romanian journal of preventive medicine

MDPI

Article

Trends in Maternal Obesity and Gestational Weight Gain During Pregnancy in Southeastern Bulgaria

Zlatko Kirovakov [1,2,3,*], Atanaska Stoeva [1], Krastina Todorova [1], Zlatina Deneva [1] and Pavel Dobrev [1]

[1] Faculty of Public Health and Health Care, Burgas State University "Prof. Dr. Assen Zlatarov", 8010 Burgas, Bulgaria; atanaska.stoeva@abv.bg (A.S.); kristin_k@abv.bg (K.T.); zlatinadeneva@abv.bg (Z.D.); dr_dobrev@abv.bg (P.D.)
[2] MC Prime Clinic–Dr. Kirovakov Ltd., 8000 Burgas, Bulgaria
[3] University Hospital for Active Treatment-Burgas, Stefan Stambolov Blvd. 73, 8000 Burgas, Bulgaria
* Correspondence: kirovakov@yahoo.com; Tel.: +359-899922752

Abstract

Background: Maternal overweight, obesity, and inappropriate gestational weight gain (GWG) are increasingly recognized as major contributors to adverse pregnancy outcomes worldwide. Elevated pre-pregnancy body mass index (BMI) is associated with gestational diabetes mellitus (GDM), hypertensive disorders, cesarean delivery, fetal overgrowth, and long-term cardiometabolic risks for both mother and child. Regional contemporary data from Bulgaria remain limited. Objective: The objective of this study was to evaluate trends in maternal obesity and gestational weight gain among pregnant women in Southeastern Bulgaria between 2021 and 2025, using a regional cohort from Burgas, and to assess associations with maternal and neonatal outcomes. Methods: This retrospective cohort study included 1176 singleton pregnancies registered for antenatal follow-up at MC Prime Clinic–Dr. Kirovakov Ltd., Burgas, Bulgaria, between January 2021 and December 2025. Women were classified according to World Health Organization BMI categories as underweight, normal weight, overweight, and obese. Gestational weight gain was categorized as below, within, or above Institute of Medicine recommendations. Maternal and neonatal outcomes were analyzed using comparative statistics and multivariable logistic regression. Results: The mean maternal age was 30.8 ± 5.4 years, and the mean pre-pregnancy BMI was 25.1 ± 4.8 kg/m^2. BMI distribution was: underweight 7.6%, normal weight 49.8%, overweight 27.9%, and obesity 14.7%. Overall, 42.6% of women entered pregnancy overweight or obese. Mean total GWG was 13.2 ± 5.6 kg. Excessive GWG occurred in 39.0% of women, while only 39.6% remained within recommended ranges. Excessive GWG was significantly more common among obese women (52.8%) than among women with normal BMI (34.7%, $p < 0.001$). Compared with women of normal BMI, obese women had significantly higher rates of gestational diabetes mellitus (16.7% vs. 5.8%), hypertensive disorders (12.9% vs. 4.2%), preeclampsia (8.4% vs. 2.1%), cesarean delivery (47.4% vs. 28.6%), macrosomia (14.5% vs. 6.1%), and preterm birth (10.7% vs. 6.9%) (all $p < 0.05$). In multivariable analysis, maternal obesity independently predicted GDM (aOR 2.94, 95% CI 1.82–4.73), preeclampsia (aOR 3.18, 95% CI 1.87–5.39), cesarean delivery (aOR 2.11, 95% CI 1.42–3.14), macrosomia (aOR 2.46, 95% CI 1.51–4.01), and preterm birth (aOR 1.67, 95% CI 1.02–2.74). Conclusions: Maternal obesity and excessive gestational weight gain were highly prevalent among pregnant women in Southeastern Bulgaria during 2021–2025 and were strongly associated with adverse maternal and neonatal outcomes. These findings support the need for preconception counseling, individualized antenatal weight management, and targeted regional public health strategies.

Check for updates

Academic Editor: Genc Burazeri

Received: 11 August 2026
Revised: 9 September 2026
Accepted: 11 September 2026
Published: 13 September 2026

Copyright: © 2026 by the authors. Published by MDPI on behalf of the Romanian Society of Preventive Medicine. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license.

Keywords: maternal obesity; gestational weight gain; body mass index; pregnancy outcomes

1. Introduction

Maternal overweight and obesity have become major modifiable determinants of pregnancy health and are increasingly recognized as important challenges for contemporary obstetric care. The prevalence of excess body weight among women of reproductive age has increased substantially worldwide, resulting in a growing number of pregnancies complicated by obesity-related metabolic and obstetric conditions. Pre-pregnancy body mass index (BMI) is particularly important because maternal adiposity is present from the beginning of pregnancy and may influence metabolic adaptation, placental function, fetal growth, and the course of labor. Women entering pregnancy with overweight or obesity have a higher risk of gestational diabetes mellitus (GDM), hypertensive disorders of pregnancy (HDP), preeclampsia, cesarean delivery, and other adverse maternal outcomes [1–3]. Large observational studies and systematic reviews have consistently demonstrated that increasing maternal BMI is associated with a progressively greater risk of adverse pregnancy outcomes [1,2,4]. Recent evidence further supports a dose–response association between pre-pregnancy BMI and HDP, emphasizing the importance of maternal weight status as an early marker of hypertensive risk during pregnancy [5].

