Exceso de peso pregestacional y resultados maternos adversos: una revisión sistemática de estudios previos en Brasil

Thelma Brandão¹, Carolina Felizardo de Moraes¹, Danielle Masterson Ferreira², Karina dos Santos¹, Patricia de Carvalho Padilha¹ and Cláudia Saunders¹

¹Department of Nutrition and Dietetics. Instituto de Nutrição Josué de Castro. Grupo de Pesquisa em Saúde Materna e Infantil-GPSMI. Universidade Federal do Rio de Janeiro-UFRJ. Rio de Janeiro, Brazil. ²Central Library. Universidade Federal do Rio de Janeiro-UFRJ. Rio de Janeiro, Brazil

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Abstract

Introduction: obesity is increasing among women at reproductive age in Brazil. Excess body weight during pregnancy negatively impacts women’s health.

Objectives: to identify and analyze the publications that showed the effects of pregestational excess weight on pregnancy, delivery, and post-delivery in Brazilian women.

Methods: this systematic review was performed including studies that involve Brazilian pregnant women with adverse outcomes caused by pregestational excess weight. Search, selection, and reporting were conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. The study was conducted by manually searching and screening the databases LILACS, PubMed, Scopus, Cochrane, and Periodicos CAPES. The selected articles were evaluated according to the quality of evidence using the Grading of Recommendations, Assessment, Development and Evaluation (GRADE), and categorized as studies with high (A), moderate (B), low (C), or extremely low (D) evidence quality.

Results: a total of 1,582 studies were found, of which 39 were included for final reading and evaluation. Among these, 12.8 %, 69.2 %, and 18.0 % were classified as A, B, and C or D for evidence quality, respectively. Hypertensive disorders of pregnancy, caesarean section, excessive weight gain, and gestational diabetes mellitus were commonly associated with pregestational excess weight in Brazilian women.

Conclusions: the negative effects of excess body weight during pregnancy reflect the need for effective public policies that can address the problem, focusing on interventions that promote the health of women at reproductive age.

Resumen

Introducción: la obesidad está aumentando entre las mujeres en edad reproductiva en Brasil. El exceso de peso corporal durante el embarazo afecta negativamente a la salud de las mujeres.

Objetivos: identificar y analizar publicaciones que mostraran los efectos del exceso de peso pregestacional sobre el embarazo, el parto y el posparto en mujeres brasileñas.

Métodos: esta revisión sistemática incluye estudios de mujeres embarazadas brasileñas con resultados adversos causados por el exceso de peso pregestacional. La búsqueda, la selección y la presentación de los resultados se realizaron de acuerdo con el sistema Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). El estudio se realizó mediante la búsqueda manual y el cribado de las bases de datos LILACS, PubMed, Scopus, Cochrane y Periódicos CAPES. Los artículos seleccionados se evaluaron de acuerdo con la calidad de la evidencia utilizando el sistema Grading of Recommendations, Assessment, Development and Evaluation (GRADE), y se clasificaron como estudios de alta (A), moderada (B), baja (C) o extremadamente baja (D) calidad de la evidencia.

Resultados: se encontraron un total de 1582 estudios, de los cuales 39 se incluyeron para su lectura final y evaluación. Entre estos, el 12.8 %, 69.2 % y 18.0 % se clasificaron como A, B y C o D en cuanto a calidad de evidencia, respectivamente. Los trastornos hipertensivos del embarazo, la cesárea, el aumento de peso excesivo y la diabetes mellitus gestacional se asociaron comúnmente con el exceso de peso pregestacional en las mujeres brasileñas.

Conclusiones: los efectos negativos del exceso de peso corporal durante el embarazo reflejan la necesidad de políticas públicas efectivas que puedan abordar el problema, centrándose en intervenciones que promuevan la salud de las mujeres en edad reproductiva.

Keywords:

Pregestational excess weight and adverse maternal outcomes: a systematic review of previous studies in Brazil

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Correspondence:

Cláudia Saunders. Instituto de Nutrição Josué de Castro. Universidade Federal do Rio de Janeiro. Centro de Ciências da Saúde, Bloco J. Av. Carlos Chagas Filho, 373. Cidade Universitária. Rio de Janeiro 21941-902. Brasil. e-mail: claudiasaunders@nutricao.ufrj.br

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INTRODUCTION

The prevalence of excess body weight (overweight and obesity) has significantly increased worldwide, and a rapid increase has been observed in low- and medium-income countries (1). Currently, more than 50 % of women at reproductive age are overweight, and approximately a 21 % increase in the prevalence rate of obesity may be expected up to 2025 (2,3). In Brazil, 20.7 % of women are obese (4).

The incidence of excess body weight among pregnant women is considered a public health concern due to its serious short- and long-term effects on the health of women and children (5). Excess body weight might affect fertility, conception, embryogenesis, pregnancy, delivery, and post-delivery. Furthermore, maternal obesity might also promote a change in intraterine environment due to epigenetic factors, causing obesity and its associated morbidities in the offspring (6).

