



Research article

Evolution of maternal and neonatal outcomes before and after the adoption of the IADPSG/WHO guidelines in Belgium: A descriptive study of 444,228 pregnancies



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ARTICLE INFO

Keywords:

Pregnancy complications
IADPSG/WHO criteria
Diabetes
Gestational diabetes mellitus
Hyperglycemia in pregnancy
Epidemiology
Prevalence

ABSTRACT

Objectives: To appraise adverse pregnancy outcomes after the adoption of IADPSG/WHO guidelines in Belgium.

Methods: A retrospective study of the Center for Perinatal Epidemiology registry was conducted. Demographic changes and adverse pregnancy outcomes were compared between a pre- and post-guideline period in women with and without hyperglycemia in pregnancy (HIP). Adjusted odds ratios with a 95% confidence interval (CI) were used to compare maternal and neonatal outcomes controlling for potential confounders (maternal age, body mass index (BMI), hypertension, parity, and multiple births).

Results: The prevalence of HIP increased (6.0%–9.2%). In the overall population regardless of glycemic status, gestational weight gain (12.3 ± 5.7 vs 11.9 ± 5.8 ; $p < 0.001$), hypertension (0.92; 95% CI, 0.89–0.94; $p < 0.001$), and neonatal intensive care unit/special care nursery (0.89; 95% CI, 0.87–0.91; $p < 0.001$) decreased despite increasing maternal age and pre-pregnancy BMI. Emergency cesarean section rates (1.07; 95% CI, 1.05–1.09; $p < 0.001$) increased, but not in the HIP population (1.02; 95% CI, 0.95–1.10; *ns*). The overall incidence of preterm birth (1.09; 95% CI, 1.06–1.12; $p < 0.001$), stillbirth (1.10; 95% CI, 1.01–1.21; $p < 0.05$), and perinatal mortality (1.10; 95% CI, 1.01–1.19; $p < 0.05$) increased, except in the HIP population (1.03; 95% CI, 0.95–1.11; *ns*), (1.04; 95% CI, 0.74–1.47; *ns*) and (1.09; 95% CI, 0.80–1.49; *ns*), respectively. The overall incidence of small-for-gestational-age remained unchanged (0.99; 95% CI, 0.97–1.01; *ns*) regardless of glycemic status. In the HIP population, large-for-gestational age (0.90; 95% CI, 0.84–0.95; $p < 0.001$) and macrosomia (0.84; 95% CI, 0.78–0.92; $p < 0.001$) decreased.

Conclusion: After the implementation of IADPSG/WHO guidelines, the prevalence of HIP increased by 53.7% and the incidence of major HIP-related pregnancy complications appears to be lower. However, we cannot conclude that the reduction of LGA-macrosomia is due to a better management of diabetes or due to greater recruitment of women with mild HIP associated with a lower risk of obstetrical complications.

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1. Introduction

Hyperglycemia in pregnancy (HIP) is associated with frequent perinatal complications that affect mothers and newborns [1]. The optimal screening regimen for HIP remains controversial, with varying recommendations for one- or two-step glucose load test, universal or selective according to HIP risk factors, early and late HIP screening during pregnancy, and conflicting glycemic thresholds among different expert groups. Because of the lack of randomized controlled trials on this issue, there is insufficient evidence to determine which better approach should be the gold standard of care during pregnancy. The Carpenter and Coustan (C&C) criteria to diagnose HIP were mainly used in Belgium, prior to the adoption of the International Association of Diabetes and Pregnancy Study Groups/World Health Organization (IADPSG/WHO) criteria in 2012 (Table 1). At the same period, studies designed to evaluate the effectiveness of IADPSG vs. C&C screening conducted shown that the IADPSG criteria reduced adverse pregnancy outcomes such as rates of gestational hypertension, prematurity, cesarean section, large-for-gestational age (LGA), small-for-gestational age (SGA) and neonatal intensive care admission and implied greater cost effectiveness [2, 3]. Therefore, for the Group of Gynecologists and Obstetricians of the French Language of Belgium (GGOLFB) [4], it had become obvious that screening according to IADPSG/WHO criteria was preferable [5]. In Flanders, the Vlaamse Vereniging voor Obstetrie en Gynaecologie (VVOG) has adjusted IADPSG/WHO recommendations by maintaining a two-step load glucose test [6, 7].