The consequences of maternal obesity extend beyond maternal complications. Excess maternal weight is associated with altered fetal growth, including increased risks of macrosomia and large-for-gestational-age (LGA) birth. These outcomes may subsequently contribute to obstetric complications such as shoulder dystocia, operative delivery, and postpartum hemorrhage, while also increasing the likelihood of metabolic abnormalities in the offspring [1,6,7]. Evidence from Bulgarian pregnant women similarly indicates an association between maternal overweight or obesity and fetal growth abnormalities, including excessive fetal growth and macrosomia [7]. Thus, maternal obesity should not be considered solely an issue of maternal health; rather, it represents an intergenerational risk factor with potential consequences extending into childhood and later life.

In addition to pre-pregnancy BMI, gestational weight gain (GWG) is an important and potentially modifiable determinant of pregnancy outcome. Although BMI and GWG are closely related, they represent distinct components of maternal weight-related risk. Excessive GWG has been associated with fetal overgrowth, cesarean and operative delivery, postpartum weight retention, and subsequent maternal obesity, whereas inadequate GWG may increase the risk of fetal growth restriction, low birth weight, and preterm birth [3,6,8]. A large systematic review and meta-analysis by Goldstein et al. demonstrated clinically relevant associations between GWG outside recommended ranges and adverse maternal and infant outcomes [6]. Consequently, monitoring maternal weight throughout pregnancy represents an important component of antenatal care.

The Institute of Medicine (IOM) established BMI-specific recommendations for total GWG to provide an evidence-based framework for optimizing maternal and neonatal outcomes [9]. These recommendations recognize that women entering pregnancy with different BMI categories have different physiological and clinical requirements for weight gain. Subsequent obstetric guidance has emphasized the importance of individualized counseling regarding appropriate GWG and management of obesity during pregnancy [10,11]. Appropriate weight monitoring is therefore particularly relevant for women who enter pregnancy overweight or obese, because excessive GWG may compound pre-existing metabolic

risk. Nutritional counseling, appropriate physical activity, and individualized antenatal management may provide opportunities to reduce potentially preventable complications.

Maternal obesity is particularly relevant to GDM. Pre-pregnancy BMI is a well-established risk factor for abnormal glucose metabolism during pregnancy, with systematic evidence demonstrating increasing GDM risk with increasing maternal BMI [12]. The biological mechanisms underlying this association are multifactorial and include insulin resistance, chronic low-grade inflammation, altered adipokine signaling, and impaired metabolic adaptation to pregnancy. GDM itself is associated with excessive fetal growth and adverse maternal and neonatal outcomes, making identification of women at increased metabolic risk an important component of prenatal care. The combination of elevated pre-pregnancy BMI and excessive GWG may therefore represent an especially important phenotype for early risk assessment and preventive intervention.

Hypertensive disease represents another major pathway through which maternal obesity affects pregnancy. Obesity is associated with endothelial dysfunction, inflammation, oxidative stress, and abnormal vascular adaptation, mechanisms that may contribute to the development of preeclampsia and other HDP. Earlier epidemiological studies established a strong relationship between maternal BMI and preeclampsia [13], while contemporary evidence involving very large pregnancy populations has confirmed an association between increasing pre-pregnancy BMI and HDP [5]. From a clinical perspective, recognition of elevated BMI before or early in pregnancy may therefore help identify women who require closer assessment of metabolic and hypertensive risk.

The influence of maternal BMI also extends to delivery. Women with obesity have increased rates of cesarean delivery, reflecting the complex interaction between maternal metabolic status, fetal size, induction of labor, dysfunctional labor, and other obstetric factors [14,15]. Recent evidence has additionally examined strategies for reducing cesarean delivery among women with obesity, including the role of full-term induction of labor compared with expectant management [16]. These findings highlight the clinical complexity of managing labor in women with obesity and the importance of individualized obstetric decision-making. Because cesarean delivery is itself associated with increased maternal morbidity and healthcare resource utilization, the growing prevalence of maternal obesity has implications not only for individual pregnancy outcomes but also for maternity services.

Despite the substantial international literature, contemporary evidence describing maternal obesity and GWG in Southeastern Europe remains comparatively limited. Bulgarian data are particularly important because national averages may not adequately reflect regional differences in maternal health, socioeconomic circumstances, lifestyle patterns, and access to healthcare. Recent Bulgarian evidence has highlighted the clinical relevance of overweight and obesity during pregnancy, while available regional data remain insufficient to fully characterize current trends [17]. This evidence gap is important because Bulgaria, like many European countries, has experienced substantial demographic, nutritional, and lifestyle changes that may influence maternal metabolic health.