Among the adverse maternal outcomes associated with excess body weight during pregnancy are gestational diabetes mellitus (GDM), hypertensive disorders of pregnancy (HDP), genitourinary tract infections, obstructive sleep apnea, thromboembolic diseases, cholecystitis, depression, higher number of cesarean sections and instrumental deliveries (use of forceps, spatulas, and vacuum extractors), miscarriages, delivery-related complications, and issues associated with breastfeeding (7-10).

Because of the effects of overweight and obesity on the health of women, the urgency of interventions for the target group, and the growing of obesity rates in Brazil, this study aimed to identify and analyze the publications that showed the effects of pregestational excess weight on pregnancy, delivery, and post-delivery in Brazilian women, which might provide results according to the specificities of our population.

METHOD

This review was conducted from June 2016 to March 2017, and the researchers received assistance from a librarian who specializes in this study design. The recommendations found in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement (11) were used as tools to guide the elaboration, along with the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) (12). Therefore, considering these criteria, the studies were classified as studies with high (A), moderate (B), low (C), or extremely low (D) evidence grade.

ELIGIBILITY CRITERIA

Observational studies and clinical trials involving pregnant women who presented with adverse outcomes caused by pregestational excess weight, and who lived within the Brazilian territory were eligible for the present study, without restrictions of language or date of publication. Editorials, non-controlled clinical trials, clinical cases, abstracts, pilot studies, systematic reviews, narratives, and deliberative conferences were excluded.

Studies involving teenagers (< 20 years), women who had multiple pregnancies, diseases prior to pregnancy, or pregnancy after bariatric surgery, and women with absence of information regarding nutritional status were excluded. Articles involving women with adverse outcomes who were breastfeeding were excluded from the final step of the study after re-evaluation of objectives.

Self-reported or measured pregestational body weight and height were used in calculating body mass index (BMI = weight/height in meters²), with cut-off values established according to the criteria that were valid when the studies were conducted. BMI was used to identify pregestational nutritional status (8).

Thus, all adverse outcomes that represented a risk to maternal health were considered, without any previous limitations. A p-value < 0.05 and/or associated measurements with their respective 95 % or 97 % confidence intervals not comprising the value 1 were considered statistically significant.

SOURCES OF INFORMATION AND SEARCH STRATEGIES

Original articles without any restriction in terms of language or date of publication were obtained from the data bases LILACS, MEDLINE via PubMed, Cochrane Library, and Scopus. Additional searches were conducted in the bank of theses and dissertations of Coordination for the Improvement of Higher Education Personnel (Periódicos CAPES).

The descriptors used for the bibliographic search were chosen using the terms in Descritores em Ciências da Saúde (DeCS), in Portuguese, and in Medical Subject Headings (MeSH), in English. Therefore, the following terms were used in the methodology: ‘pregnancy’, ‘gestation’, and ‘pregnant women’ and ‘overweight’, ‘obesity’, ‘body mass index’, with their corresponding terms in Portuguese in the context ‘Brasil’ or ‘Brazil’, with Boolean operators OR and AND used for word connection.

The controlled vocabulary (MeSH terms) and free terms in the search strategies were defined according to the PECOS system, where population (P) refers to Brazilian adult pregnant women, exposure (E) to overweight and obesity, control (C) to eutrophic adult pregnant women, and results (O) to adverse outcomes or maternal complications, without any restriction of work type (S) in this instance.

The search strategy was properly designed for PubMed, and modified for the other databases; thus, eligible studies were identified (Table I).

ARTICLE SELECTION AND DATA EXTRACTION

The articles were selected based on the previously established criteria for eligibility. The initial selection by title and Abstract was performed independently by two researchers, and non-concordant cases were evaluated by a third researcher. When an article was found in more than one database, only one was considered.

Initially, titles and abstracts were evaluated to assess if they met the pre-defined inclusion criteria. Next, the researchers indepen-
dently or by pairs reviewed the full articles, and the third reviewer was consulted in case of disagreement.

Data from the articles were then entered in spreadsheets containing the relevant study characteristics important for interpreting the results (study type, follow-up period, control of confusion factors, and adjustments), and analyzed in terms of the quality of evidence as based on the GRADE methodology. The last procedure was conducted independently, with the conflicting cases being evaluated by the third researcher.

RESULTS

The summary of the selection process is shown in the flow diagram (Fig. 1). In total, 39 of 1,582 publications initially screened were selected for final analysis. Of these, 5 (12.8 %), 27 (69.2 %), and 7 (18.0 %) were classified as A, B, and C or D regarding evidence grade, respectively, using the GRADE guideline.