We conducted a large-scale national observational study in a French-speaking region of Belgium using data from the Center for Perinatal Epidemiology (CEpiP) database that includes all deliveries.

Obstetrical data from all maternity units were compulsorily recorded by midwives and obstetricians into a computerized database. CEpiP is an interuniversity organization under the aegis of The Brussels Health Observatory and the Walloon Agency for Quality of Life (AViQ) (<https://www.cepip.be>).

We collected data from the CEpiP database from the Brussels and Wallonia regions, located in the central and southern parts of Belgium, where C&C and IADPSG/WHO criteria screening had been successfully applied. The Flemish data were not retained for the reasons mentioned above.

The objectives of this study were to:

- (1) compare adverse pregnancy outcomes in overall population studied after the adoption of the IADPSG/WHO criteria screening and estimate the new prevalence of HIP in pregnant women.
- (2) compare changes in adverse pregnancy outcomes by women's HIP or no HIP status after the adoption of the IADPSG/WHO criteria screening.

2. Research design and methods

2.1. Data on population

Data from 604,964 pregnant women in 50 maternity hospitals were collected from 2009 to 2018 in a computerized CEpiP database.

The data provide information on patient demographics, including nationality of origin (ethnicity is not available in the registry), pregnancy-related maternal risk factors such as HIP, overweight, hypertension, medically assisted procedures, delivery method, and perinatal outcomes.

Although the HIP diagnosis was documented for each pregnant woman, the glycemic values were not recorded in the registry. However, the literature indicates that HIP is represented by gestational diabetes mellitus (GDM) in 98.8%–99.5% of cases and overt diabetes with an estimated prevalence from 0.2% to 1.2% [8, 9, 10, 11]. The prevalence of pre-existing diabetes in Europe was low (0.5%, 95 %CI 0.4–0.7), and the pooled prevalence of pre-existing type 1 and type 2 diabetes were 0.3% (95 %CI 0.2–0.4) and 0.2% (95 %CI 0.0–0.9) respectively [12]. Therefore, we can consider that HIP was mainly represented by GDM.

Data from all women with maternal ages <18 and ≥40 years were excluded, as advanced maternal age (defined as ≥ 40 years) has been associated with an increased risk of maternal and fetal complications, which may induce interpretation bias [13].

2.2. Ethical declaration

Access to the anonymized data has been accepted by the CEpiP, after approval by the Direction de la recherche, de la statistique et de la veille des politiques (Agence pour une Vie de Qualité (AViQ)) and the

Table 1. Methods of screening for hyperglycemia in pregnancy.

Two-step screening (Carpenter and Coustan)	One-step screening (IADPSG/WHO)*
2009 to 2012	2015 to 2018
Before 24th week of gestation	
<i>(early screening)</i>	
no GDM** screening	GDM if FPG*** ≥92–125 mg/dl
	Overt diabetes if FPG ≥126 mg/dl
After 24 - 28th weeks of gestation	
50 g OGTT (non-fasting test)	no preload test
if BG	
≥200 mg/dl: diabetes	
or	
1 h later a value of >130 or 140 mg/dL:	
GDM is suspected then 100-g OGTT is indicated	
100-g Oral glucose tolerance test (fasting test)	75-g Oral glucose tolerance test (fasting test)
GDM if 2 abnormal BG values	GDM if at least 1 abnormal BG value
0' ≥ 95 mg/dl	0' ≥ 92 mg/dl
1h ≥ 180 mg/dl	1h ≥ 180 mg/dl
2h ≥ 155 mg/dl	2h ≥ 153 mg/dl
3h ≥ 140 mg/dl	Diabetes if FPG ≥126 mg/dl or ≥200 mg/dl (after 2h)

*IADPSG/WHO: International Association of the Diabetes and Pregnancy Study Groups/World Health Organization.

