Impact of gestational weight gain on maternal and neonatal clinical outcomes: A retrospective cohort study.

Mahmoud F. Hassan (mahmoudfathy74@yahoo.com)
Ain Shams University, Cairo, Egypt https://orcid.org/0000-0001-9594-0203
Nancy Mohamed Ali Rund
Ain Shams University, Cairo, Egypt, Bugshan Hospital, Jeddah, Saudi Arabia https://orcid.org/0000-0001-9638-4245
Amr Helmy Yehia
Ain Shams University, Cairo, Egypt https://orcid.org/0000-0002-6584-1009
Salha A. Alghanimi
Air Base Hospital, Dhahran, Saudi Arabia
Enas A.A. Abdallah
Cairo University, Cairo, Egypt https://orcid.org/0000-0002-1714-8816

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Abstract

We aim to explore the association between gestational weight gain and adverse events during pregnancy. A retrospective study was conducted to evaluate the perinatal outcomes in singleton women whose weight gain during pregnancy was below, within, or above the 2009 Institute of Medicine's (IOM) guidelines, and delivered between 24 and 42 weeks' gestation. GWG was derived using weight at delivery minus the pre-pregnancy or first trimester weight. Our results indicated that mothers with low GWG had increased odds of having small-for-gestational-age neonates (adjusted OR 1.202; 95% CI 1.031-1.403), and preterm birth (adjusted OR 2.03; 95% CI 1.769-2.439), but decreased odds of having macrosomia (adjusted OR 0.523; 95% CI 0.24-0.991). Meanwhile, mothers with GWG above the IOM recommendations had higher odds of having hypertensive disease of pregnancy (adjusted OR 2.07; 95% CI 1.314-3.535), gestational diabetes (adjusted OR 1.227; 95% CI 1.038-1.448), cesarean section (adjusted OR 1.34; 95% CI 1.279-1.512), induced labor (adjusted OR 1. 219; 95% CI 1.051-1.409), failure of induced labor (adjusted OR 1.432; 95% CI 1.03-1.992), macrosomia (adjusted OR 1.987; 95% CI 1.384-2.725), and shoulder dystocia (adjusted OR 1.715; 95% CI 1.292-2.18. In conclusion, GWG is an important predictor of adverse maternal and neonatal outcomes during pregnancy.

Introduction

Gestational weight gain (GWG) is a distinctive and composite biological phenomenon that supports the functions of fetal growth and development. [1] However, the great variability and differences in GWG observed in pregnant females maybe affected by ethnic and racial variation, the medical status of the patient, including the presence of pre-existing conditions such as diabetes mellitus and hypertension. [2] Research conducted across the world has considered the impact of GWG on maternal and fetal clinical outcomes. [3-5] Excess or deficient GWG is associated with a higher risk of adverse pregnancy outcomes, including preterm birth, macrosomia, and cesarean delivery. [5]

Clinically, it is considered unfavorable to have excessive weight gain in women suffering from obesity. On the other hand, underweight women are considered high-risk cases if they do not gain the weight required for the normal, physiologically complex, and interactive processes occurring during pregnancy. [6] The weight gain process can be influenced by lifestyle and dietary patterns before and throughout pregnancy. [7,8] In attempts to improve health outcomes, the Institute of Medicine's (IOM) 2009 guidelines categorize the appropriateness of GWG with reference to pre-pregnancy body mass index (BMI). [9]

Despite various research studies investigating the impact of gestational weight gain on perinatal outcomes, no studies have evaluated the relationship between GWG and perinatal outcomes in the Middle East or Saudi Arabia. Therefore, the objective of this study was to evaluate the maternal and neonatal clinical outcomes with regard to GWG at a large private hospital in Jeddah, Saudi Arabia.