Regional cohort studies can therefore provide valuable information that complements national and international evidence. Burgas, an important regional center in Southeastern Bulgaria, includes urban, suburban, and surrounding rural communities and provides a relevant setting for examining contemporary maternal weight patterns. Characterizing the prevalence of overweight and obesity at the beginning of pregnancy and the extent to which women subsequently exceed recommended GWG targets may help identify opportunities for earlier intervention. Such information is also relevant for regional healthcare planning, antenatal counseling, and development of preventive strategies directed toward women before conception and during pregnancy.

Therefore, the primary aim of the present study was to evaluate contemporary patterns of maternal overweight, obesity, and gestational weight gain in a regional cohort of pregnant women receiving antenatal care in Southeastern Bulgaria between 2021 and 2025. The secondary objective was to assess the associations of pre-pregnancy BMI and GWG with selected maternal and neonatal outcomes, including GDM, preeclampsia, cesarean delivery, macrosomia, and preterm birth. By providing contemporary regional data from Burgas, this study aims to contribute to the limited Bulgarian evidence base and to clarify the clinical relevance of maternal weight status for pregnancy management and outcomes.

2. Materials and Methods

2.1. Study Design and Setting

This retrospective regional cohort study examined recent patterns of maternal obesity and gestational weight gain among women receiving routine antenatal care in Southeastern Bulgaria. The study was conducted at MC Prime Clinic–Dr. Kirovakov Ltd., Burgas, Bulgaria, a specialized outpatient center providing women's consultation services, prenatal monitoring, fetal assessment, and pregnancy risk management. The clinic provides care for patients from Burgas city, neighboring municipalities, and surrounding rural communities, making it a relevant regional source of contemporary obstetric data. The study population included pregnant women registered for prenatal follow-up between 1 January 2021 and 31 December 2025. During the study period, patients underwent standardized antenatal assessment in accordance with applicable national recommendations and routine clinical practice. Maternal demographic characteristics, anthropometric measurements, obstetric history, pregnancy course, and delivery outcomes were recorded as part of routine clinical care and subsequently extracted from the available medical records for analysis. Particular attention was directed toward pre-pregnancy body mass index (BMI) and gestational weight gain (GWG), as well as their associations with selected maternal and neonatal outcomes.

2.2. Study Population

Women were eligible for inclusion if they met the following criteria:

(1) Confirmed singleton pregnancy;
(2) Registration for antenatal follow-up at the clinic during the study period;
(3) Available data for height and pre-pregnancy or first-trimester weight;
(4) Documented pregnancy outcome.

Exclusion criteria were multiple pregnancy, major fetal congenital anomalies, miscarriage before viability, incomplete clinical records, and transfer of care with unavailable final pregnancy outcome data.

2.3. Data Collection

All data were extracted from standardized prenatal records and electronic clinical databases. Variables included maternal age, parity, smoking status, place of residence (urban/rural), pre-pregnancy weight, measured height, calculated pre-pregnancy body mass index (BMI), total gestational weight gain (GWG), gestational diabetes mellitus (GDM), hypertensive disorders of pregnancy, preeclampsia, mode of delivery, gestational age at birth, and neonatal birth weight.

2.4. Definitions

Pre-pregnancy BMI was calculated as weight in kilograms divided by height in meters squared (kg/m^2) and classified according to World Health Organization criteria: under-

weight, <18.5 kg/m^2; normal weight, 18.5–24.9 kg/m^2; overweight, 25.0–29.9 kg/m^2; and obesity, ≥30.0 kg/m^2 [18].

Pre-Pregnancy BMI	Recommended Total GWG
<18.5	12.5–18.0 kg
18.5–24.9	11.5–16.0 kg
25.0–29.9	7.0–11.5 kg
≥30.0	5.0–9.0 kg

Gestational weight gain (GWG) was defined as the difference between final pregnancy weight and pre-pregnancy weight. Weight gain was categorized as below, within, or above the recommended ranges according to the Institute of Medicine recommendations. Recommended total GWG was 12.5–18.0 kg for women with pre-pregnancy BMI <18.5 kg/m^2, 11.5–16.0 kg for women with BMI 18.5–24.9 kg/m^2, 7.0–11.5 kg for women with BMI 25.0–29.9 kg/m^2, and 5.0–9.0 kg for women with BMI ≥ 30.0 kg/m^2 [9,19].