** GDM: Gestational diabetes mellitus; ***FPG: Fasting plasma glucose; ****BG: Blood glucose.

Observatorium voor Gezondheid en Welzijn in Brussels. Data on births and stillbirths are anonymous and stored in a secure database at CEpiP. The study participants cannot identify the subjects registered in this database. These data allow for retrospective studies. The patient's consent is not requested in this study because the data are collected in a legal and mandatory manner. Therefore, a favorable decision to perform this study was given on June 19, 2020 by the ethics committee n° OM 174 of the Hospital Center of Mouscron.

2.3. Screening exposure periods

Two screening periods were chosen to compare pregnancy outcomes.

The first was from January 1, 2009 to December 31, 2012, when the C&C criteria were fully implemented, and the second from January 1, 2015 to December 31, 2018, when the IADPSG/WHO criteria were fully utilized (Table 1).

The data period from 2013 to 2014 was excluded from the selection because both screening guidelines could still be used. This period is considered a transition period therefore, these data may be confounded.

2.4. Pregnancy outcomes studied

Studied variables associated with HIP studied were:

- Maternal age, parity, pre-pregnancy body mass index (BMI), gestational weight gain (GWG) during pregnancy was calculated by subtracting the weight at the end of pregnancy from the weight at the beginning of pregnancy and hypertension were collected from CEpiP electronic records (excess weight status before pregnancy was defined as a BMI ≥ 25 kg/m², and obesity was defined as a BMI ≥ 30 kg/m²). Hypertension (defined as a systolic blood pressure ≥ 140 mmHg or a diastolic blood pressure ≥ 90 mmHg), including new-onset high blood pressure during gestation and pre-existing hypertension.

The proportion of pregnant women with cumulative high risk factors for HIP, such as age ≥ 30 years and ≥ 35 years and BMI ≥ 25 kg/m², was studied [14]. Other risk factors for HIP, such as a family history and previous GDM or macrosomia, were not investigated because these data were not recorded in the CEpiP database.

- Fetal outcomes of interest associated with HIP studied were admission to a neonatal intensive care unit (NICU) or a special care nursery (SCN), large-for-gestational age (LGA, birthweight $>90^{\text{th}}$ percentile), macrosomia (birth weight ≥ 4000 g), small-for-gestational age (SGA, birth weight $\leq 10^{\text{th}}$ percentile) according to the Intergrowth-21 curves [15], preterm birth (birth <37 weeks of gestation), stillbirths (fetal deaths in utero from 22 weeks of gestation onward or 500 g for all births; this rate considers spontaneous deaths or medical terminations of pregnancies) and perinatal deaths (including stillbirths and neonatal mortality in the first week of life).

2.5. Statistical analyses

Continuous variables were reported using the mean with standard deviation (SD), and categorical variables were reported as frequencies (%).

To analyze the characteristics of pregnant women and newborn (maternal age, BMI, GWG, gestational age, newborn birth weight) according to the HIP screening period, a comparison of parametric continuous variables was performed using unpaired Student t test.

The normality and equality of the variances (Levene's test) were verified, categorical variables (proportions of risk factors for HIP, nulliparity, multiple pregnancies, prevalence of HIP and obstetrical outcomes) were compared with the chi-squared test, and changes were analysed by chi-squared tests.

To compare pregnancy outcomes between the 2 screening exposure periods, we used also multiple logistic regression models before and after

adjustment for confounding risk factors for HIP available in the CEpiP database including maternal age, BMI, hypertension, parity, and multiple pregnancy. The results were expressed for categorical variables as odds ratios (ORs) and adjusted odds ratios (aORs) with their 95% confidence intervals (CIs). Pregnant women screened according to C&C criteria were used as the reference population. Variables with $p < 0.05$ were statistically significant. All statistical analyses were performed by State V.14.0 software.