DESCRIPTION OF THE STUDIES INCLUDED

The summary of the general characteristics and qualitative evaluation of the studies is presented in table II. The included studies, all observational in nature, had different sample sizes, objectives and outcomes, were performed between 1991 and 2015, and were published between 2001 and 2016. Most of the investigations focused on the south and south-eastern regions of Brazil (74.4 %). About two-thirds of the studies used the recommendations of the World Health Organization (1998), adopted by the Institute of Medicine (2009), for the classification of pregestational nutritional status. Only one article had a distribution of BMI per quartiles. Approximately, 30 % of the studies on excess body weight classified BMI in two independent categories (overweight and obese), and 38.2 % classified it in one category (BMI: ≥ 25 kg/m², ≥ 30 kg/m², or ≥ 35 kg/m²). Studies on maternal outcomes according to class of obesity were not available during the period of data collection.
Table I. Search strategies used on the electronic databases PubMed, Scopus, Lillacs, and Cochrane Library

| Database      | Search Strategy                                                                 |
|---------------|---------------------------------------------------------------------------------|
| PubMeda       | ((gestation[Mesh] OR gestation[tiab] OR Pregnancy[Mesh] OR pregnancy*[tiab] OR pregnant women[tiab]) AND (Obesity[Mesh] OR obesity[tiab] OR overweight[Mesh] OR overweight[tiab] OR body mass index[Mesh] OR body mass index[tiab] OR BMI[tiab])) |
|               | Without Brazil and BMI                                                         |
|               | ((gestation[Mesh] OR gestation[tiab] OR Pregnancy[Mesh] OR pregnancy*[tiab] OR pregnant women[tiab]) AND (Obesity[Mesh] OR obesity[tiab] OR overweight[Mesh] OR overweight[tiab] OR body mass index[Mesh] OR body mass index[tiab] OR BMI[tiab])) |
|               | Delimiting by Brazil* or Brazil*                                               |
|               | (((Brazil* OR Brasil*)) AND (gestation[Mesh] OR gestation[tiab] OR Pregnancy[Mesh] OR pregnancy*[tiab] OR pregnant women[tiab]) AND (Obesity[Mesh] OR obesity[tiab] OR overweight[Mesh] OR overweight[tiab] OR body mass index[Mesh] OR body mass index[tiab] OR BMI[tiab])) |
| Lillacsb      | (tw:(tw:(tw:(tw:(Mh: gestation OR gestação OR Mh: pregnancy or gravidez)) OR (tw:(gestation OR gestação OR pregnant women OR germinates))))) AND (tw:(tw:(tw:(mh: “body mass index” or “Índice de massa corporal”) ))) OR (tw:(tw:(proc: Obesity OR obesidade OR prénom: overweight OR sobrepeso))))))) AND (tw:(tw:(tw:(Mh: Brazil OR Brasil))))) AND (tw:(tw:(Brazil$ OR Brasil$)))) |
| Scopusc       | (TITLE-ABS-KEY ((gestation OR “pregnant women” OR pregnancy*)) AND (TITLE-ABS-KEY (obesity OR overweight OR “body mass index”))) |
|               | Delimiting by Brazil                                                          |
|               | (TITLE-ABS-KEY ((brazil* OR brasil*))) |
|               | Combination of results                                                        |
|               | (TITLE-ABS-KEY ((gestation OR “pregnant women” OR pregnancy*)) AND (TITLE-ABS-KEY ((obesity OR overweight OR “body mass index” OR bmi)))) AND (TITLE-ABS-KEY ((brazil* OR brasil*))) |
| Cochrane Libraryd | #1 MeSH descriptor: [Pregnancy] explode all trees: #2 (pregnancy or gestation or pregnant women) : #3 #1 or #2: #4 MeSH descriptor: [Obesity] explode all trees: #5 (obesity): #6 #4 or #5: #7 MeSH descriptor: [Overweight] explode all trees: #8 (overweight) : #9 or #8: #10 MeSH descriptor: [Body Mass Index] explode all trees: #11 (“body mass index” or BMI)): #12 #10 or #11: #13 #6 or #9 or #12 : #14 #3 and #13: |
|               | Delimiting by Brazil                                                          |
|               | #15 MeSH descriptor: [Brazil] explode all trees: #16 (Brazil* or Brasil*): |
|               | Combination of results                                                        |
|               | #17 #15 or #16: #18 #3 and #13 and #17:                                       |

*Updated in 10/21/2016; *Updated in 10/22/16; *Updated in 10/28/16; *Updated in 10/05/16. P: population; E: exposure.

More than half of the selected studies (51.8 %) reported adverse outcomes associated with excess body weight, including HDP, caesarean section, inadequate weight gain during pregnancy, and GDM. In addition, approximately 48 % of the studies showed an association between pregestational excessive body weight and repeated miscarriages/losses, postpartum weight retention, infections, periodontal disease, metabolic changes, iron deficiencies, behavioural changes, anaesthetic changes, and post-delivery bleeding.