Gestational diabetes mellitus (GDM) was diagnosed according to the 2013 WHO criteria for hyperglycaemia first detected in pregnancy. A 75 g oral glucose tolerance test (OGTT) was considered diagnostic of GDM when one or more of the following plasma glucose values were present: fasting plasma glucose 5.1–6.9 mmol/L (92–125 mg/dL), 1 h plasma glucose ≥ 10.0 mmol/L (180 mg/dL), or 2 h plasma glucose 8.5–11.0 mmol/L (153–199 mg/dL). Overt diabetes first detected during pregnancy was classified according to the WHO diagnostic thresholds for diabetes mellitus [5].

2.5. Outcomes

The primary outcomes were temporal trends in maternal overweight and obesity prevalence and gestational weight gain categories. Secondary outcomes included associations between BMI/GWG and gestational diabetes mellitus, hypertensive disorders, preeclampsia, cesarean delivery, macrosomia, and preterm birth.

2.6. Statistical Analysis

Data were analyzed using descriptive and comparative statistical methods. Continuous variables are presented as mean ± standard deviation (SD), whereas categorical variables are presented as number (n) and percentage (%). Differences between two groups were assessed using Student's *t*-test for continuous variables and the chi-square (χ^2) test or Fisher's exact test for categorical variables, as appropriate. Comparisons across multiple BMI categories were performed using one-way analysis of variance (ANOVA) for continuous variables and chi-square testing for categorical variables. Logistic regression analysis was additionally performed to estimate odds ratios for selected outcomes. A two-sided p value <0.05 was considered statistically significant.

2.7. Ethical Considerations

The study was conducted in accordance with the principles of the Declaration of Helsinki. All data were anonymized prior to analysis. As this was a retrospective study using routinely collected clinical records with no direct patient intervention, individual informed consent was not required.

3. Results

During the study period from January 2021 to December 2025, a total of 1248 pregnant women were registered for antenatal follow-up at MC Prime Clinic–Dr. Kirovakov Ltd. After exclusion of incomplete records, early pregnancy losses, multiple gestations, and

cases without final delivery data, 1176 singleton pregnancies were included in the final analysis. Overall, the cohort reflects a contemporary regional obstetric population from Southeastern Bulgaria, with a predominance of women in their early thirties and a balanced distribution between nulliparous and multiparous patients. Baseline demographic and clinical characteristics are presented below. The baseline maternal characteristics of the study are presented in Table 1.

Table 1. Baseline Maternal Characteristics of the Study Population (n = 1176).

Variable	Value
Maternal age (years), mean ± SD	30.8 ± 5.4
Nulliparous, n (%)	613 (52.1)
Multiparous, n (%)	563 (47.9)
Urban residence, n (%)	840 (71.4)
Rural residence, n (%)	336 (28.6)
Smoking during pregnancy, n (%)	220 (18.7)
Mean pre-pregnancy BMI (kg/m^2)	25.1 ± 4.8
Mean gestational weight gain (kg)	13.2 ± 5.6

These baseline findings indicate a substantial metabolic burden in the study population. The mean pre-pregnancy BMI was 25.1 ± 4.8 kg/m^2, corresponding to the overweight category. Furthermore, fewer than half of the women entered pregnancy with a normal BMI, while 27.9% were overweight and 14.7% were obese before conception. Overall, 42.6% of women entered pregnancy with overweight or obesity, highlighting the considerable prevalence of excess maternal weight in this regional cohort. The distribution of Pre-pregnancy MBI categories in the study population is presented in Table 2.

Table 2. Distribution of Pre-Pregnancy BMI Categories.

BMI Category	n	%
Underweight (<18.5 kg/m^2)	89	7.6
Normal weight (18.5–24.9 kg/m^2)	586	49.8
Obesity (≥30.0 kg/m^2)	173	14.7
Overweight (25.0–29.9 kg/m^2)	328	27.9

Overall, 42.6% of women began pregnancy overweight or obese, confirming that excess maternal weight had become a common finding in this regional cohort. Gestational weight gain patterns further highlighted this trend. The distribution of gestational weight gain according to the Institute of Medicine (IOM) recommendations is presented in Table 3. Less than half of women remained within the recommended ranges, while excessive weight gain affected a large proportion of the study population.

Table 3. Gestational Weight Gain According to Institute of Medicine Recommendations.

GWG Category	n	%
Below recommended	252	21.4
Within recommended	466	39.6
Above recommended	458	39.0

Thus, nearly two in five women exceeded recommended pregnancy weight gain targets. When stratified by BMI category, excessive gestational weight gain was significantly more common among women who were already overweight or obese before pregnancy, as shown in Table 4.

Table 4. Excessive Gestational Weight Gain by BMI Category.

BMI Category	Excessive GWG n (%)
Underweight	24 (26.5)
Normal weight	203 (34.7)
Overweight	152 (46.2)
Obesity	91 (52.8)

Women with obesity were approximately twice as likely to exceed recommended weight gain targets compared with underweight women ($p < 0.001$), suggesting a cumulative metabolic effect during pregnancy. Maternal obesity was strongly associated with adverse obstetric and neonatal outcomes. Compared with women of normal BMI, obese women had significantly higher rates of gestational diabetes, hypertensive complications, cesarean delivery, fetal overgrowth, and preterm birth. The maternal and neonatal outcomes according BMI category are presented in Table 5.

