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Review Article

Analysis of the incidence of maternal-fetal complications after using the IADPSG criteria for the diagnosis of gestational diabetes - an integrative review

Análise da incidência de complicações materno-fetais após o uso dos critérios da IADPSG para o diagnóstico do diabetes gestacional – uma revisão integrativa

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ABSTRACT: *Introduction*: Gestational Diabetes Mellitus (GDM) is defined as any degree of glucose intolerance, with onset or first recognition during pregnancy that resolves after delivery. Hyperglycemia during the pregnancy-puerperal cycle is responsible for the increased risk of unwanted perinatal outcomes and maternal-fetal complications. The introduction of new criteria by the International Association of Diabetes and Pregnancy Study Groups (IADPSG) aims to improve such long-term outcomes. OBJECTIVE: To analyze the incidence of maternal-fetal complications after using the IADPSG criteria for the diagnosis of gestational diabetes. *Methods*: The study is an integrative literature review, using the PUBMED databases and the Virtual Health Library (VHL), which includes the MEDLINE, SciELO, and LILACS databases. The descriptors applied were "gestational diabetes", "outcomes", "incidence" and "IADPSG", permuted by the boolean "AND". Articles published in the last 10 years were selected, totaling 264 articles. In the end, 16 publications were selected following the eligibility criteria. *Results*: An increase in the prevalence of GDM diagnosis was evidenced by the application of the IADPSG criteria. It can be seen that most maternal, fetal, and perinatal complications had their respective incidences reduced. This result is probably associated with the treatment of these pregnant women when diagnosed early with the IADPSG criteria. Despite the discordance of results, most authors support the use of the IADPSG recommendations for the diagnosis of GDM. *Conclusion*: The implementation of the IADPSG criteria showed a significant reduction in maternal complications and a reduction in some fetal and perinatal complications analyzed in the present study. Thus, the use of the IADPSG criteria to assess the reduction in the incidence of maternal and fetal adverse outcomes requires further research to determine the advantages of using these criteria when compared to the others.

Keywords: Incidence; Gestational diabetes; Outcomes; IADPSG.

RESUMO: *Introdução*: O Diabetes Mellitus Gestacional (DMG) é definido como qualquer grau de intolerância à glicose, com início ou primeiro reconhecimento durante a gestação que se resolve após o parto. A hiperglicemia durante o ciclo gravídico-puerperal é responsável pelo risco aumentado de desfechos perinatais indesejados e de complicações materno-fetais. A introdução de novos critérios pela *International Association of Diabetes and Pregnancy Study Groups* (IADPSG) visa melhorar tais desfechos a longo prazo. *Objetivo*: Analisar a incidência das complicações materno-fetais após o uso dos critérios da IADPSG para o diagnóstico de diabetes gestacional. *Métodos*:

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Trata-se de uma revisão integrativa de literatura, utilizando as bases de dados PUBMED e a Biblioteca Virtual em Saúde (BVS), que inclui as bases de dados MEDLINE, SciELO e LILACS. Os descritores aplicados foram "*gestational diabetes*", "*outcomes*", "*incidence*" e "IADPSG", permutados pelo booleano "*AND*". Foram selecionados os artigos publicados nos últimos 10 anos, totalizando 264 artigos. Ao final, 16 publicações foram selecionadas seguindo os critérios de elegibilidade. *Resultados*: Evidenciou-se o aumento da prevalência do diagnóstico de DMG com a aplicação do critério da IADPSG e redução da incidência da maioria das complicações maternas, fetais e perinatais. Provavelmente, tal resultado está associado com o tratamento dessas gestantes quando diagnosticadas precocemente com o critério da IADPSG. Apesar da discordância de resultados, grande parte dos autores apoia o uso das recomendações da IADPSG para o diagnóstico da DMG. *Conclusão*: A implementação dos critérios da IADPSG apresentou importante redução das complicações maternas e redução de algumas complicações fetais e perinatais analisadas no presente estudo. Assim, a utilização do critério IADPSG para avaliar a redução da incidência dos desfechos adversos maternos e fetais necessita de continuidade nas pesquisas a fim de determinar as vantagens do uso de tal critério quando comparado aos demais.

Palavras-chave: Incidência; Diabetes gestacional; Complicações; IADPSG.