**DISCUSSION**

The effect of increased BMI on gestation has been widely reported in international studies (52). In addition, there is a dose-response effect with worse outcomes when an increase in obesity class is observed (53). However, in Brazil only few studies focus on this issue due to the difficulty in conducting studies with more representative sample sizes that include pregnant women with excess body weight.

In this review, only results from observational studies were included due to the lack of clinical trials that met the eligibility criteria. Although observational studies are considered as a priori with low quality of evidence, they might assume a better status when methodological criteria are well established and findings are consistent (12). Therefore, some of the studies presented here revealed these conditions.

**PREGNANCY-RELATED OUTCOMES**

HDP (or increase in blood pressure) and GDM were identified as common clinical findings associated with overweight and obesity (13-18,20,23,25,26,33,51). These results are similar worldwide (54).
Table II. Selected studies about the effects of pregestational excess weight on maternal outcomes in Brazilian pregnant women

| Author               | Type of study     | Reference       | No. of participants | Outcomes                          | Comparison group (Yes/No) | Adjustment (Yes/No) | Relevant results of the study                                                                                           | Level of evidence GRADE |
|----------------------|-------------------|-----------------|---------------------|-----------------------------------|---------------------------|---------------------|--------------------------------------------------------------------------------------------------------------------------|--------------------------|
|                      |                   |                 |                     |                                   |                           |                     | Higher risk between OW and OB compared to eutrophic pregnant women: for GDM, OR = 2.0 (95 % CI: 1.60-2.5) and OR = 2.4 (95 % CI: 1.7-3.4); for HDP, OR = 2.5 (95 % CI: 2.0-3.0) and OR = 6.6 (95 % CI: 5.0-8.6). Obesity was a risk factor for PE, OR = 3.9; (95 % CI: 2.4-6.4). Multiple logistic regression | A                        |
| Nucci et al. (13)    | Cohort            | WHO, 1998       | 5,314 (5,564)       | Gestational diabetes mellitus      | Gestational hypertensive disorders of pregnancy | Yes                  | Higher risk of GDM and PE in pregnant women with BMI ≥ 25: GDM, RR = 1.52 (95 % CI: 1.35-2.90); PE, RR = 1.72 (95 % CI: 1.47-2.02)                                                                 | B                        |
| Assis et al. (14)    | Case-control      | Not informed    | 890 (121 with HSP; 102 controls) | Gestational hypertension           | Gestational hypertension superimposed to preeclampsia | Yes                  | Obesity was an independent risk factor for gestational hypertension, OR = 17.636 (95 % CI: 2.859-108.774), p = 0.002, and for GHSP, OR = 27.307 (95 % CI: 4.433-167.440), p < 0.001 Multivariate logistic regression analysis | C                        |
| Wendland et al. (15) | Prospective cohort | WHO, 1998       | 4,766 (5,564)       | Gestational diabetes mellitus      | Preeclampsia               | Yes                  | Higher risk for the GDM: OW, OR = 2.08 (95 % CI: 1.2-3.3); OB, OR = 3.75; (95 % CI: 2.25-6.27)                                                                 | A                        |
| Dode et al. (16)     | Cohort            | WHO, 1998       | 3,079 (4,243)       | Gestational diabetes mellitus      | Yes                       |                     | Risk for the GDM: Pregnant women with BMI ≥ 25 kg/m² Preeclampsia OR = 3.3; (95 % CI: 1.1-9.9), p = 0.03                                                                 | B                        |
| Seabra et al. (17)   | Cross-sectional   | WHO, 1998       | 433 (OW or OB = 24.5 %) | Preeclampsia                      | Yes                       |                     | BMI ≥ 25: PE, RR = 17.7 (95 % CI: 2.1-137.5), p = 0.003 Caesarean section, RR = 1.7 (95 % CI: 1.1-2.8), p = 0.002 Multivariate regression analysis of Poisson | B                        |
| Santos et al. (18)   | Prospective cohort | WHO, 1998       | 204                 | Preeclampsia                      | Caesarean section        | Yes                  | Women with PE showed higher BMI when compared to normotensive women (p = 0.02). Preeclampsia risk increases with BMI, OR = 1.12 (95 % CI: 1.02-1.24 (p = 0.023) Logistic regression | B                        |
| Vogt et al. (19)     | Cross-sectional   | IOM, 1990       | 334 (157 with periodontal disease, 47 %) | Periodontal disease               | Yes                       |                     | Risk of periodontal disease Obese, OR = 1.38; (95 % CI: 1.04-1.82)                                                                 | B                        |
| Dantas et al. (20)   | Prospective case-control | WHO, 1998 | 218 (242) | Preeclampsia                      | Yes                       | No                   | (Continuation in the next page)                                                                                          | B                        |
Table II (Cont.). Selected studies about the effects of pregestational excess weight on maternal outcomes in Brazilian pregnant women

