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

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ABSTRACT

Obesity is increasing among women at reproductive age in Brazil. Excess body weight during pregnancy negatively impacts women's health. The present 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. 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. 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. 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.

Keywords: Pregnancy. Overweight. Obesity. Body mass index. Systematic review.

RESUMEN

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. El objetivo de este estudio fue identificar y analizar publicaciones que mostraran los efectos del exceso de peso pregestacional sobre el embarazo, el parto y el posparto en mujeres brasileñas. 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. 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. 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.

Palabras clave: Embarazo. Sobrepeso. Obesidad. Índice de masa corporal. Revisión sistemática.

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 intrauterine 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 caesarean 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 analysz 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 a re-evaluation of objectives.

Self-reported or measured pregestational body weight and height were used in calculating body mass index (BMI = weight/height in meters squared), 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 II).

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 independently 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 I. 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.

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). 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 tha 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, excessive 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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Table I. 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
Gestational outcomes: clinical complications					
Nucci *et al*. (13)	Cohort WHO, 1998	5,314 (5,564) Capitals of CE, SP, RJ, RS, BA and AM States 1991-1995	Gestational diabetes mellitus Hypertensive disorders of pregnancy Preeclampsia Yes Yes	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
Assis *et al*. (14)	Case-control Not informed	890 (121 with HSP; 102 controls) Goiânia, GO 2005	Gestational hypertension Gestational hypertension superimposed to preeclampsia Yes 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: 4.453-167.440), p < 0.001 Multivariate logistic regression analysis	C
Wendland *et al. (15)*	Prospective cohort WHO, 1998	4,766 (5,564) RS, SP, RJ, BA, CE and AM States 1991-1994	Gestational diabetes mellitus Preeclampsia Yes 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) Multivariate logistic regression analysis	B
Dode *et al*. (16)	Cohort	3,079 (4,243)	Gestational	Risk for the GDM:	

	WHO, 1998	Pelotas, RS 2004	diabetes mellitus Yes Yes	OW, OR = 2.08, (95% CI: 1.2-3.3); OB, OR = 3.75, (95% CI: 2.25-6.27) Multiple logistic regression	A
Seabra *et al.* (17)	Cross-sectional WHO, 1998	433 (OW or OB = 24.5%) Rio de Janeiro, RJ 1999-2006	Preeclampsia Yes Yes	Pregnant women with BMI ≥ 25 kg/m² Preeclampsia OR = 3.3; (95% CI: 1.1-9.9), p = 0.03 Chi-square test/Anova	B
Santos *et al.* (18)	Prospective cohort WHO, 1998	204 Salvador, BA 2007-2008	Preeclampsia Caesarean section Yes 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
Vogt *et al.* (19)	Cross-sectional IOM, 1990	334 (157 with periodontal disease, 47%) Campinas, SP 2004-2005	Periodontal disease Yes Yes	Risk of periodontal disease Obese, OR = 1.38; (95% CI: 1.04-1.82) Multiple logistic regression	B
Dantas *et al.* (20)	Prospective case-control WHO, 1998	218 (242) Natal, RN 2004-2006	Preeclampsia Yes No	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
Camargo *et al.* (21)	Cross-sectional IOM, 1990	146 (221) (Losses 21%) Cuiabá, MT 2008-2009	Iron deficiency	Correlation between pregravid BMI and iron deficiency (p = 0.025). Pearson's coefficient of correlation	D
Oliveira *et al.*	Cross-sectional	495	Urinary	Pregnant women with OW	

(22)	Multicentric IOM, 1990	SP, RS, PR 2009	incontinence Yes Yes	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 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 Yes	The changes are different according to pregravidic 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 variation DBP variation Yes 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 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	Change in the profile of lipids during gestation: Total cholesterol LDL-cholesterol Triglycerides	Higher triglycerides, total cholesterol and LDL-C, and lower HDL-C in pregnant women with BMI ≥ 25 (OW and OB) compared to eutrophic	B

		Rio de Janeiro, RJ 2009-2011	HDL-cholesterol Yes Yes	ones ($p < 0.05$) Linear mixed-effect longitudinal model of regression	
Oliveira *et al. (28)*	Prospective cohort WHO, 1998	115 (299) Rio de Janeiro, RJ 2009-2011	Changes in CRP throughout gestation Yes 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 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
Ribeiro *et al.* (30)	Cross-sectional WHO 1998	233 (260) São Paulo, SP 2011-2014	Sleep quality measured by the Pitsburg 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) ($p \leq 0.05$) Pearson association test Comparison: one-way ANOVA and Scheffé post-hoc	D
Meireles *et al. (32)*	Cross-sectional	386 (417)	Body image (“Body Attitudes	Body image associated with BMI ($p < 0.05$)	C

	WHO, 1998	Juiz Fora/MG (public and private hospitals) Year not informed	Questionnaire") No Yes	Multiple linear regression forward	
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
Gestational outcomes: adequacy of weight gain					
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 No	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
Drehmer *et al.* (37)	Cohort	667 (780) (24% ≤ 19 years)	Weight gain	Excessive weight gain: OW, RR = 1.75; (95% CI:	B