INTRODUCTION

Diabetes Mellitus (DM) is defined as a metabolic disease characterized by hyperglycemia resulting from failure in the production and/or action of insulin. Gestational Diabetes Mellitus (GDM) is defined as any degree of glucose intolerance, with onset or first recognition during gestation[1], which resolves after delivery[2]. Usually, GDM is diagnosed in the second or third trimester of pregnancy and corresponds to the most common metabolic disorder during pregnancy, which is associated with an increase in maternal-fetal morbidity[3].

Pregnancy is characterized as a state of insulin resistance. Some hormones produced by the placenta and others increased by pregnancy, such as placental lactogen, cortisol, and prolactin, promote reduced insulin sensitivity. This condition, together with the intense change in blood glucose control mechanisms due to glucose consumption by the embryo, may contribute to the occurrence of glycemic alterations, favoring the development of GDM[2,4].

Multiple risk factors for GDM are known such as age over 35 years, ethnicity, overweight or obesity, chronic hypertension, polycystic ovary syndrome, family history of diabetes, and obstetric history such as previous GDM, uncertain fetal/neonatal death, polyhydramnios, macrosomia and fetal malformation[2,5]. Thus, the prevalence of gestational diabetes is increasing in accord with a sedentary lifestyle, obesity and advanced age at gestation[6].

Moreover, it is known that, for women, the main risk factor for the development of type 2 DM and metabolic syndrome is the obstetric history of GDM. In this context, hyperglycemia during the pregnancy-puerperal cycle is a relevant current problem, not only because of the risk of worse perinatal outcomes but also for maternal-fetal complications and the development of future diseases[7,4]. Hyperglycemia is a risk factor for fetal macrosomia, polyhydramnios and tocotrauma, mainly due to shoulder dystocia, neonatal hyperbilirubinemia, newborn respiratory distress syndrome, hypocalcemia, neonatal hypoglycemia, prematurity, and fetal death[2,3,7]. Women with GDM have a higher risk of cesarean delivery compared to non-diabetic women. There is also an association with the development of gestational hypertension, preeclampsia, and the risk of preterm delivery. Many studies have also found increased complications in the adult life of newborns of mothers with GDM, such as increased incidence of obesity, hypertension, metabolic syndrome, and diabetes[7,8].

Given this scenario, the adequate treatment of GDM should be prioritized, since it is a very frequent complication that may be related to considerable perinatal risks. Thus, early screening of asymptomatic pregnant women for GDM is a very important part of prenatal care and has been associated with a reduction in maternal-fetal complications[3,6].

There has been a lack of consensus for over 50 years on the appropriate diagnostic criteria for GDM and the importance of diagnosis[5]. In 1964, O'Sullivan and Mahan proposed the first diagnostic criteria for GDM. After this period, several other diagnostic methods were proposed, such as that of the *National Diabetes Data Group* (NDDG) in 1979, Carpenter and Coustan in 1982, and Sacks et al. in 1989[9].

As early as 1999, the World Health Organization (WHO) diagnostic criteria was instituted, in which the 75g oral glucose tolerance test (OGTT) was performed between the 24th and 28th week since this is the period most susceptible to insulin resistance during pregnancy. However, some patients with high-risk factors performed the test prior to this period for early detection and if the result was negative, the test was repeated around the 24th to 28th week or any time a new risk factor emerged[7].

In 2008, the HAPO (*Hyperglycemia and Adverse Pregnancy Outcome*) study examined the relationship between OGTT and adverse pregnancy outcomes, concluding that there is a positive and linear correlation between maternal blood glucose values and the frequency of maternal and neonatal complications, such as preeclampsia, cesarean section, macrosomia, neonatal hypoglycemia and elevated C-peptide concentration in cord blood[4,6]. Subsequently, in 2010, the *International Association of Diabetes and Pregnancy Study Groups* (IADPSG) introduced new diagnostic criteria, which were based on data from the HAPO study[5,6]. By IADPSG, the diagnosis of GDM is confirmed when: fasting blood glucose is ≥ 92 mg/

dL and ≤ 125 mg/dL; at least one of the 75g OGTT values is ≥ 92 mg/dL fasting, ≥ 180 mg/dL in the first hour and ≥ 153 mg/dL in the second hour, being performed between 24 and 28 weeks of gestational age[4,5,9].

After the publication of this IADPSG position paper, some challenges became evident, the main one being the significant increase of 33% in the number of women who were classified as having GDM[4,5]. There is still no consensus on the improvement of maternal-fetal outcomes in the long term with the use of the IADPSG diagnostic criteria[5]. Thus, the present study aims to analyze the incidence of maternal-fetal complications after the use of the IADPSG diagnostic criteria for gestational diabetes through an integrative review.