3. Results

The final analysis was limited to 444,228 pregnant women: 222,011 in the 2009–2012 period and 222,217 in the 2015–2018 period (see flow chart: Figure 1).

For the first endpoint of the study, all maternal characteristics (regardless of pregnant women's glycemic status) are presented in Table 2, and neonatal outcomes are shown in Table 3.

Over time, the maternal age and proportion of pregnant women ≥ 30 years and ≥ 35 years had increased ($p < 0.001$), as did the pre-pregnancy BMI ≥ 25 kg/m² and ≥ 30 kg/m² ($p < 0.001$). The proportion of nulliparous women decreased ($p < 0.001$). The common nationalities were European (75%), North African (12%), sub-Saharan African (6%) and other (7%).

The prevalence of HIP was 6.0% in the 2009–2012 period and 9.2% in the 2015–2018 period ($p < 0.001$), showing an increase of 53.7% after the implementation of the new guidelines (Table 3). The average GWG during pregnancy decreased (12.3 ± 5.7 vs 11.9 ± 5.8 ; $p < 0.001$), as did hypertension (aOR 0.92; 95% CI, 0.89–0.94; $p < 0.001$), between the 2 periods.

The rates of scheduled cesarean sections remained stable (aOR 1.01; 95% CI, 0.99–1.03; ns).

In contrast, emergency cesarean section (aOR 1.07; 95% CI, 1.05–1.09; $p < 0.001$) and preterm birth (aOR 1.09; 95% CI, 1.06–1.12; $p < 0.001$) rates slightly increased. The rate of NICU/SCN admissions decreased (aOR 0.89; 95% CI, 0.87–0.91; $p < 0.001$). The SGA, LGA rates and macrosomia remained stable. Stillbirth and perinatal death rates increased (aOR 1.10; 95% CI, 1.01–1.21; $p < 0.05$ and aOR 1.10; 95% CI, 1.01–1.19; $p < 0.05$, respectively).

We showed a decrease in GWG independent of maternal glycemic status, HIP (9.9 ± 6.3 vs. 9.7 ± 6.3 kg; $p < 0.01$) and no-HIP (12.4 ± 5.6 vs. 12.1 ± 5.7 kg; $p < 0.001$) (Table 3).

In Figure 2, comparison of neonatal outcomes is presented between the HIP and non-HIP groups across study periods. The rate of hypertension decreased regardless of maternal glycemic status, HIP (aOR 0.87; 95% CI, 0.80–0.94; $p < 0.01$) and no-HIP (aOR 0.89; 95% CI, 0.86–0.92; $p < 0.001$).

Emergency cesarean section rates increased in the no-HIP group (aOR 1.07; 95% CI, 1.04–1.09; $p < 0.001$) but not in the HIP group (aOR 1.02; 95% CI, 0.95–1.10; ns).

The rates of scheduled cesarean sections decreased in the HIP group (aOR 0.89; 95% CI, 0.83–0.95; $p < 0.01$); in contrast, no change was observed in the no-HIP group (aOR 1.01; 95% CI, 0.99–1.04; ns).

In the HIP/no-HIP groups, the rates of NICU/SCN admission decreased significantly but were even higher in the HIP group (aOR 0.67; 95% CI, 0.63–0.71; $p < 0.001$) than in the no-HIP group (aOR 0.91; 95% CI, 0.89–0.93; $p < 0.001$).

The rates of LGA decreased significantly in the HIP group (aOR 0.90; 95% CI, 0.84–0.95; $p < 0.001$), as did the rates of macrosomia (aOR 0.84; 95% CI, 0.78–0.92; $p < 0.001$); on the other hand, the rates remained stable in the no-HIP [LGA (aOR 0.99; 95% CI, 0.97–1.01; ns) and macrosomia (aOR 0.99; 95% CI, 0.97–1.02; ns)] groups.

In the HIP/no-HIP groups, the rates of SGA remained similar (aOR 1.03; 95% CI, 0.94–1.13; ns and aOR 0.99; 95% CI, 0.97–1.01; ns).