Materials And Methods

A retrospective population-based cohort study was conducted on 23,736 women giving birth to a singleton baby over a period of 8 years. All women admitted to the obstetric department of a large private hospital in Jeddah, Saudi Arabia, from January 1st, 2010 to December 31st, 2017, were included in the study. Data were collected from a hospital database. The study was approved by the Local Institutional Review Board and Ethics Committee. All women with a singleton pregnancy who had delivered between 24 and 42 weeks of gestational age were included. In addition, included women were required

to have a documented height and pre-pregnancy or first-trimester weight (defined as 13 weeks of gestation or less), and weight at delivery. Pregnant women with pre-gestational diabetes and/or chronic hypertension were excluded from our study. Women with extreme weight gain (greater than 50 kg) or loss (greater than 30 kg) were also excluded, as per Beyerlein et al. [10]

GWG was derived by means of a pre-pregnancy or first prenatal visit weight at 13 weeks of gestation or less subtracted from a delivery weight. Maternal pre-pregnancy BMI was categorize d into underweight (<18.5 kg/m2), normal (18.5–24.9 kg/m2), and overweight (≥25 kg/m2), according to the classification by the World Health Organization. [11] GWG was defined as the average weight gained per week during pregnancy, based on the IOM guidelines. [9] The IOM recommends a GWG of 12.5–18.0 kg for underweight women, 11.5–16.0 kg for normal-weight women, 7.0–11.5 kg for overweight women, and 5.0–9.0 kg for obese women. [9]

Maternal outcomes evaluated in relation to GWG encompassed the following: hypertensive disorders during pregnancy, gestational diabetes mellitus (GDM), labor induction, failure of labor induction, length of labor, cesarean delivery rate, postpartum hemorrhage (defined as more than 1000 mL of postpartum blood loss), third or fourth degree laceration for women who had a vaginal delivery and postpartum infection (defined as the occurrence of any of the following: endometritis, wound infection or dehiscence after cesarean section or episiotomy). Neonatal outcomes comprised of: preterm birth (defined as a delivery before 37 weeks), shoulder dystocia, macrosomia (defined as a birth weight >90th percentile for gestational age), small for gestational age (SGA; defined as birth-weight < 10th percentile for gestational age) and neonatal hypoglycemia requiring treatment.

Baseline clinical characteristics and maternal and neonatal clinical outcomes were compared according to gestational weight gain categories (below, within, and above the IOM guidelines). The quantitative data with a parametric distribution were presented as mean and standard deviations. Qualitative variables were presented as number and percentages. Comparisons between groups for the qualitative data were done using the Chi-square test, and for quantitative data were done using one-way analysis of variance (ANOVA) testing, as appropriate. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for each of the clinical outcomes of interest. Multivariable logistic regression was used to adjust for maternal age, pre-pregnancy BMI, smoking status, parity, prior delivery type, and gestational age at delivery. A p value was considered significant at the level of <0.05. All analyses were performed using the Statistical Package for Social Science (SPSS) version 23 for Windows (IBM Corp., Armonk, NY, USA).

Results

Initial recruitment included 23,736 women. 14,364 women were eligible for our study. Based on the IOM guidelines, 3,045 (21.2%) women had low GWG, 3,993 (27.8%) women had normal GWG, and 7,326 (51%) women had high GWG (Figure 1).

Table 1 reveals the demographic characteristics of the research study cohort comparing low, normal, and high GWG research groups. There was a statistically significant difference between them in relation to age, nulliparity, pre-pregnancy BMI, smoking, and gestational age at delivery (ps <0.001). There was also a statistically significant difference observed with regards to prior cesarean delivery (p = 0.013).

Table 2 displays the maternal outcomes in line with IOM weight gain categories (below, within, and above GWG). Comparing the below and within GWG groups found no statistically significant difference in relation to maternal outcomes. Conversely, comparison between the within and above GWG categories revealed that there was a higher odds of having hypertensive disease of pregnancy (adjusted OR 2.07; 95% CI 1.314 to 3.535), GDM (adjusted OR 1.227; 95% CI 1.038 to 1.448), cesarean section (adjusted OR 1.34; 95% CI 1.279 to 1.512), induced labor (adjusted OR 1. 219; 95% CI 1.051 to 1.409), and failure of induced labor (adjusted OR 1.432; 95% CI 1.03 to 1.992).

With reference to neonatal outcomes, mothers with low GWG had an increased odds of having an SGA neonate (adjusted OR 1.202; 95% CI 1.031 to 1.403), preterm birth (adjusted OR 2.03; 95% CI 1.769 to 2.439), spontaneous preterm birth (adjusted OR 1.981; 95% CI 1.652 to 2.314), and planned preterm birth (adjusted OR 1.711; 95% CI 1.337 to 2.314); however, they were also at lower odds of having macrosomia (adjusted OR 0.523; 95% CI 0.24 to 0.991; Table 3). On the other hand, mothers with GWG above the IOM recommendations had a higher odds of having macrosomia (adjusted OR 1.987; 95% CI 1.384 to 2.725), shoulder dystocia (adjusted OR 1.715; 95% CI 1.292 to 2.18), and treatment for neonatal hypoglycemia (adjusted OR 1.742; 95% CI 1.229 to 2.506; Table 3).