METHOD

This is an integrative literature review in which a systematic search was conducted in PUBMED and the Virtual Health Library (VHL), which includes MEDLINE, SciELO, and LILACS databases, with the following descriptors validated by the Health Science Descriptors (DeCS): "*gestational diabetes*", "*outcomes*", and "*incidence", in* addition to the descriptor "IADPSG", a more recently used diagnostic criterion for gestational diabetes. The descriptors were permuted by the boolean "*AND*". Articles published in the last 10 years were selected, and in the end, 142 articles were found in the PUBMED database and 122 articles in the VHL, for a total of 264 articles.

As inclusion criteria, the articles should be complete, in Portuguese or English, from the last decade (2011 to 2021), to select the most recent articles on the subject. In addition, the research should include pregnant women diagnosed with gestational diabetes mellitus according to the IADPSG criteria, who should also have undergone treatment. Furthermore, the studies should address maternal-fetal outcomes and analyze whether the use of the IADPSG diagnostic criteria influenced positively or negatively the incidence of maternal-fetal complications, compared to other diagnostic criteria previously used.

Studies that did not answer the research question, incomplete articles, articles in languages other than Portuguese and English, and literature review studies were excluded. Other exclusion criteria were papers that did not address maternal-fetal comorbidities and that did not compare the IADPSG with other diagnostic criteria. In addition, articles containing participants who did not undergo treatment after diagnosis of gestational diabetes by the criteria were also discarded.

The 264 articles found were independently evaluated. A total of 112 duplicate articles were observed using the duplicate analysis tool of the *Mendeley software, which* were discarded, leaving 152 articles for analysis of the title and abstract. During this phase, 73 articles in which the titles and abstracts were not consistent with the proposed theme were excluded, leaving 79 articles for the evaluation of the full text. From this, inclusion and exclusion criteria were established for the evaluation of the selected articles. After careful analysis of the full texts, 63 studies were excluded, remaining 16 articles for the composition of this integrative review (Figure 1).

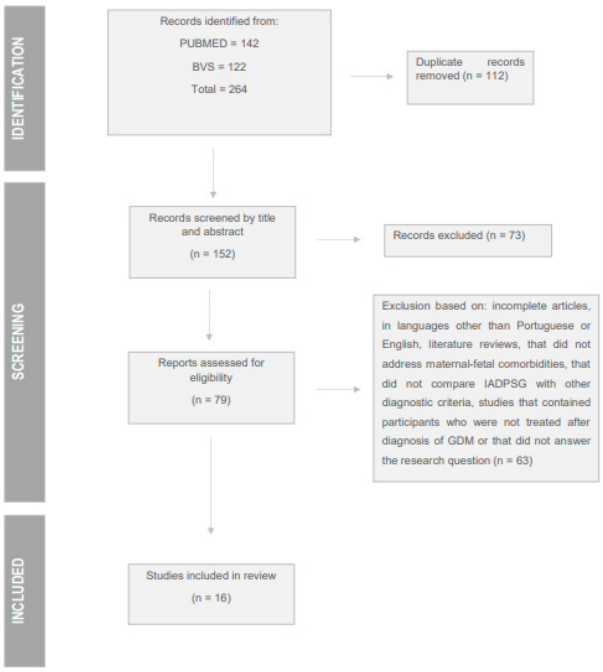

Figure 1. Flowchart of the article selection

RESULTS

Table 1 presents a description of the data from the studies found in this review. The authors, year of publication, number of research participants, and diagnostic criteria used in the study were systematized in the table. The articles were organized in chronological order based on the year of publication, which ranged from 2013 to 2021. The number of participants in the studies ranged from 276 to 23,509, and the total number of participants analyzed among the 16 articles was 100,487.