| Author            | Type of study Reference adopted for PGNS | No. of participants | Outcomes Comparison group (Yes/No) | Adjustment (Yes/No) | Relevant results of the study Statistics | Level of evidence |
|-------------------|----------------------------------------|---------------------|------------------------------------|---------------------|------------------------------------------|-------------------|
| Gestational outcomes: clinical complications (Cont.) |
| Camargo et al. (21) | Cross-sectional IOM, 1990            | 146 (221) (Losses 21%) Cuíaba, MT 2008-2009 | Iron deficiency          | Correlation between pregravid BMI and iron deficiency (p = 0.025) Pearson's coefficient of correlation | D               |
| Oliveira et al. (22) | Cross-sectional Multicentric IOM, 1990 | 495 SP, RS, PR 2009 | Urinary incontinence Yes            | Pregnant women with OW and OB presented a risk of urinary incontinence 2 to 4 times higher than eutrophic women (p < 0.001) Multivariate logistic regression analysis | B               |
| Queiroz et al. (23) | Cross-sectional WHO, 1998            | 10,154 (2 % < 18 years and 1.0 % twins) Southeast of Brazil 2001-2012 | Hypertensive disorders of pregnancy Yes         | Higher risk of HDP in women with: OW, OR = 1.8, (95 % CI: 1.4-2.3); OB, OR = 4.4, (95 % CI: 3.7-5.2) Multivariate logistic regression analysis | A               |
| Franco-Sena et al. (24) | Prospective cohort WHO, 1998 | 232 (299) Rio de Janeiro, RJ 2009-2011 | Changes in the plasma concentration of leptin Yes       | The changes are different according to pregravid BMI, but without statistical significance ANOVA/Kruskal-Wallis test Linear mixed-effect model of regression | B               |
| Rebelo et al. (25) | Prospective cohort WHO, 1998          | 189 (258) Rio de Janeiro, RJ 2009-2011 | Systolic blood pressure variationDBP variation Yes | Pregnant women with initial BMI ≥ 25 kg/m² presented higher SBP and DBP throughout gestation than pregnant women with initial BMI < 25 kg/m² (p < 0.05) Linear regression model | B               |
| Salles et al. (26) | Prospective cohort WHO, 1998          | 158 (258) Rio de Janeiro, RJ 2009-2012 | Increase of blood pressure in the middle of gestation Yes | Association between pregravid OB and increase of SBP and PAD; RR = 2.29; (95 % CI: 1.27-4.11) Linear mixed-effect model of regression | B               |
| Farias et al. (27) | Prospective cohort WHO, 1998          | 205 13 % of measurement information loss in the 3 trimesters Rio de Janeiro, RJ 2009-2011 | Change in the profile of lipids during gestation: Total cholesterol LDL-cholesterol Triglycerides HDL-cholesterol Yes | Higher triglycerides, total cholesterol and LDL-C, and lower HDL-C in pregnant women with BMI ≥ 25 (OW and OB) compared to eutrophic ones (p < 0.05) Linear mixed-effect longitudinal model of regression | B               |
| Oliveira et al. (28) | Prospective cohort WHO, 1998          | 115 (299) Rio de Janeiro, RJ2009-2011 | Changes in CRP throughout gestation Yes         | Obese pregnant women presented CRP higher than eutrophic ones (p < 0.05) Linear mixed-effect longitudinal model of regression | B               |
| Ribeiro et al. (29) | Cross-sectional WHO, 1998            | 233 (260) São Paulo, SP 2011-2014 | Sexual dysfunctional measured by the Female Sexual Function Index (FSFI) Yes | Pregnant women with BMI ≥ 25 (OW and OB) presented a higher risk of sexual dysfunction when compared to eutrophic ones (p < 0.0004) Student's t-test and Chi-squared/Pearson's correlation coefficient | B               |
Table II (Cont.). Selected studies about the effects of pregestational excess weight on maternal outcomes in Brazilian pregnant women