Finally, in the HIP group, the differences between preterm births (aOR 1.03; 95% CI, 0.95–1.11, ns), stillbirths (aOR 1.04; 95% CI, 0.74–1.47; ns) and perinatal deaths (aOR 1.09; 95% CI, 0.80–1.49; ns) were not significant. In contrast, in the no-HIP group, preterm births (aOR 1.09; 95% CI,

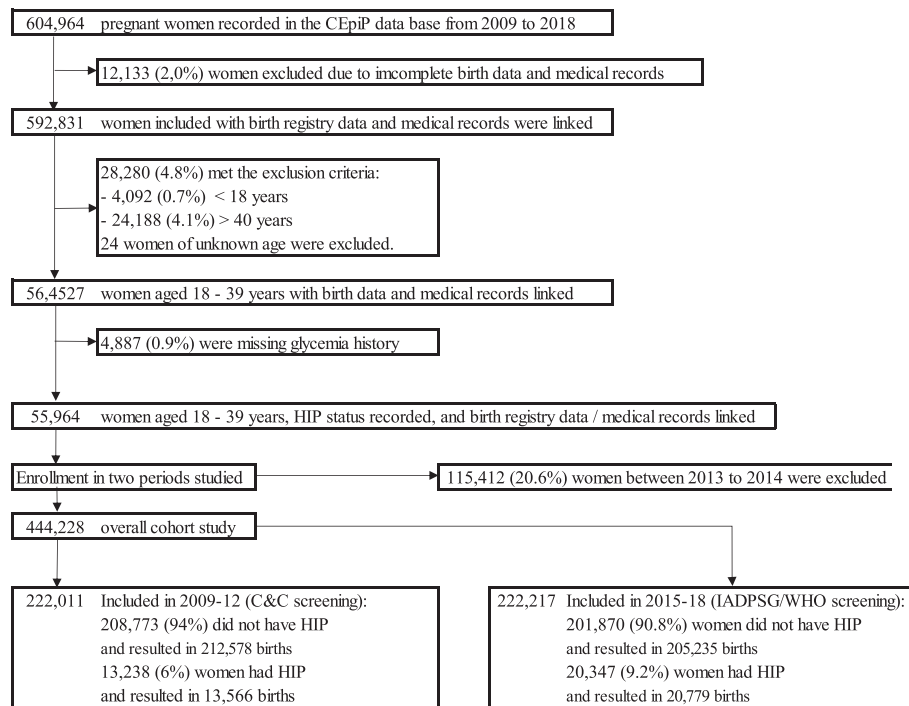


Figure 1. Flowchart of the study population. CEpiP : Centre d'Epidemiologie Perinatale; HIP : Hyperglycemia in pregnancy. C&C : Carpenter & Coustan. IADPSG/WHO : International Association of Diabetes and Pregnancy Study Groups/ World Health Organization.

1.06–1.11; $p < 0.001$), stillbirths (aOR 1.11, 95% CI, 1.10–1.22; $p < 0.05$) and perinatal deaths (aOR 1.10; 95% CI, 1.01–1.20; $p < 0.05$) increased.

4. Discussion

To improve adverse diabetes-related outcomes in pregnancy, the GGOFLB recommended the adoption of the IADPSG/WHO guidelines rather than the C&C screening criteria based on the conclusions of the Hyperglycemia and Adverse Pregnancy Outcome study (HAPO) [16]. To date, no large-scale Belgian population study has been carried out to confirm the effectiveness of these guidelines. Indeed, international studies show conflicting results on the effects of screening and treatment of HIP by comparing the one-step approach with the two-step approach. Some studies have reported better pregnancy outcomes [3, 17, 18, 19], while others have not [20, 21, 22, 23, 24].

In the present study, we show an increase in the HIP prevalence from 6.0 to 9.2% after the implementation of IADPSG/WHO guidelines.