Table 1. Summary of the articles analyzed in the integrative review

Authors / year	Number of participants	Diagnostic criteria
Liao et al. 2013	5360	IADPSG and WHO
Sibartie; Quinlivan 2015	10277	IADPSG and ADIPS
Hung; Hsieh 2015	6697	IADPSG and ACOG
Djelmis et al. 2016	4646	IADPSG and NICE
Wu et al. 2016	1840	IADPSG and Carpenter–Coustan
Ogunleye et al. 2016	404	IADPSG and Carpenter–Coustan
Feldman et al. 2016	6066	IADPSG and Carpenter–Coustan
Oriot et al. 2017	5163	IADPSG and Carpenter–Coustan
Palatnik et al. 2017	23509	IADPSG and Carpenter–Coustan
Basri et al. 2018	520	IADPSG and WHO
Costa et al. 2019	6051	IADPSG and Carpenter–Coustan
Pouliot et al. 2019	3117	IADPSG and CDA
Lucovnik et al. 2020	276	IADPSG and Carpenter-Coustan
He et al. 2020	7.794	IADPSG and 7th edition textbook
Ghaffari et al. 2020	11249	IADPSG and Carpenter-Coustan
Yuen et al. 2021	7518	IADPSG and NZSSD / NZMOH

Description**:** IADPSG: International Association of Diabetes and Pregnancy Study Groups; WHO: World Health Organization; ADIPS: Australasian Diabetes in Pregnancy Society; ACOG: American College of Obstetricians and Gynecologists; NICE: National Institute for Health and Care Excellence; 7th edition textbook: 7ª edition Chinese textbook Obstetrics and Gynecology criteria; CDA: Canadian Diabetes Association.

Among the diagnostic criteria for gestational diabetes, all articles used the IADPSG criteria as the main criterion compared to a second one. The IADPSG recommends the treatment of pregnant women with only one altered sample in the 75g OGTT, while the other criteria applied as a comparison used a 2-step strategy, in which blood glucose levels were measured at hourly intervals and a diagnosis of GDM was considered when two or more values were altered.

Out of a total of 16 articles, 8 (50%) applied the Carpenter-Coustan as the second diagnostic criterion, being the most used. The remaining 8 articles used different criteria, such as the ADIPS (*Australasian Diabetes in Pregnancy Society*), ACOG (*American College of Obstetricians and Gynecologists),* NICE (*National Institute for Health & Care Excellence),* WHO (*World Health Organization),* NZSSD/NZMOH (*New Zealand Society for the Study of Diabetes/New Zealand Ministry of Health*), CDA (*Canadian Diabetes Association*) and the criteria of the 7th edition of the Chinese book *Obstetrics and Gynecology*, published by *People's Medical Publishing House*.

The great majority of articles (75%) applied the diagnostic criteria between the 24th and 28th week of gestation, and only 2 (12.5%) of them diverged, carrying out this analysis between the 25th and 28th week[18] and between the 24th and 32nd week of gestation[13]. The other 2 remaining articles (12.5%) did not specify the period of application, however, reinforced in their methodology that the criteria were applied as the guideline recommends.

An increase in the prevalence of GDM diagnosis was found with the use of the IADPSG in relation to any of the other diagnostic criteria used by the studies. The increase in prevalence ranged from 0.1 to 14.1 percentage points, and the mean prevalence variable was 7.62 percentage points. Three of the 16 analyzed articles showed a percentage increase, however, they were not included in the calculation of percentage points because they presented different statistical comparison units than the other studies.