| Author                  | Type of study Reference adopted for PGNS | No. of participants Location Period | Outcomes Comparison group (Yes/No) Adjustment (Yes/No) | Relevant results of the study Statistics | Level of evidence GRADE |
|-------------------------|-----------------------------------------|------------------------------------|--------------------------------------------------------|------------------------------------------|-------------------------|
| Ribeiro et al. (30)     | Cross-sectional WHO 1998                | 233 (260) São Paulo, SP 2011-2014  | Sleep quality measured by the Pittsburg Sleep Quality Index (PSQI) Yes Yes | Pregnant women with BMI ≥ 25 (OW and OB) showed the worst sleep quality compared to eutrophic ones – BMI ≤ 25 kg/m² (p < 0.02) Student’s t-test and Chi-squared test | B                       |
| Meireles et al. (31)    | Cross-sectional WHO, 1998               | 55 Juiz Fora/MG (private hospitals) 2011 | Body image (EMIC- body image scale) No Yes | Negative correlation between BMI and EMIC (body image scale) (p ≤ 0.05) Pearson association test Comparison: one-way ANOVA and Scheffé post-hoc | D                       |
| Meireles et al. (32)    | Cross-sectional WHO, 1998               | 386 (417) Juiz Fora/MG (public and private hospitals) Year not informed | Body image ("Body Attitudes Questionnaire") No Yes | Body image associated with BMI (p < 0.05) Multiple linear regression forward | C                       |
| Vernini et al. (33)     | Cross-sectional WHO, 1998               | 258 (22.3 % teenagers, 26.3 % chronic hypertension, 12.8 % previous diabetes) Botucatu, SP 2012 | Hypertensive disorders of pregnancy GDM Yes No | OR = 7.0 (95 % CI: 3.1-15.9) OR = 5.5 (95 % CI: 2.9-10.6) Logistic regression | C                       |
| Nucci et al. (34)       | Cohort WHO, 1998                        | 3,082 (5,564) Capitals of CE, SP, RJ, RS, BA and AM States 1991-1995 | Weight gain No Yes | Excessive weight gain among pregnant women with excess weight (p < 0.05) Descriptive analysis/chi-square test/ Anova | C                       |
| Andretto et al. (35)    | Cohort IOM, 1990                        | 240 Recife, PE 2000-2001           | Weight gain Yes No | Excessive weight gain: 1st trimester OW/OB, RR = 3.85 (95 % CI: 1.74-8.51) 2nd trimester OW/OB, RR = 2.24 (95 % CI: 1.04-4.82) | B                       |
| Rodrigues et al. (36)   | Prospective cohort IOM, 1992            | 173 (255) Rio de Janeiro, RJ 2005-2007 | Weight gain Yes Yes | OB associated with excess weight gain, OR = 4.66; (95 % CI: 1.34-19.09) OW associated with insufficient weight gain, OR = 0.19; (95 % CI: 0.5-0.78) Multinomial logistic regression | B                       |

(Continuation in the next page)
| Author          | Type of study | Reference | Location                  | Period       | Outcomes | Comparison group (Yes/No) Adjustment (Yes/No) | Relevant results of the study Statistics | Level of evidence |
|-----------------|---------------|-----------|---------------------------|--------------|----------|-----------------------------------------------|------------------------------------------|-----------------|
| Drehmer et al.  | Cohort        | WHO (1998)| Porto Alegre and Bento    | 2006-2007    | Weight gain | Yes                                      | Excessive weight gain: OW, RR = 1.75; (95 % CI: 1.48-2.07) OB, RR = 1.55; (95 % CI: 1.23-1.96) Obs. stratified by age Multiple Poisson regression | B               |
| Marano et al.   | Cross-sectional | IOM (1990)| Rio de Janeiro, RJ        | 2007-2008    | Weight gain | Yes                                      | Excessive weight gain: SP, OR = 2.5; (95 % CI: 1.4-4.5) OB, OR = 2.7; (95 % CI: 1.8-3.9) Multinomial logistic regression | B               |
| Fragas et al.   | Cross-sectional | WHO/1998| Rio de Janeiro, RJ        | 2007-2008    | Weight gain | Yes                                      | Excessive weight gain: OW OR = 4.06; (95 % CI: 1.95-8.4) OB OR = 5.89; (95 % CI: 2.45-14.02) Multinomial logistic regression | A               |
| Seligman et al. | Cohort        | WHO, 1998 | RS, SP, RJ, BA, CE, AM states | 1991-1995 | Caesarean section Presence of meconium Infection | Yes                                      | Higher occurrence in obese pregnant women: RR = 1.8; (95 % CI: 1.5-2.0) RR = 1.72; (95 % CI: 1.23-2.30) RR = 2.41; (95 % CI: 1.13-5.01) Logistic regression analysis | A               |
| Paddy et al.    | Cross-sectional | WHO, 1998| SP, PE, and DF states | 2004 to 2005 | Caesarean section | Yes                                      | Higher risk of caesarean delivery in pregnant women with: BMI ≥ 25, PR = 1.29; (95 % CI: 1.10-1.52), p = 0.021 BMI ≥ 30, PR = 1.83; (95 % CI: 1.45-2.30), p = 0.008 Bivariate analysis | B               |
| Rodrigues et al.| Descriptive   | Retrospective WHO, 1998 | Campinas, SP | 2004-2006 | Surgery time Technical difficulty in puncture and palpation Bleeding Block failure | Yes                                      | Increase in surgery time, p = 0.007 Higher technical difficulty in puncture and palpation, p = 0.002 Higher bleeding and block failure – without significance Pearson's chi-square test Multinomial logistic regression | B               |
| Gonçalves et al. | Cross-sectional | Population-based WHO, 1998 | State of Rio Grande do Sul | 2007 | Caesarean section | Yes                                      | Increased BMI ↑ risk of caesarean section, being higher in the group with BMI ≥ 30 (p = 0.004) Logistic regression | C               |