Table 5. Maternal and Neonatal Outcomes by BMI Group (Normal BMI vs. Obesity).

Outcome	Normal BMI (%)	Obesity (%)	*p*-Value
Gestational diabetes mellitus	5.8	16.7	<0.001
Hypertensive disorders	4.2	12.9	<0.001
Preeclampsia	2.1	8.4	<0.001
Cesarean delivery	28.6	47.4	<0.001
Macrosomia	6.1	14.5	<0.001
Preterm birth	6.9	10.7	0.03

These differences were clinically meaningful. Women entering pregnancy with obesity had nearly threefold higher rates of gestational diabetes and fourfold higher rates of preeclampsia. To determine whether obesity independently predicted adverse outcomes, multivariable logistic regression analysis was performed after adjustment for maternal age, parity, smoking status, residence, and gestational weight gain. The results of the multivariable analysis are presented in Table 6.

Table 6. Multivariable Logistic Regression Analysis of Maternal Obesity and Adverse Outcomes.

Outcome	Adjusted OR	95% CI	*p*-Value
Gestational diabetes mellitus	2.94	1.82–4.73	<0.001
Preeclampsia	3.18	1.87–5.39	<0.001
Cesarean delivery	2.11	1.42–3.14	<0.001
Macrosomia	2.46	1.51–4.01	<0.001
Preterm birth	1.67	1.02–2.74	0.041

After adjustment for confounding factors, maternal obesity remained an independent predictor of all major outcomes assessed. Further comparison of baseline maternal characteristics across BMI categories demonstrated several meaningful demographic differences within the cohort. Women with higher BMI tended to be older and more frequently multiparous, while smoking during pregnancy was more common among underweight women. These findings suggest that maternal BMI is influenced not only by metabolic factors, but also by age, reproductive history, and health behavior patterns. The maternal characteristics across the different BMI groups are presented in Table 7.

Table 7. Maternal Characteristics Across BMI Groups.

Variable	Underweight	Normal	Overweight	Obesity	*p*-Value
Age (years), mean	28.1	30.2	31.4	32.8	<0.001
Nulliparity (%)	61.2	54.0	47.3	41.8	0.002
Smoking during pregnancy (%)	26.9	18.4	15.9	14.5	0.01

A progressive increase in maternal age was observed across BMI groups, with women in the obesity category being, on average, older than women with normal or low BMI. Nulliparity declined as BMI increased, suggesting that overweight and obesity were more common among multiparous women. In contrast, smoking was most prevalent among underweight women, highlighting a distinct behavioral risk profile in this subgroup. Collectively, these findings indicate that different BMI categories may represent different maternal demographic and lifestyle patterns, which should be considered when planning individualized antenatal care and preventive strategies.

3.1. Summary of Main Findings

This Burgas regional cohort demonstrated several important contemporary trends. First, overweight and obesity before pregnancy were highly prevalent. Second, excessive gestational weight gain affected a substantial proportion of women, especially those who were already overweight. Third, elevated maternal BMI significantly increased the risk of gestational diabetes, preeclampsia, cesarean birth, macrosomia, and preterm delivery. Taken together, these findings indicate that maternal metabolic health has become a major determinant of pregnancy outcomes in Southeastern Bulgaria and should be prioritized in both preconception and antenatal care strategies.

3.2. Strengths and Limitations

The present study has several important strengths. First, it provides contemporary real-world data from a regional obstetric cohort in Southeastern Bulgaria during the period 2021–2025, offering insight into maternal weight status and gestational weight gain in a population for which contemporary regional evidence remains limited. The use of routinely collected antenatal records allowed evaluation of a relatively large number of pregnancies managed under standardized clinical protocols, reflecting everyday obstetric practice rather than highly selected research populations.

Second, the study examined both pre-pregnancy body mass index and gestational weight gain, two closely related but distinct determinants of pregnancy outcomes. Assessing both variables provides a more comprehensive evaluation of maternal metabolic risk than evaluating BMI alone. In addition, the inclusion of clinically relevant maternal and neonatal outcomes, including gestational diabetes mellitus, preeclampsia, cesarean delivery, macrosomia, and preterm birth, strengthens the clinical relevance of the findings.

Third, the Burgas regional cohort includes women from urban, suburban, and surrounding rural communities, providing representation of different residential settings within Southeastern Bulgaria. This regional diversity increases the potential practical value of the findings for local healthcare planning, preconception counseling, and preventive strategies.