Table 2. Maternal and fetal/perinatal complications

Authors (year)	Maternal complications	Fetal/perinatal complications
Liao et al. (2013)	Gestational hypertension, polyhydramnios	Premature birth, neonatal hypoglycemia, APGAR <7 at the 5th minute, macrosomia, LGA, congenital malformation, respiratory stress
Sibartie; Quinlivan (2015)	Perineal rupture, cesarean section, postpartum hemorrhage	Shoulder dystocia, LGA, increased umbilical artery pH, neonatal ICU admission, fetal death, neonatal death
Hung; Hsieh (2015)	Pre-eclampsia, placenta previa, placenta accreta, placental abruption, premature rupture of membranes, polyhydramnios, oligohydramnios, postpartum hemorrhage	Premature birth, APGAR <7 at the 5th minute, macrosomia, LGA, SGA, neonatal ICU admission, fetal death, neonatal death
Djelmis et al. (2016)	Pre-eclampsia, gestational hypertension, cesarean section, weight gain	Macrosomia, LGA, congenital malformation, jaundice
Wu et al. (2016)	Pre-eclampsia, gestational hypertension, cesarean section, weight gain	Shoulder dystocia, neonatal hypoglycemia, macrosomia, jaundice, neonatal ICU admission, and fetal death
Ogunleye et al. (2016)	Pre-eclampsia, gestational hypertension, cesarean section	Neonatal hypoglycemia, APGAR <7 at the 5th minute, macrosomia, respiratory stress, jaundice, and neonatal ICU admission
Feldman et al. (2016)	Pre-eclampsia, cesarean section	Shoulder dystocia, premature delivery, macrosomia, LGA, jaundice, neonatal ICU admission, fetal death
Oriot et al. (2017)	Cesarean section	Macrosomia, LGA, SGA
Palatnik et al. (2017)	Gestational hypertension, cesarean section	Shoulder dystocia, neonatal ICU admission
Basri et al. (2018)	Pre-eclampsia, gestational hypertension, cesarean section	Shoulder dystocia, premature birth, neonatal hypoglycemia, macrosomia, SGA
Costa et al. (2019)	Gestational hypertension, cesarean section	Shoulder dystocia, premature delivery, neonatal hypoglycemia, APGAR <7 at the 5th minute, macrosomia, LGA, neonatal ICU admission
Pouliot et al. (2019)	Pre-eclampsia, gestational hypertension, cesarean section, induction of labor, weight gain	Shoulder dystocia, premature delivery, macrosomia, LGA, SGA, neonatal ICU admission, respiratory stress
Lucovnik et al. (2020)	Cesarean section, weight gain	Shoulder dystocia, neonatal hypoglycemia, LGA, SGA, Erb's palsy
He et al. (2020)	Perineal rupture, cesarean section	Neonatal hypoglycemia, neonatal ICU admission, fetal death, fetal distress, umbilical cord around the neck, neonatal encephalopathy, birth trauma
Ghaffari et al. (2020)	Pre-eclampsia, cesarean section	Shoulder dystocia, macrosomia, neonatal ICU admission, birth weight
Yuen et al. (2021)	Gestational hypertension, cesarean section, weight gain	Macrosomia, birth weight

Description: * The total number of articles that analyzed a given complication; LGA: large for gestational age; SGA: small for gestational age.

Table 3. Complication x incidence ratio

Maternal complications	Reduced incidence	No changes	Increased incidence	Total*
Pre-eclampsia	55,60%	33,30%	11,10%	9
Gestational hypertension	40%	30%	30%	10
Placenta previa	0%	100%	0%	1
Placenta accreta	0%	100%	0%	1
Placental abruption	0%	100%	0%	1
Premature rupture of membranes	0%	100%	0%	1
Perineal rupture	50%	50%	0%	2
Polyhydramnios	66,70%	33,30%	0%	3
Oligohydramnios	0%	100%	0%	1
Cesarean section	23%	38,50%	38,50%	13
Induction of labor	100%	0%	0%	1
Postpartum hemorrhage	0%	100%	0%	2
Weight gain	25%	0%	75%	4
Fetal/Perinatal complications	**Reduced incidence**	**No changes**	**Increased incidence**	**Total***
Shoulder dystocia	33,30%	55,60%	11,10%	9
Premature birth	16,70%	66,60%	16,70%	6
Neonatal hypoglycemia	42,90%	42,90%	14,20%	7
APGAR <7 in the 5th minute	25%	75%	0%	4
Macrosomia	46,15%	46,15%	7,70%	13
LGA	50%	37,50%	12,50%	8
SGA	0%	100%	0%	7
Congenital malformation	0%	100%	0%	2
Respiratory stress	0%	100%	0%	2
Jaundice	33,30%	33,30%	33,30%	3
Increased umbilical artery pH	100%	0%	0%	1
Neonatal ICU Admission	27,30%	45,40%	27,30%	11
Fetal death	40%	40%	20%	5
Neonatal Death	0%	100%	0%	2

Description: * The total number of articles that analyzed a given complication; LGA: large for gestational age; SGA: small for gestational age.

Table 2 presents the main maternal and fetal/perinatal complications addressed in the studies. Table 3 shows the total number of articles that addressed certain maternal and fetal complications, which were subdivided according to the results of the studies into reduction or increase in the incidence of complications and absence of changes in outcomes using the IADPSG criteria. The percentages shown in the table refer to the total number of articles that addressed a particular complication, which is represented in the last column.

Regarding maternal complications, approaching the relation complication *versus* incidence after application

of the IADPSG criteria, we observed a reduction in the incidence of preeclampsia in 55.6%, an increase in incidence in 11.1%, and no change in 33.3% of the studies that presented this complication. Gestational hypertension did not present great variations among the results, of which 40% had a reduction, 30% had an increase, and 30% had no change in the incidence of this complication. Thirteen articles evaluated the incidence of the cesarean section after applying the new criteria, and there was a reduction in only 23% of the studies, an increase of 38.5%, and no change in the incidence of 38.5%. Weight gain as a maternal complication was analyzed by 4 articles, and 75% of them reported increased incidence and 25% reduced. The other complications in the table were not addressed by a significant number of articles, not presenting much relevance, since they did not compare maternal complications with an expressive number of studies.

