health and nutrition of pregnant women also depends on the interrelations among these factors.

Both developed and developing countries, such as Brazil, have experienced changes in social and urban standards since the beginning of the 21st century, with improvements in sanitary conditions and reduction of misery and poverty. It is possible that these standards, when considered in a neoliberal globalization context, have influenced the health and nutritional conditions of women and men differently41. In this scenario, emphasis is given to the phenomena of epidemiological and nutritional transition, in which, paradoxically, FI is associated both with infectious/contagious diseases and deficiencies, such as chronic non-transmissible diseases that mainly affect psychosocial biologically vulnerable groups, such as pregnant women41.

The relation between FI and anemia in pregnant women and those of reproductive age was another important object of investigation in the studies22,37. This relationship was confirmed in the surveys conducted by Park & Eicher-Miller1, on North American pregnant women. Quintero Tabares et al.21 performed only a descriptive approach on the prevalence of outcomes investigated, among which anemia and FI were included.

Considering that pregnant women belong to a psycho-biologically vulnerable group, it is possible that in the context of socio-economic vulnerability and FI, the development of anemia could occur at a higher rate during pregnancy31,37. Anemia causes undesirable effects to the health of pregnant women and fetuses. This is because its occurrence during pregnancy has been associated with a higher mortality rate for mother and fetus, an increase in the risk of alterations to the immunological and cardiovascular functions of pregnant women, with a higher blood loss during birth, and a higher risk of premature birth and weight deviations at birth (low weight). Also,
newborns may have iron reserves below normal and a higher risk of developing anemia during the first months of their lives\textsuperscript{35,37}.

While investigations using a quantitative approach of an epidemiological nature were concerned with examining the association between FI and specific outcomes or identifying prevalent factors associated with FI, those using a qualitative and theoretical approach aimed to analyze and understand the interrelations between FI and both macro and microstructural factors such as neoliberal globalization and economic policies that empower women farmers, as well as aspects such as gender, psychosocial factors, culture, environment, and access to health services\textsuperscript{7-9}.

Limitations and future directions

This meta-analysis has some limitations, the first being with regard to the study design. The review was dominated by cross-sectional studies, hindering the investigation between exposure to FI and the emergence of adverse nutritional outcomes and making it difficult to determine causality. Future studies on this subject should take into account the design of the prospective studies. The second limitation refers to how food insecurity was classified in the studies analyzed. It was not possible to achieve greater detail on the degree of food insecurity due to different scales used in the evaluation of the FI situation. Even considering such limitations, this is the first systematic review using meta-analysis on the relationship between FI, social determinants, and nutritional outcomes, and which emphasizes the importance of focusing on food and nutrition policies aimed at promoting and realizing the right to adequate food for pregnant women.

Regarding the methodological quality of the studies analyzed, most presented low bias risk. The main problems found with the studies were absence of sample calculations and the use of non-probabilistic sampling. It is evident that epidemiological studies with representative samples should be conducted on the association between FI, social determinants, and nutritional state in pregnant women.

A greater frequency of studies was noted reporting that black skin color, low education levels, and participation in social protection programs are consistently associated with an elevated occurrence of FI in pregnancy.

Food insecurity has important implications for the health and nutrition of individuals. FI increased the chances of both excessive weight gain and inadequate weight gain during pregnancy. Gaps remain in understanding the direction of association and causality of these events.

This review also demonstrated that scientific research on FI, gestation, and their interrelations is still scarce. FI in women encompasses a wide range of factors, from nutritional and health issues to social, cultural, economic, environmental, and political issues, indicating the importance of interdisciplinary and integrated approaches.

The development of prospective studies in different countries is recommended, in order to test the relationship between food insecurity and social determinants, mental health, and nutritional outcomes in pregnancy. The sample size should be suitable for comparison between the groups, confounding control and reverse causation assessment. Further studies are needed that may contribute towards extending the range of knowledge on the effects of FI on the health of pregnant women and of the family, and the formation of health and nutrition policies that guarantee the FNS of women during gestation.
Collaborations

F Demetrio and M Pereira participated in the article’s conception, systematic literature review, analysis, and writing and final revision. DB Santos and CAS Teles participated in the critical revision and approval of the final version.

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