Discussion

Maternal GWG is a natural physiologically progressive process that reflects adaptive changes in normal pregnancy. [12,13] However, the disturbance of this normal physiological phenomena has been correlated with adverse maternal and neonatal clinical outcomes whether by excessive or reduced maternal GWG. [14] The results of the current study suggest that not achieving the normal GWG is associated with multiple deleterious maternal and neonatal consequences including hypertensive disease of pregnancy, gestational diabetes, rates of induced labor, failure of induced labor, cesarean delivery, neonates that are small for gestational age, preterm birth, macrosomia, and shoulder dystocia.

In agreement with our findings, many studies have found that GWG above the IOM recommendations is associated with large for gestational age (LGA) neonates and fetal macrosomia. Conversely, GWG below the IOM recommendations has been associated with small-for-gestational-age neonates. [15,16] In addition, several studies have recognized the relationship between low GWG and preterm birth. [17,18] Hannaford and colleagues conducted a prospective cohort study including singleton, non-anomalous fetuses to evaluate perinatal outcomes in patients who gained weight below or above the IOM's recommendations, and found that women who gained weight below the IOM recommendations were 2.5 times more likely to deliver SGA neonates, and twice as likely to deliver preterm. [19]

An association between excess GWG and cesarean delivery and induced labor is plausible. Excess GWG is associated with a higher incidence of LGA neonates and fetal macrosomia, and hence, a higher incidence of labor induction and cesarean delivery. This relationship has been evaluated previously by Maier and colleagues, who studied weight gain in pregnancy and its association with birthing complications among 591 women. They found that women with more GWG were at a higher risk for induced labor (55.0% vs. 45.7%, p = 0.007), significantly higher rates of secondary cesarean section (22.4% vs. 15.4%), and decreased chances of spontaneous vaginal birth (57.5% vs. 61.4%; p = 0.008). [20]

Associations between excessive GWG and gestational diabetes as well as hypertensive disorders have been reported, but the evidence for these associations is limited. [21] A positive correlation between excess gestational weight gain and GDM was reported in a recent prospective cohort study that included 565 pregnant women; [22] the investigators found that pre-

pregnancy obesity and excessive GWG during the first and second trimesters of pregnancy may increase the risk of GDM. However, a meta-analysis conducted by Brunner and co-workers found no evidence for an effect of GWG on GDM contingent on maternal pre-pregnancy BMI category. [23] These conflicting opinions may be related to the use of total GWG as the exposure variable rather than weight gain until the time of diagnosis of GDM, because the management of GDM includes dietary control and efforts to control weight gain. [10] Likewise, there is a lack of evidence to support the notion that GWG is associated with gestational hypertension and preeclampsia. [24] It is well-known that preeclampsia is associated with vascular permeability and reduced plasma oncotic pressure, and hence rapid weight gain. Nonetheless, it is difficult to ascertain whether excessive GWG is a cause or effect of preeclampsia. [25]

The strengths of our study include the large sample size and the assessment of multiple maternal and neonatal outcomes. However, there are several potential limitations to our study. First, we used the total GWG at delivery; this method is hypothetical and could differ from actual measurements. Second, pre-pregnancy BMI estimation is often self-managed and not performed by a healthcare professional, and as such a bias of under- or overestimation to an unknown degree is possible. Third, our study was conducted among women delivering in Saudi Arabia only.

In conclusion, our study has found that GWG both above and below the recommendations of the IOM guidelines have adverse maternal and neonatal consequences. However, racial and ethnic differences should be considered in future research studies, as they could influence the impact on GWG on clinical adverse outcomes.

Declarations

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Data availability

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

Author Contributions

M.F.H. and N.M.A.R. developed the study concept, designed the study, and developed the protocol. N.M.A.R., S.A.A. and E.A.A.A. collected data. M.F.H., A.H.Y. and E.A.A.A. analyzed data. M.F.H. and N.M.A.R. wrote the paper. All authors revised the manuscript for intellectual content, approved the final version, and agreed with all aspects of the work.