Of the fetal/perinatal complications, 13 articles presented macrosomia as a possible complication, of which 46.1% showed a reduced incidence using the IADPSG criterion, 46.1% had no change, and only 7.8% had an increased complication. Seven articles analyzed neonatal hypoglycemia, and of these, 42.9% showed a reduction, in 42.9% there was no change, and in 14.2% there was an increase in the incidence of the complication. With the application of the IADPSG recommendations, 27.3% had a reduction, 45.4% no change, and 27.3% increased the incidence of neonatal ICU admission after delivery. Shoulder dystocia as a complication was studied in nine studies, and a reduction in incidence was identified in 33.3%, no change in 55.6%, and an increase in 11.1%. Preterm birth was identified in six articles, reporting reduced incidence in 16.7%, no change in 66.6%, and an increase in 16.7%. Of the 7 articles that addressed the small for gestational age (SGA) parameter, none showed a change in incidence with the application of the criterion. As for the parameter large for gestational age (LGA), 50% had reduced incidence, 37.5% had no change and 12.5% increased incidence. The APGAR <7 at the 5th minute was unchanged at 75%, with a decrease of only 25%. Fetal death was reduced by 40%, with no change in 40%, and increased incidence by only 20%, while neonatal death showed no change in its results.

Despite the divergence between the reduction or not of incidences of maternal-fetal complications, it was observed that among a total of 16 articles analyzed in this review, 8 (50%) publications agree with the use of the IADPSG criteria for the diagnosis of gestational diabetes, 3 (18.75%) do not agree, and 5 (31.25%) present an inconclusive opinion and/or refer the need for further studies on the subject.

DISCUSSION

Gestational diabetes is one of the most frequent medical complications of pregnancy, and its incidence has increased in recent years. It is defined as carbohydrate intolerance of varying intensity (hyperglycemia) and is first recognized or diagnosed during pregnancy, not meeting the diagnostic criteria for *overt* diabetes. Several risk factors have been identified, such as advanced maternal age, ethnicity (Hispanic, African-American, and Asian), high preconceptional body mass index (BMI), history of GDM, or family history of type 1 or type 2 diabetes mellitus[23,24].

Previous studies have shown a relationship between hyperglycemia and short and long-term adverse maternal and perinatal outcomes[25]. Hypertensive disorders of pregnancy such as pregnancy-induced hypertension (PGH) and pre-eclampsia (PE), increased risk of metabolic syndrome and cardiovascular disease, as well as the risk of developing type 2 diabetes mellitus in the future are examples of maternal complications. Fetal outcomes such as Large for Gestational Age (LGA) newborn (NB)/ macrosomic fetus, increased cesarean section rate, shoulder dystocia, NB breathing difficulty syndrome, and metabolic complications may be present in this clinical condition[23,26].

Despite the variety of manifestations of gestational diabetes, it can also be asymptomatic in pregnant women[24], therefore, clinical diagnosis of GDM, antepartum fetal surveillance, and the respective interventions are important to reduce maternal and perinatal morbidity and mortality associated with this comorbidity, since there is growing evidence that treatment reduces adverse outcomes for both mother and baby[27,28].

From 2000 to 2010, the recommended diagnosis of gestational diabetes was based on a two-step approach - initially, a screening test with a 50 g oral glucose overload was performed in the 2nd and 3rd trimesters, or in the first trimester if risk factors were present, followed by a diagnostic test with a 100 g oral glucose overload after a positive screening test. In 2002, the HAPO study revolutionized the screening of this disease, in which glucose tolerance was assessed between 24 and 32 weeks of gestation, using for the diagnosis of GDM criteria first-trimester fasting glucose ≥ 92 mg/dL or an altered value on the oral glucose tolerance test, demonstrating a linear relationship between maternal glucose levels and maternal, fetal, and perinatal morbidities. Based primarily on the HAPO study, IADPSG recommended new diagnostic criteria for GDM in 2010[23,28].

The IADPSG criteria are the first based on pregnancy outcomes, being able to identify complications that were often difficult to diagnose by two-step methods[26,29], and since then, these guidelines have been endorsed by many organizations, such as WHO and ADIPS in 2013; ADA and *Endocrine Society* in 2014 and *International Federation of Gynecology and Obstetrics* (FIGO) in 2015[25].