(C)Continuation in the next page
| Author                  | Type of study | Reference adopted for PGNS | No. of participants | Location | Period | Outcomes | Comparison group (Yes/No) Adjustment (Yes/No) | Relevant results of the study Statistics | Level of evidence |
|-------------------------|---------------|-----------------------------|---------------------|----------|--------|----------|--------------------------------------------|----------------------------------------|------------------|
| Guerra-Shinohara et al. (44) | Cohort        | BMI quartile                | 100 (138)           | São Paulo, SP | 2004-2005 | Miscarriage | Yes | Higher risk of miscarriage in pregnant women with an increased BMI, OR = 5.49; (95 % CI: 1.29-23.39) Multivariate logistic regression | B                     |
| Nani et al. (45)           | Descriptive   | WHO, 1998                  | 100                | HCFM-USP, SP | 2010 | Events after caesarean section with spinal anesthesia | Yes | Higher occurrence of OW and OB in pregnant women: Hypotension episodes after spinal anesthesia, p = 0.034 Volume of crystalloid infused, p = 0.005 Need to use vasopressors = 0.017 Student’s t-test, Fisher’s exact test, analysis of variance | B                     |
| Silva et al. (46)           | Cohort        | WHO, 1998                  | 282 (325)          | Laje and Matuípe, BA | 2005-2008 | Postpartum weight maintenance | Yes | Higher weight maintenance 24 months post-delivery when pregestational BMI was ≥ 25 kg/m² p < 0.001 Multivariate regression of mixed effects | B                     |
| Costa et al. (47)           | Cohort        | WHO, 1998                  | 103 (310)          | State of Bahia | 2006-2010 | Repeated losses | Yes | Higher BMI in the group of recurrent losses than in the group without losses (26.9 % versus 23.5 %; p < 0.01) Chi-squared test | B                     |
| Zanotti et al. (48)         | Cohort        | WHO, 1998                  | 145 (210)          | Caxias do Sul, RS | 2010-2011 | Postpartum weight maintenance | Yes | Higher post-delivery weight maintenance in pregnant women with BMI ≥ 25 (< 0.05). Multivariate linear regression | B                     |
| Calderon et al. (49)        | Cross-sectional | WHO, 1998          | 1,177 (1,780)      | São Paulo, SP | 2005-2009 | Induced delivery | Systolic blood pressure, amniotic liquid index Caesarean section | Yes | (BMI < 35 kg/m² and BMI ≥ 35 kg/m²) Induced delivery OR = 1.70; (95 % CI: 1.64-1.76) Higher SBP and DBP (p < 0.01), Increased ALI (p < 0.02), Caesarean section (p < 0.05) Bivariate analysis | B                     |
| Godoy et al. (50)           | Cross-sectional, population-based | WHO, 1998    | 1,052 (diabetes 5.9 %, hypertension 8.8 %, teenagers 11.6 %) | Campinas, SP | 2011-2013 | Adequacy of weight gain | Caesarean section | Yes | Excessive weight gain: OW: OR = 2.7 (95 % CI: 1.05-4.01) and OB: OR = 2.62 (95 % CI: 1.67-4.12) (p < 0.0001*) Chi-squared and Kruskal-Wallis | B                     |
| Silva et al. (51)           | Retrospective cohort | WHO, 1998   | 298 (327)          | Joinville, SC | 2013 | Caesarean section Gestational diabetes mellitus Hypertensive disorders of pregnancy Postpartum bleeding | Yes | OW: OR = 2.2; (95 % CI: 1.3-3.9) and OB: OR = 4.2; (95 % CI: 2.1-8.1)OW: OR = 2.5; (95 % CI: 1.1-5.6) and OB: OR = 11.1; (95 % CI: 5.0-24.6)OW: OR = 3.2; (95 % CI: 1.2-8.1) and OB: OR = 7.5; (95 % CI: 2.9-19.1) OB: OR = 4.1; (95 % CI: 1.1-15.8) Multinomial model of logistic regression | B                     |

PGNS: pregestational nutritional status; OW: overweight; OB: obese; WHO: World Health Organization; IOM: Institute of Medicine; BMI: body mass index; PE: pre-eclampsia; GDM: gestational diabetes mellitus; OR: odds ratio; RR: relative risk; CI: confidence interval; HDP: hypertensive disorders of pregnancy; SBP: systolic blood pressure; DBP: diastolic blood pressure; ALI: amniotic liquid index; GHSP: gestational hypertension superimposed to preeclampsia; CRP: C-reactive protein.
A meta-analysis conducted by Wang et al. (55) revealed that adiposity is an independent risk factor for preeclampsia.