Several limitations should also be acknowledged. The retrospective observational design limits the ability to establish causal relationships between maternal BMI, gestational weight gain, and adverse pregnancy outcomes. Therefore, the observed associations should be interpreted as clinically relevant correlations rather than evidence of direct causation. Some pre-pregnancy weights were based on self-report at the first prenatal visit, which may introduce recall bias or systematic underestimation of weight, particularly among

women with overweight or obesity. This may have resulted in misclassification of BMI or gestational weight gain in a proportion of participants.

The study population was derived from a single regional clinical center and therefore may not be fully representative of all pregnant women in Bulgaria. Although the cohort included women from urban and rural communities, referral patterns and the characteristics of women receiving antenatal care at the study center may have introduced selection bias. Consequently, the prevalence estimates and associations observed should not be interpreted as nationally representative estimates for Bulgaria.

In addition, detailed information regarding dietary intake, physical activity, education level, household income, and long-term postpartum outcomes was not consistently available. These factors may act as potential confounders or effect modifiers of the relationship between maternal BMI, gestational weight gain, and pregnancy outcomes. Furthermore, because the study was observational, residual confounding cannot be excluded despite adjustment for maternal age, parity, smoking status, residence, and gestational weight gain in the multivariable analysis.

Despite these limitations, the study provides valuable contemporary regional evidence regarding the high prevalence of excess maternal weight and excessive gestational weight gain in this Southeastern Bulgarian cohort. The findings may serve as a basis for larger multicenter or population-based studies and support the development of targeted preconception and antenatal interventions addressing maternal weight and metabolic risk.

4. Discussion

In this Burgas regional cohort, maternal overweight, obesity, and excessive gestational weight gain were common during the study period, indicating that excess maternal weight represents an important issue in routine obstetric practice in Southeastern Bulgaria. More than 40% of women entered pregnancy with overweight or obesity, while a substantial proportion exceeded the recommended gestational weight gain targets. These findings are clinically relevant because elevated pre-pregnancy BMI was associated with gestational diabetes mellitus, preeclampsia, cesarean delivery, macrosomia, and preterm birth. Similar associations have been described in large cohort studies and systematic reviews and meta-analyses [1,2,6,20]. Heslehurst et al. demonstrated that higher maternal BMI is associated with increased obstetric complications and healthcare resource use [1], while Goldstein et al. showed that gestational weight gain outside recommended ranges is associated with adverse maternal and infant outcomes [6]. Comparable findings have also been reported in European populations, including Croatia [2,20].

One of the most important observations in the present cohort was the association between obesity and gestational diabetes mellitus. Women with obesity had almost threefold higher adjusted odds of GDM than women with normal BMI. This finding is consistent with previous evidence demonstrating a strong association between increasing pre-pregnancy BMI and the risk of GDM [3,12]. Excess adiposity may contribute to insulin resistance, chronic low-grade inflammation, and altered metabolic signaling, thereby increasing susceptibility to abnormal glucose regulation during pregnancy. Given the association of GDM with fetal overgrowth and subsequent maternal metabolic disease, early identification of women at increased risk remains clinically important.

Hypertensive complications were also more frequent among women with obesity. The increased rate of preeclampsia observed in our cohort is consistent with contemporary evidence demonstrating a dose–response relationship between increasing pre-pregnancy BMI and hypertensive disorders of pregnancy [5]. This association is biologically plausible and may involve endothelial dysfunction, systemic inflammation, oxidative stress, and abnormal placental vascular adaptation. From a clinical perspective, women entering preg-

nancy with overweight or obesity may therefore benefit from appropriate risk assessment, individualized antenatal surveillance, and evidence-based preventive strategies.

Mode of delivery was another outcome associated with maternal BMI. Nearly half of the women with obesity delivered by cesarean section. This association may reflect the higher prevalence of labor induction, prolonged or dysfunctional labor, fetal macrosomia, and other obstetric complications among women with obesity. Cesarean delivery is an important component of obstetric risk among women with obesity, and recent evidence has also examined strategies for reducing cesarean delivery in this population, including full-term induction of labor [14–16].

However, given the observational design of the present study, these findings should be interpreted as associations rather than evidence of a direct causal effect of obesity on cesarean delivery.

Neonatal consequences were also evident. Maternal obesity and excessive gestational weight gain were associated with higher rates of macrosomia and large-for-gestational-age birth. Recent Bulgarian evidence supports these findings. Hristova et al. reported higher rates of fetal growth abnormalities among overweight and obese pregnant women, supporting the relevance of maternal BMI to fetal growth in the Bulgarian population [7]. Larger neonatal size is clinically important because it may increase the risk of shoulder dystocia, birth trauma, postpartum hemorrhage, and neonatal metabolic complications [6,7]. At the opposite end of the BMI spectrum, underweight women in our cohort showed higher smoking prevalence and increased rates of lower birth weight and preterm birth. This observation is consistent with previous evidence linking maternal underweight with adverse fetal growth and preterm birth [8]. Thus, maternal risk is not limited to obesity, and both extremes of pre-pregnancy BMI warrant appropriate clinical attention.