In the present study, all included articles used the IADPSG as the main criterion compared to a second two-step criterion. The most commonly used diagnostic method

compared to IADPSG was Carpenter-Coustan, the other articles used different recommendations for comparison of maternal-fetal outcomes such as that of ADIPS, ACOG, NICE, WHO, NZSSD/NZMOH, CDA, and the 7th edition of the Chinese textbook *Obstetrics and Gynecology* criteria.

The optimal recommended screening period was between the 24th and 28th weeks of gestation since it covers a larger number of diagnosed cases[23]. Although the IADPSG recommendations for diagnosing GDM in the first trimester have been questioned by some studies, their recommendations for diagnosing GDM at 24-28 weeks are based on evidence correlating maternal glucose concentrations to fetal outcomes[30]. Most of the articles reviewed (75%) applied the diagnostic criteria between the 24th and 28th week of gestation, with only 2 (12.5%) of them deviating from this period and the remaining 2 articles (12.5%) did not identify the period of application of the criteria. However, the period of application recommended by the IADPSG and Carpenter-Coustan guidelines was followed, which justifies remaining in the present study.

In the study by Li et al.[24], there was also great variability in the period of the screening institution, and most of them did it after the 24th week of gestation. It was shown that the percentage of cases of GDM diagnosed before the 24th week of gestation was a little lower when compared to the period after this date since the most diabetogenic period of gestation is between the 24th and 28th week when the counterregulatory hormones are more significantly elevated.

There is a wide variation in the prevalence of gestational diabetes ranging from <1 to 28% in the literature, and the risk of developing GDM in Asian women is five times higher than in Caucasian women, with Indian women having the highest incidence of the disease, with a prevalence range of 0 to 41.9%[25]. With the implementation of the IADPSG diagnostic criteria, there has been an important increase in the prevalence of GDM[25,26]. A systematic review compared the WHO and IADPSG criteria in ten studies, all of which reported an increase in prevalence with the use of IADPSG, with the difference between the two criteria ranging from 0.16 to 25.9%[24]. The present study is in agreement with the literature since it also showed an increase in prevalence ranging from 0.1 to 14.1 percentage points, and the mean of this variable was 7.62 percentage points.

The higher prevalence using IADPSG may be due to the low fasting blood glucose threshold of 92 mg/dL[24], and this increased prevalence with the criterion may offer a window of opportunity to identify a large number of women at increased risk for glucose intolerance in the future[26], however, concerns about the excessive increase in screening and diagnosis of GDM in pregnancies considered healthy has prevented widespread adoption of this diagnostic criterion[25].

According to the study by Bhavadharini et al.[30] the application of the IADPSG criteria was associated with decreased adverse pregnancy outcomes, such as preeclampsia, cesarean delivery, macrosomia, and admission to the neonatal intensive care unit (NICU), compared to the Carpenter and Coustan criteria. However, the outcome of some complications, such as cesarean delivery and admission to the neonatal intensive care unit was discordant with the present review.

According to the study by Wu et al.[14] the adoption of the IADPSG criteria was associated with a reduction in the risk of cesarean section, in contrast to the result found in the present study, which showed that only 23% of the articles showed a reduction in this incidence. As for hypertensive disorders in pregnancy, in the study by Lucovnik et al.[3] the implementation of the IADPSG criteria in a country with a relatively low prevalence of GDM did not result in higher rates of this condition, which is in agreement with the 40% statistic of this article.

In a study by Koivunen et al.[31] 4,033 Finnish women were screened for GDM, and of these, 1,249 were considered to have the condition by the IADPSG criteria. The research analyzed the presence of maternal and fetal complications in individuals screened by the IADPSG recommendations and another two-step criterion. In the research, the LGA parameter showed no changes when compared to the control group. In the present review, however, it was analyzed that after the adoption of the IADPSG criteria for diagnosis of GDM, most studies reported decreased incidence of complications in newborns. Regarding the SGA parameter, it was observed that the application of the criteria for diagnosis of GDM in only one stage did not change the incidence of the complication, which is in agreement with the results found by Hung and Hsieh[12].