	WHO (1998)	Porto Alegre and Bento Gonçalves, RS 2006-2007	Yes Yes	1.48-2.07) OB, RR = 1.55; (95% CI: 1.23-1.96) Obs. stratified by age Multiple Poisson regression	
Marano *et al. (38)*	Cross-sectional IOM (1990)	1,287 (1,678) (22% < 18 years) Rio de Janeiro, RJ 2007-2008	Weight gain Yes 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
Fraga *et al*. (39)	Cross-sectional WHO/1998	1,069 (1,168) OW = 218, OB = 149 (23% < 18 years) Rio de Janeiro, RJ 2007-2008	Weight gain Yes 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
Delivery outcomes					
Seligman *et al*. (40)	Cohort WHO, 1998	4,486 (4,496) RS, SP, RJ, BA, CE, AM states 1991-1995	Caesarean section Presence of meconium Infection Yes 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
Pádua *et al*. (41)	Cross-sectional WHO, 1998	5,049 (15,354) SP, PE, and DF states 2004 to 2005	Caesarean section Yes No	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.* (42)	Descriptive Retrospective WHO, 1998	315 Campinas, SP 2004-2006	Surgery time Technical difficulty in puncture and palpation Bleeding Block failure Yes 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.* (43)	Cross-sectional Population-based WHO, 1998	1,117 (2,257) State of Rio Grande do Sul 2007	Caesarean section Yes Yes	Increased BMI ↑ risk of caesarean section, being higher in the group with BMI ≥ 30 (p = 0.004) Logistic regression	C
Postpartum outcomes					
Guerra-Shinohara *et al. (44)*	Cohort BMI quartile	100 (138) São Paulo, SP 2004-2005	Miscarriage Yes 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 No	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	Postpartum weight maintenance	Higher weight maintenance 24 months post-delivery when pregestational BMI	B

		2005-2008	Yes Yes	was ≥ 25 kg/m² p < 0.001 Multivariate regression of mixed effects	
Costa *et al*. (47)	Cohort WHO, 1998	103 (310) State of Bahia 2006-2010	Repeated losses Yes 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)* 2015	Cohort WHO, 1998	145 (210) Caxias do Sul, RS 2010-2011	Postpartum weight maintenance Yes Yes	Higher post-delivery weight maintenance In pregnant women with BMI ≥ 25 (< 0.05). Multivariate linear regression	B
Combined outcomes					
Calderon *et a*l. (49)	Cross-sectional WHO, 1998	1,177 (1,780) São Paulo, SP 2005-2009	Induced delivery Systolic blood pressure, aminiotic liquid index Caesarean section Yes No	(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 No	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*/**) Increased risk in pregnant women with overweight and obesity (p < 0.0001*) */**Chi-squared and Kruskal-Wallis	B
Silva *et al. (51)*	Retrospective cohort	298 (327) Joinville, SC	Caesarean section	OW: OR = 2.2; (95% CI: 1.3-3.9) and OB: OR = 4.2; (95% CI: 2.1-8.1)	

	WHO, 1998	2013	Gestational diabetes mellitus Hypertensive disorders of pregnancy Postpartum bleeding Yes Yes	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: aminiotic liquid index; GHSP: gestational hypertension superimposed to preeclampsia; CRP: C-reative protein.

Table II. Search strategies used on the electronic databases PubMed, Scopus, Lillacs, and Cochrane Library

Search P and E ***PubMed***[a]	((gestation[Mesh] OR gestation[tiab] OR Pregnancy[Mesh] OR pregnanc*[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 pregnanc*[tiab] OR pregnant women[tiab]) AND (Obesity[Mesh] OR obesity[tiab] OR overweight[Mesh] OR overweight[tiab)
Delimiting by Brazil* or Brazil*	(((brazil* OR Brasil*))) AND ((gestation[Mesh] OR gestation[tiab] OR Pregnancy[Mesh] OR pregnanc*[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]))
Search P and E ***Lillacs***[b]	(tw:(tw:(tw:(tw:(Mh: gestation OR gestação OR Mh: pregnancy or gravidez))) OR (tw:(gestation OR gestação OR pregnancy OR gravidez OR pregnant women OR gestantes))))))) AND (tw:(tw:(tw:(mh: "body mass index" or "Índice de massa corporal"))))) OR (tw:(tw;(Mh: Obesity OR obesidade OR Mh: overweight OR sobrepeso)))))))))
Delimiting by Brazil	(tw:(tw;(tw;(Mh: Brazil OR Brasil))))) AND (tw;(tw;(Brazil$ OR Brasil$))))))).