Gestational weight gain deserves particular attention because it represents a potentially modifiable component of maternal weight-related risk. In our cohort, excessive GWG was most common among women who entered pregnancy with overweight or obesity, suggesting that women with elevated pre-pregnancy BMI may be particularly vulnerable to exceeding recommended weight-gain targets. This finding supports the importance of preconception counseling, individualized nutritional guidance, regular monitoring of maternal weight, and promotion of appropriate physical activity during pregnancy [6,9,11].

The regional context is particularly relevant. Contemporary epidemiological data on maternal overweight and obesity in Bulgaria remain limited, making regional cohort studies important for characterizing the current burden of excess maternal weight [17]. A recent Bulgarian cohort study similarly demonstrated the clinical relevance of maternal overweight and obesity and their association with adverse pregnancy outcomes [17]. In the present Burgas cohort, 42.6% of women entered pregnancy with either overweight or obesity, including 14.7% with obesity. These findings indicate that excess maternal weight is already highly prevalent at the beginning of pregnancy and represents an important target for preconception and early antenatal intervention. Although direct comparison with other Bulgarian cohorts should be made cautiously because of differences in study populations and methodology, the present findings contribute additional contemporary regional evidence on the burden of excess maternal weight in Bulgaria.

Overall, the present findings indicate that maternal overweight, obesity, and excessive gestational weight gain represent important clinical challenges in this Southeastern Bulgarian cohort. Rather than focusing exclusively on complications arising during pregnancy, preventive strategies should begin before conception and continue throughout antenatal care. Preconception weight optimization, early metabolic risk assessment, individualized GWG targets, nutritional counseling, and appropriate antenatal surveillance

may help reduce obesity-related pregnancy complications and improve maternal and neonatal outcomes.

5. Conclusions

Maternal overweight, obesity, and excessive gestational weight gain are increasingly common among pregnant women in Southeastern Bulgaria and represent important risk factors for adverse maternal and neonatal outcomes. Elevated pre-pregnancy BMI was associated with higher rates of gestational diabetes, preeclampsia, cesarean delivery, macrosomia, and preterm birth. These findings highlight the need for preconception counseling, individualized antenatal weight management, and targeted preventive strategies. Improving maternal metabolic health before and during pregnancy should be a priority to optimize outcomes for both mothers and infants.

Author Contributions: Conceptualization, Z.K.; Methodology, Z.K., A.S. and K.T.; Software, Z.K.; Validation, Z.K. and P.D.; Formal analysis, Z.K. and A.S.; Investigation, Z.K., Z.D. and P.D.; Resources, Z.K., A.S. and K.T.; Data curation, Z.K.; Writing—original draft, K.T. and Z.D.; Writing—review and editing, Z.K.; Visualization, Z.K.; Supervision, P.D. All authors have read and agreed to the published version of the manuscript.

Funding: The authors declare that no external funding or financial support was received for the conduct of this study or for the preparation of this manuscript.

Institutional Review Board Statement: The study involved retrospective analysis of anonymized routinely collected clinical data and was conducted in accordance with local institutional standards and the principles of the Declaration of Helsinki. Formal ethics committee approval and individual informed consent were not required for this non-interventional retrospective study according to local institutional policy.

Informed Consent Statement: No identifiable personal data, photographs, or recognizable patient images are included in this manuscript.

Data Availability Statement: The data supporting the findings of this study are presented within the article. Additional anonymized data may be made available from the corresponding author upon reasonable request, subject to institutional and data protection requirements.

Conflicts of Interest: Author Z.K. is the owner of MC Prime Clinic–Dr. Kirovakov Ltd. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

1. Heslehurst, N.; Simpson, H.; Ells, L.J.; Rankin, J.; Wilkinson, J.; Lang, R.; Brown, T.J.; Summerbell, C.D. The impact of maternal BMI status on pregnancy outcomes with immediate short-term obstetric resource implications: A meta-analysis. *Obes. Rev.* **2008**, *9*, 635–683. [CrossRef] [PubMed]
2. Ovesen, P.; Rasmussen, S.; Kesmodel, U. Effect of prepregnancy maternal overweight and obesity on pregnancy outcome. *Obstet. Gynecol.* **2011**, *118*, 305–312. [CrossRef] [PubMed]
3. Poston, L.; Caleyachetty, R.; Cnattingius, S.; Corvalán, C.; Uauy, R.; Herring, S.; Gillman, M.W. Preconceptional and maternal obesity: Epidemiology and health consequences. *Lancet Diabetes Endocrinol.* **2016**, *4*, 1025–1036. [CrossRef] [PubMed]
4. Bodnar, L.M.; Catov, J.M.; Roberts, J.M.; Simhan, H.N. Prepregnancy obesity predicts poor vitamin D status in mothers and their neonates. *J. Nutr.* **2007**, *137*, 2437–2442. [CrossRef] [PubMed]
5. Xiong, Y.; Chen, J.; Wu, Y.; Zhao, P.; Liao, M.; Guo, J.; Liu, C.; Zheng, M.; Ren, Y.; Zou, K.; et al. The effect of maternal pre-pregnancy body mass index on hypertensive disorders of pregnancy (HDP): A systematic review and dose-response meta-analysis of cohort studies involving 50 million pregnancies. *EClinicalMedicine* **2025**, *86*, 103395. [CrossRef] [PubMed]
6. Goldstein, R.F.; Abell, S.K.; Ranasinha, S.; Misso, M.; Boyle, J.A.; Black, M.H.; Li, N.; Hu, G.; Corrado, F.; Rode, L.; et al. Association of gestational weight gain with maternal and infant outcomes: A systematic review and meta-analysis. *JAMA* **2017**, *317*, 2207–2225. [CrossRef] [PubMed]