About fetal/perinatal complications, of the 16 articles, 13 presented macrosomia as a possible complication of gestational diabetes, and there was a 46.15% reduction in incidence with the institution of the IADPSG criterion, the other 46.15% showed no change, and only 7.7% showed an increase in this outcome. Hung and Hsieh[12] showed that the adoption of the IADPSG criterion was associated with a lower incidence of macrosomia, explaining that perhaps the treatment of these mothers diagnosed with the new criterion is the reason for the decrease in complications since through the two-step method many pregnant women were considered non-diabetic and consequently were not treated. In contrast, in the studies by Feldman et al.[16] and Ogunleye et al.[15] the adoption of the IADPSG was not associated with a reduction in the incidence of macrosomia in this population.

In the study by Gariani et al.[32], the neonatal hypoglycemia complication was lower with the use of the IADPSG criteria when compared to the Carpenter and Coustan method. This finding is in agreement with the results found in our research. Moreover, preterm birth

was an adverse outcome identified in six of the studies analyzed, in which 66.6% had no change and the rest showed equivalence between the percentages of increased and decreased incidence when compared to the two-step criteria. In the analysis by Liao et al.[10], the use of the ADA criterion showed a significant increase in the risk of preterm birth, which was probably caused by the higher incidence of induced labor or cesarean section in women with gestational diabetes previously defined by this criterion.

Costa et al.[18] found that despite the increased prevalence of the diagnosis of GDM with the introduction of the IADPSG screening criteria, there was no statistically significant impact regarding shoulder dystocia, which is in line with the 55.6% statistic in the present study.

Hung and Hsieh[12] stated in their research that there was no difference in the incidence of NICU admission of newborns when compared with the one-step and two-step criteria. The same result was presented in a study by Ghaffari et al.[21] confirming the results found in this article, in which the majority also showed no changes in this outcome.

It was believed that, after the recommendations made by the HAPO study, the controversies about the diagnostic criteria for GDM would be resolved; however, what happened was a long discussion about the pros and cons of the existing criteria. In this context, a point that favors the application of the IADPSG criteria is to have used the HAPO study for its realization, since it is a prospective, blinded, multinational, observational study with great methodological rigor. Moreover, it is known that the application of the IADPSG recommendations in pregnant women did not change the proportion of insulin use, but established changes in lifestyle habits, such as improved diet and physical exercise, for blood glucose control. That is, the IADPSG criterion, despite increasing the prevalence of GDM in the population, did not cause excessive treatment of patients. Another point to be considered is that this criterion is able to identify women who, until then, were not considered to have GDM, but who presented clinical features and complications in pregnancy that were very similar to those women who were considered to have GDM by the criteria that used 2 steps for the diagnosis[33].

Despite the benefits mentioned, it is known that there are still controversies regarding the use of the IADPSG diagnostic criteria for GDM. Among the weaknesses observed in the studies present in the literature, there are more medical and obstetric interventions and higher health costs, since more women are diagnosed with GDM based on this criterion[26]. However, with regard to costs, Duran et al[34] in a large cohort study conducted in Spain showed that there was a decrease in costs since with GDM screening there was a reduction in the number of cesarean sections and newborns admitted to the neonatal ICU, which offset the expenses with more outpatient consultations and rapid glucose test strips[33].

Thus, although not all articles in our review present a reduction in the incidence of maternal-fetal complications, among the 16 articles analyzed in this review, 8 support the use of the IADPSG criteria for the diagnosis of gestational diabetes, 3 do not agree, and 5 present an inconclusive opinion and/or refer to the need for further studies on the subject. Lapolla and Metzger[33] conclude in their paper that most of the different existing diagnostic criteria are not completely wrong in their approaches, which is one of the problems for the implementation of the IADPSG criteria universally. Different screening procedures and diagnostic criteria are still being followed in different countries, with no single standard criteria established for the diagnosis of GDM so far[25].

CONCLUSION

In conclusion, all articles in the present review showed an increase in the prevalence of gestational diabetes diagnosis with the application of the IADPSG criteria. It can be observed that among the fetal and perinatal complications that had a change in incidence with the use of the criterion, there was a predominant reduction of these outcomes, as well as a great part of our articles showed a reduction in the incidence of maternal complications. This result is probably associated with the treatment of these pregnant women when they were diagnosed early with the IADPSG criteria since they were often considered non-diabetic even presenting glucose intolerance by the other two-stage criteria. Despite the discordant results in the incidence of complications, most authors support the use of the IADPSG recommendations for the diagnosis of gestational diabetes. It is concluded, therefore, that further studies addressing the use of IADPSG to assess the reduction or not of the incidence of maternal and fetal adverse outcomes are needed to determine the advantages of using such criteria when compared to the others.

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