Our findings are in line with previous studies that observed an increase in the prevalence of HIP based on IADPSG/WHO screening [25]. However, the Belgian prevalence appears to be lower than in some previous studies in other countries (18.9–35.5%) [3, 26, 27]. Previous studies in Belgium have shown that the prevalence of HIP before and after application of the IADPSG/WHO criteria increased from 3.3% to 5.7% at the University Hospital of Gasthuisberg (UZ Leuven) [21], from 3.4% to 16.2% at the Erasme Hospital Brussels [22], and from 8.0% to 23.0% at the Mouscron Hospital Centre in Western Hainaut [23]. The reasons for these discrepancies are unclear but may be related to universal screening for HIP and the high or low proportion of diabetes risk factors in the pregnant populations studied (age, excess weight, different ethnicities, or social demographic statuses) [21, 23, 28, 29]. The observed increase in prevalence is also related to the IADPSG/WHO guidelines that call for universal screening for HIP, which is diagnosed when a single blood glucose value is above the threshold defined by the one-step loading test.

Table 2. Comparison of socio-demographic characteristics and obstetrical conditions between the two study periods.

Periods	2009–2012 (C&C screening)	2015–2018 (IADPSG/WHO screening)	p-value
Number of pregnant woman	222011	222217	
Pregnant woman age (years)	27.7 ± 4.9	30.4 ± 4.7	< 0.001
Pregnant woman age ≥30 years	107582 (48.5)	119172 (53.6)	< 0.001
Pregnant woman age ≥35 years	35737 (16.1)	41014 (18.5)	< 0.001
Pre-pregnancy BMI (kg/m ²)	24.2 ± 5.0	24.6 ± 5.1	< 0.001
Pre-pregnancy BMI ≥25 kg/m ²	65182 (34.1)	77714 (37.7)	< 0.001
Pre-pregnancy BMI ≥30 kg/m ²	23835 (12.5)	29443 (14.3)	< 0.001
Proportion ≥30 years and/or BMI ≥25 kg/m ²	125416 (65.6)	146050 (70.8)	< 0.001
Proportion ≥35 years and/or BMI ≥25 kg/m ²	84068 (44.0)	99923 (48.5)	< 0.001
Nulliparity (%)	98617 (44.6)	93956 (42.3)	< 0.001
Multiple pregnancy (%)	4065 (1.8)	3732 (1.7)	< 0.001

C&C: Carpenter & Coustan. IADPSG/WHO: International Association of Diabetes and Pregnancy Study Groups/World Health Organization.

Reference group: 2009–2012. The results are expressed as means ± SD, or n or n (%).

Table 3. Comparison of overall neonatal outcomes for women and newborns according to HIP screening period.

Periods	2009–2012 (C&C screening)	2015–2018 (IADPSG/WHO screening)	OR* (95% CI)	p-value	aOR** (95% CI)	p-value
Number of pregnant women	222011	222217				
Prevalence of HIP	13238 (6.0)	20347 (9.2)				< 0.001
Gestational weight gain (kg)	12.3 ± 5.7	11.9 ± 5.8				< 0.001
- HIP group:	9.9 ± 6.3	9.7 ± 6.3				< 0.01
- no-HIP group	12.4 ± 5.6	12.1 ± 5.7				< 0.001
Gestational age at delivery (weeks)	38.7 ± 1.9	38.7 ± 2.0				< 0.001
Hypertension	9988 (4.5)	9520 (4.3)	0.95 (0.92–0.98)	< 0.001	0.92 (0.89–0.94)	< 0.001
Scheduled cesarean sections	21060 (9.5)	21805 (9.8)	1.04 (1.02–1.06)	< 0.001	1.01 (0.99–1.03)	ns
Emergency cesareans sections	22724 (10.3)	23399 (10.5)	1.03 (1.01–1.05)	< 0.01	1.07 (1.05–1.09)	< 0.001
Number of newborn	226144	226014				
Newborn birth weight (g)	3.245 ± 571	3.252 ± 573				< 0.001
Preterm birth <37 weeks	19275 (8.5)	19468 (8.6)	1.01 (0.99–1.03)	ns	1.09 (1.06–1.12)	< 0.001
NICU [†] or SCN [‡] admissions	24701 (11.2)	22416 (9.9)	0.87 (0.86–0.89)	< 0.001	0.89 (0.87–0.91)	< 0.001
SGA [§] (birth weight <10 th)	19681 (8.7)	18691 (8.3)	0.94 (0.93–0.96)	< 0.001	0.99 (0.97–1.01)	ns
LGA ⁺⁺ (birth weight >90 th)	26047 (11.6)	26862 (11.9)	1.04 (1.02–1.05)	< 0.001	0.99 (0.98–1.01)	ns
Macrosomia (birth weight ≥4000 g)	15242 (6.8)	15558 (6.9)	1.02 (0.99–1.05)	ns	0.99 (0.96–1.01)	ns
Stillbirth	1456 (0.6)	1530 (0.7)	1.05 (0.98–1.13)	ns	1.10 (1.01–1.21)	< 0.05
Perinatal death	1787 (0.8)	1875 (0.8)	1.05 (0.98–1.12)	ns	1.10 (1.01–1.19)	< 0.05