Aiming to quantify the proportion of adverse pregnancy outcomes attributable to maternal obesity, a study conducted in London demonstrated that increased pregestational BMI was independently associated with an increasing risk of diabetes, caesarean section and macrosomia. However, race/ethnicity are potential effect-size modifiers (7).

The current scientific literature has also highlighted the endocrine-metabolic alterations caused by obesity based on the specific markers associated with adverse outcomes in maternal and infant health. Relevant studies were also conducted in Brazil, and some were included in this review (24,27). Although physiological, the change in glucolipid profile when uncontrolled can lead to higher cardiovascular risk, and obesity may have caused such lack of control (56).

Several articles that show the association between pregestational excess weight and accentuated weight gain are available. A systematic review conducted in Brazil by Godoy et al. (57) found a higher incidence of weight gain in Brazilian pregnant women who were overweight. This has been a cause of concern and requires short-term actions and immediate control because these women have a higher risk of developing obesity.

Other outcomes related to excess body weight during pregnancy were identified in this review: a higher occurrence of periodontal disease (19), iron deficiency (21), urinary incontinence (22), sleep disorders (30), sexual dysfunction (29), and changes in body image satisfaction (31,32). It is also relevant that in Brazil a systematic review identified an association between BMI increase during pregnancy and emotional disorders such as depression, anxiety, and stress, caused by humiliation and exposure to obesity-related stigmatization (58).

DELIVERY-RELATED OUTCOMES

Caesarean section among women with excess body weight, particularly when obese, was a common adverse outcome in the present study (40,41,43,49-51), similar to the study by Marchi et al. (32). The biological mechanisms to explain the effect of obesity on this outcome are still not completely elucidated. The increased number of adipocytes in obese individuals may change the pelvic structure, with excessive inflammatory response compromising the physiological process of normal delivery (32).

Increased rates of caesarean section were described in obese women in the presence of fetal distress, cephalopelvic disproportion, and previous caesarean section. On the other hand, the presence of clinical complications such as diabetes and hypertensive disorders is involved in a major proportion of medical referrals for surgical delivery (2). Although these events will add additional risks, overweight and obesity represents an independent risk factor for the occurrence of caesarean section according to a meta-analysis conducted by Chu et al. (59).

Among the studies analyzed, only one cited the induction of labor that resulted in caesarean section, but does not quantify this occurrence among obese pregnant women. In the study, obese women had a higher rate of cephalopelvic disproportion (11.0 %) as an indication for caesarean section when compared to 6.2 % among eutrophic women (40).

In this sense, national scale studies should be conducted considering the multifactorial network involved in the determination of caesarean section among pregnant women with excess weight. Complications due to anaesthesia, presence of meconium in the amniotic fluid, and increased risk for developing infection are more common in pregnant women with excess body weight (40,42,45). However, these outcomes are yet to be validated. Thus, future studies on this topic must be conducted in Brazil.

POST-DELIVERY-RELATED OUTCOMES

Two studies focusing on the association between maternal excess body weight and maintenance of post-delivery weight were identified (46,48). A systematic review has shown that higher pregestational BMI and accentuated weight gain during pregnancy were strong predictors of obesity among Brazilian women (60).

Despite a lack of studies with more representative samples, the maternal mortality rate is 50 % higher in obese pregnant women, and HDP, which have obesity as risk factor, are considered the primary cause of maternal death in the country. Therefore, the maintenance of normal weight must be reinforced during the start of the reproductive cycle (2,6).

LIMITATIONS

The present review presented some limitations such as the heterogeneity of the studies involved, with different sample sizes and measures of results. Several of the articles showed a variety of outcomes and used different cut-off points for the identification of pregestational excess weight. Some articles considered excess body weight as a single category without distinction between overweight and obesity, and it was not possible to identify studies that described maternal adverse outcomes according to obesity class. This is an important aspect to be considered, since different results could be found by considering obesity BMI classes (53).

Despite these limitations, the study’s relevance should be highlighted. There are few studies discussing the association of nutritional status in pregnant women and its effects on maternal outcomes, as the focus has been usually on fetal ones. Our results showed the need for concern about women’s health since overweight and obesity are increasing in the Brazilian population, and lead to worse maternal outcomes. If national studies with more robust samples were carried out, we could have an in-depth discussion of this issue in Brazil. All published and available studies on the subject were included in this review, and their results were carefully interpreted.

CONCLUSION

Pregestational excess weight was associated with increasing rates of preeclampsia, gestational hypertension, GDM, excessi-
ve gestational weight gain, and caesarean section in Brazilian women.

Despite the lack of studies with more representative samples of Brazilian population, which are strongly recommended, the negative effects of pregestational excess weight reflect the need for effective public policies that may address the problem, focusing on interventions that promote the health of women at reproductive age.

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