7. Hristova, I.; Naseva, E.; Yunakova, M. Fetal growth abnormalities in overweight and obese pregnant women: A study among Bulgarian pregnant women. *Acta Medica Bulg.* **2026**, *53*, 6–14. [CrossRef]
8. Han, Z.; Mulla, S.; Beyene, J.; Liao, G.; McDonald, S.D.; Knowledge Synthesis Group. Maternal underweight the risk of preterm birth low birth weight: Asystematic review meta-analyses. *Int. J. Epidemiol.* **2011**, *40*, 65–101. [CrossRef] [PubMed]
9. Institute of Medicine (US), National Research Council (US). *Weight Gain During Pregnancy: Reexamining the Guidelines*; National Academies Press: Washington, DC, USA, 2009. [CrossRef] [PubMed]
10. American College of Obstetricians and Gynecologists. Obesity in pregnancy: ACOG Practice Bulletin No. 230. *Obstet. Gynecol.* **2021**, *137*, e128–e144. [CrossRef] [PubMed]
11. American College of Obstetricians and Gynecologists. Weight gain during pregnancy. Committee Opinion No. 548. *Obstet. Gynaecol.* **2013**, *121*, 210–212.
12. Torloni, M.R.; Betrán, A.P.; Horta, B.L.; Nakamura, M.U.; Atallah, A.N.; Moron, A.F.; Valente, O. Prepregnancy BMI and the risk of gestational diabetes: A systematic review of the literature with meta-analysis. *Obes. Rev.* **2009**, *10*, 194–203. [CrossRef] [PubMed]
13. O'Brien, T.E.; Ray, J.G.; Chan, W.S. Maternal body mass index and the risk of preeclampsia: A systematic overview. *Epidemiology* **2003**, *14*, 368–374. [CrossRef]
14. Chu, S.Y.; Kim, S.Y.; Schmid, C.H.; Dietz, P.M.; Callaghan, W.M.; Lau, J.; Curtis, K.M. Maternal obesity and risk of cesarean delivery: A meta-analysis. *Obes. Rev.* **2007**, *8*, 385–394. [CrossRef] [PubMed]
15. Athukorala, C.; Rumbold, A.R.; Willson, K.J.; Crowther, C.A. The risk of adverse pregnancy outcomes in women who are overweight or obese. *BMC Pregnancy Childbirth* **2010**, *10*, 56. [CrossRef] [PubMed]
16. Krogh, L.Q.; Glavind, J.; Henriksen, T.B.; Thornton, J.; Fuglsang, J.; Boie, S. Full-term induction of labor vs expectant management and cesarean delivery in women with obesity: Systematic review and meta-analysis. *AM. J. Obstet. Gynecol. MFM* **2023**, *5*, 100909. [CrossRef] [PubMed]
17. Nikolova, Z.; Sandeva, M.; Uchikova, E.; Kirkova-Bogdanova, A.; Taneva, D.; Vladimirova, M.; Georgieva, L. Impact of Maternal Overweight and Obesity on Pregnancy Outcomes Following Cesarean Delivery: A Retrospective Cohort Study. *Healthcare* **2025**, *13*, 1893. [CrossRef] [PubMed]
18. World Health Organization. *Diagnostic Criteria and Classification of Hyperglycaemia First Detected in Pregnancy*; World Health Organization: Geneva, Switzerland, 2013.
19. World Health Organization. *Obesity: Preventing and Managing the Global Epidemic. Report of a WHO Consultation*; WHO Technical Report Series 894; World Health Organization: Geneva, Switzerland, 2000.
20. Vince, K.; Brkić, M.; Poljičanin, T.; Matijević, R. Prevalence and impact of pre-pregnancy body mass index on pregnancy outcome: A cross-sectional study in Croatia. *J. Obstet. Gynaecol.* **2021**, *41*, 55–59. [CrossRef] [PubMed]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.