Reference: 2009–2012 period.

The results are expressed as means ± SD, or n or n (%) or *OR: Odds ratio, and **aOR: adjusted Odds Ratio, adjusted for maternal age, pre-pregnancy BMI, hypertension, parity, and multiple pregnancy.

95% CI: confidence interval. C&C: Carpenter & Coustan. IADPSG/WHO: International Association of Diabetes and Pregnancy Study Groups/World Health Organization.

[†]NICU: neonatal intensive care unit. [‡]SCN: special Care Nursery. ⁺⁺LGA: larg-for-gestational age, [§]SGA: small-for-gestational age.

Some studies have shown that women with “mild HIP” (women who met the IADPSG criteria but would not have been diagnosed with HIP based on the Carpenter and Coustan 2-step diagnostic strategy) had higher rates of adverse outcomes than those without HIP [30]. Therefore, the increase in prevalence could also be related to the fact that more pregnant women were diagnosed with mild HIP. However, the prevalence could also be higher because risk factors for HIP in pregnant women changed significantly over the 9-year period analyzed, as evidenced by advanced pregnancy age, overweight and obesity.

We showed for overall maternal and fetal outcomes a decrease in the rate of GWG, hypertension and NICU/SCN admissions with a significant trend in women with HIP.

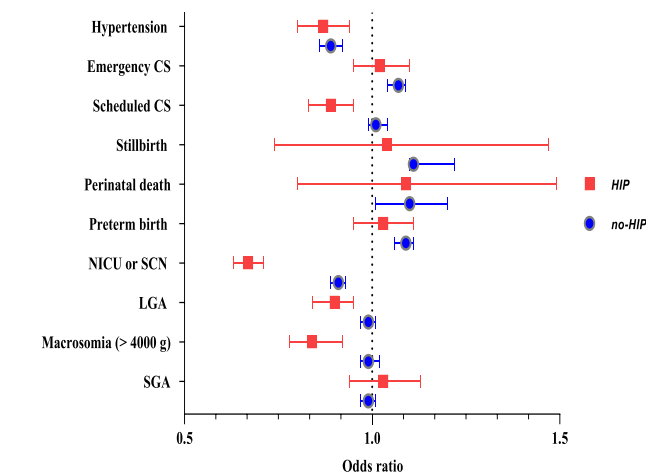


Figure 2. Comparisons of maternal-fetal outcomes in hyperglycemia in pregnancy (HIP) group and no-HIP group in the periods 2009-2012 and 2015-2018. Odds ratios and 95% confidence intervals are shown. Odds ratios were adjusted for maternal age, body mass index, hypertension, parity, and multiple pregnancy. Abbreviations : CS : Cesarean section; LGA: large-for-gestational age; SGA : small-for-gestational age; NICU: neonatal intensive care unit; SCN : special care nursery.