Combination of results	(tw:(tw:(tw:(tw:(Mh: gestation OR gestação OR Mh: pregnancy or gravidez))) OR (tw:(gestation OR gestação OR pregnancy OR gravidez OR pregnant women OR gestantes))))))) AND (tw:(tw:(tw:(mh: “body mass index” or “Índice de massa corporal”))))) OR (tw:(tw;(Mh: Obesity OR obesidade OR Mh: overweight OR sobrepeso)))))))))) AND (tw:(tw;(tw;(Mh: Brazil OR Brasil))))) AND (tw;(tw;(Brazil$ OR Brasil$))))))).
Search P and E ***Scopus***[c]	((TITLE-ABS-KEY ((gestation OR “pregnant women” OR pregnanc*)) (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 pregnanc*)) AND (TITLE-ABS-KEY ((obesity OR overweight OR “body mass index” OR bmi))) AND (TITLE-ABS-KEY ((brazil* OR brasil*)))
Search P and E ***Cochrane Library***[d]	#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 #7 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 (Brasil* or Brazil*):
Combination of results	#17 #15 or #16: #18 #3 and #13 and #17:

P: population; E: exposure. [a]Updated in 10/21/2016; [b]Updated in 10/22/16; [c]Updated in 10/28 /16; [d]Updated in 10/05/16.

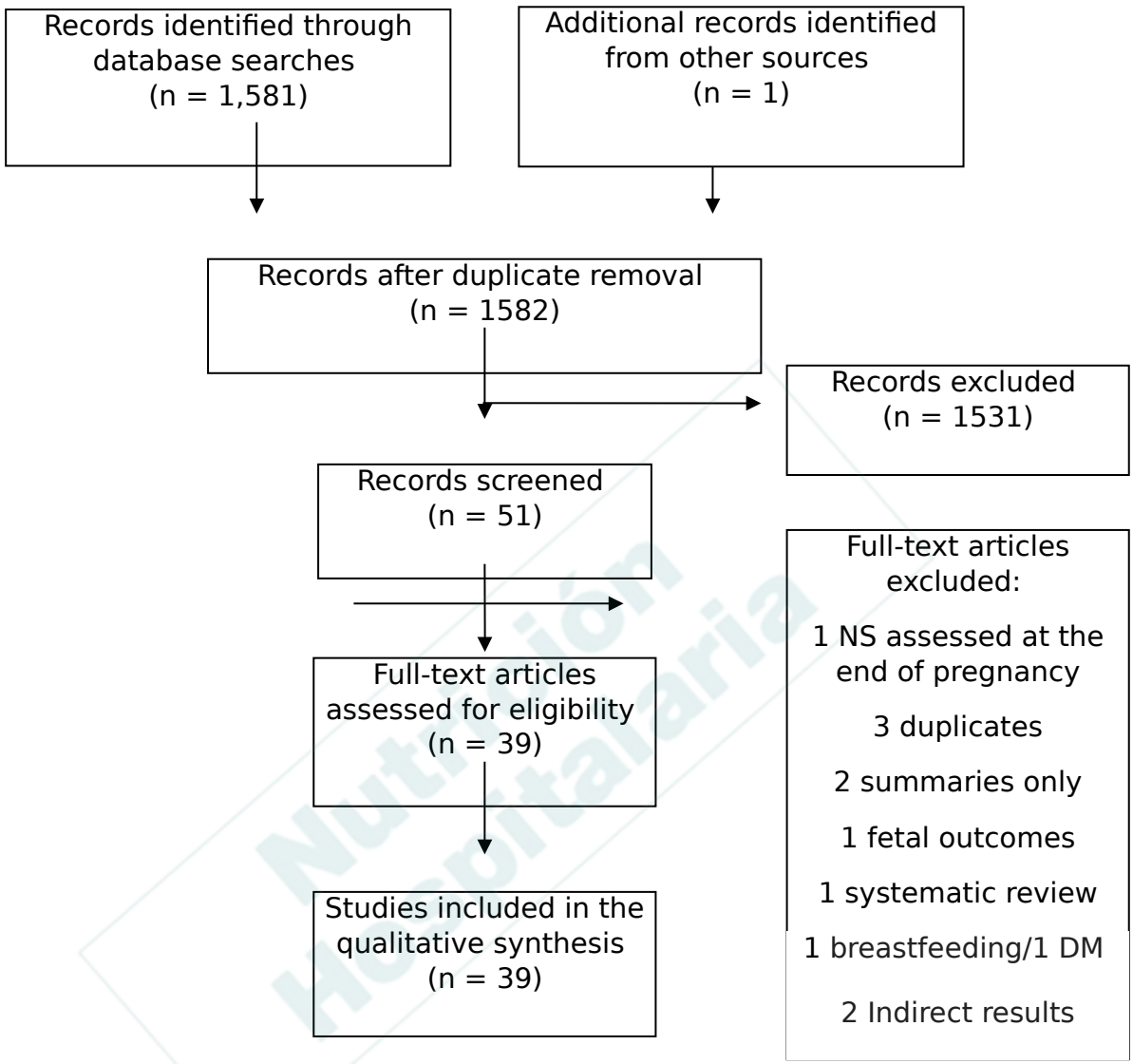

Fig. 1. Flow chart for study selection (DM: diabetes mellitus; NS: nutritional status).