The overall rates of emergency cesarean sections (no scheduled cesarean sections) continued to increase even after implementing the new guidelines. However, this trend was observed in women no-HIP.

Our current data are in contradiction with some literature that showed that the increase in the prevalence of HIP could lead to an increase in the rates of cesarean sections in the HIP population [31, 32].

SGA rates did not change significantly in the total population, including women with HIP. These results do not support the assumption proposed by some authors that IADPSG/WHO guidelines could lead to an increased risk for SGA newborns due to overtreatment in HIP pregnant women [33, 34].

The rates of LGA and macrosomia did not change significantly in the overall population. On the other hand, women with HIP had less hypertension, cesarean sections, NICU admissions, LGA and macrosomia than women without HIP. Rates of SGA, preterm births, stillbirth, and perinatal mortality remained stable in women with HIP. In contrast, a previous Belgian study by Benhalima et al [21] showed no significant differences in the rates of hypertension, LGA, and caesarean delivery between women screened by the IADPSG/WHO criteria and the two-step approach in a population with a lower prevalence of GDM. However, in this study, the early screening of GDM was not considered. However, our study does not allow us to confirm that early screening and early health care management of HIP explain this difference in outcomes.

The limitations and bias are described below, including the following:

- The retrospective nature of the analysis performed across clinical sites.
- Pregnancies were followed over a long period of time (2009–2018), so differences in practice and management of medical care could be present. However, diabetes health care for pregnant HIP women did not change during these periods.
- Some historical risk factors, such as a history of GDM, macrosomia and a history of familial diabetes, could not be included as potential confounders.
- Because we do not have data on blood glucose levels, we cannot conclude that the difference in obstetric outcomes between the two

periods is solely due to glycemic management. The analysis of these data would be interesting to help us to understand whether the observed improvement in neonatal outcomes was due to better detection and care management of women with mild HIP. Therefore, it is not possible to conclude that the improvement in LGA/macrosomia outcomes observed over the last period was simply the result of treating more women with HIP or recruiting more “mild-HIP” individuals with a lower risk of adverse outcomes.

The major strength of this study is the large cohort of pregnant women and their newborns with clinical data from the CEpiP database with the ability to study a wide variety of outcomes and to adjust for several confounding factors. Analysis of this large cohort supports the study of outcomes such as cesarean sections, NICU admission, LGA, SGA, preterm birth, stillbirth and neonatal death. Therefore, the present study provided information on all pregnant women with and without HIP after the introduction of the IADPSG/WHO criteria in this part of Belgium.

5. Conclusion

In the overall population, there was less GWG, hypertension, and NICU/SCN in pregnant women. There was no increase in SGA or LGA. Emergency cesarean sections, preterm births, stillbirths, and perinatal deaths increased slightly. The prevalence of HIP increased by 53.7%, but this was associated in HIP women by a decrease in LGA, macrosomia, and NICU/SCN admission rates, with no increase in SGA and scheduled cesarean section rates. Rates of preterm birth, stillbirth, and perinatal mortality remained stable. The decrease in LGA and macrosomia rates observed in pregnant HIP women may be related to glycemic management but also to a greater recruitment of women with mild diabetes and therefore at low risk of obstetric complications.

Declarations

Author contribution statement

Philippe Oriot: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

Charlotte Leroy: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

Virginie Van Leeuw, Jean Christophe Philips, Jean François Vanderijst, Aline Vuckovic, Elena Costa, Christian Debauche and Frederic Chantraine: Conceived and designed the experiments; Analyzed and interpreted the data.

Funding statement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

Acknowledgements

The authors thank all the doctors, nurses, and CEpiP staff who participated in data collection and patient care.

We thank the Brussels Health Observatory and the “Agence wallonne pour une vie de qualité” (AViQ) for giving permission to use the data.

We would like to thank Pr Emmanuel COSSON (Département d'endocrinologie-diabétologie-nutrition, hôpital Jean-Verdier, université Paris 13, Sorbonne Paris Cité, Bondy, France) for the thorough review of this article.

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