Compliance with ethical standards

Competing interests

The authors declare no competing interests.

Ethical approval:

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent:

Informed consent was exempted by the Local Institutional Review Board as no individual participants included in the study.

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References

[1] Abrams, B. & Selvin, S. Maternal weight gain pattern and birth weight. *Obstet. Gynecol.* **86**, 163–169 (1995).

[2] Ferraro, Z.M. et al. Excessive gestational weight gain predicts large for gestational age neonates independent of maternal body mass index. *J. Matern. Fetal. Neonatal. Med.* **25**, 538–542 (2012).

[3] Bodnar, L.M., Hutcheon, J.A., Parisi, S.M., Pugh, S.J. & Abrams, B. Comparison of gestational weight gain z-scores and traditional weight gain measures in relation to perinatal outcomes. *Paediatr. Perinat. Epidemiol.* **29**,11–21 (2015).

[4] Ludwig, D.S. & Currie, J. The association between pregnancy weight gain and birthweight: a within-family comparison. *Lancet* **376**, 984–990 (2010).

[5] Gaillard, R. et al. Risk factors and outcomes of maternal obesity and excessive weight gain during pregnancy. *Obesity (Silver Spring)* **21**, 1046–1055 (2013).

[6] Vesco, K.K. et al. Newborn size among obese women with weight gain outside the 2009 Institute of Medicine recommendation. *Obstet. Gynecol.* **117**, 812–818 (2011).

[7] Goldstein, R.F. et al. Association of gestational weight gain with maternal and infant outcomes: a systematic review and meta-analysis. *JAMA* **317,** 2207–2225 (2017).

[8] Kominiarek, M.A. et al. Gestational weight gain and obesity: is 20 pounds too much? *Am. J. Obstet. Gynecol.* **209**, 214.e1–214.e11 (2013).

[9] Institute of Medicine (US) and National Research Council (US) Committee to Reexamine IOM Pregnancy Weight Guidelines. *Weight gain during pregnancy: reexamining the guidelines* (eds. Rasmussen, K.M. & Yaktine, A.L.) Washington (DC): National Academies Press (US); 2009.

[10] Beyerlein, A., Schiessl, B., Lack, N. & von Kries, R. Optimal gestational weight gain ranges for the avoidance of adverse birth weight outcomes: a novel approach. *Am. J. Clin. Nutr.* **90**, 1552–1558 (2009).

[11] World Health Organization. Obesity: preventing and managing the global epidemic. Geneva, Switzerland: *World Health Organization;* 2000.

[12] Callaghan, W.M., Creanga, A.A. & Kuklina, E.V. Severe maternal morbidity among delivery and postpartum hospitalizations in the United States. *Obstet. Gynecol.* **120**, 1029–1036 (2012).

[13] Kim, S.Y., Sharma, A.J., Sappenfield, W., Wilson, H.G. & Salihu, H.M. Association of maternal body mass index, excessive weight gain, and gestational diabetes mellitus with large-for-gestational-age births. *Obstet. Gynecol.* **123**, 737–744 (2014).

[14] Truong, Y.N., Yee, L.M., Caughey, A.B. & Cheng, Y.W. Weight gain in pregnancy: does the Institute of Medicine have it right? *Am. J. Obstet. Gynecol.* **212**, 362.e1–362.e8 (2015).

[15] Faucher, M.A. & Barger, M.K. Gestational weight gain in obese women by class of obesity and select maternal/newborn outcomes: A systematic review. *Women Birth* **28**, e70–e79 (2015).

[16] Zhao, R., Xu, L., Wu, M.L., Huang, S.H. & Cao, X.J. Maternal pre-pregnancy body mass index, gestational weight gain influence birth weight. *Women Birth* **31**, e20–e25 (2018).

[17] Woolfolk, C.L., Harper, L.M., Flick, L., Mathews, K. & Chang, J.J. Gestational weight gain and preterm birth: disparities in adolescent pregnancies. *J. Perinatol.* **36**, 1055–1060 (2016).

[18] Wen, T. & Lv, Y. Inadequate gestational weight gain and adverse pregnancy outcomes among normal weight women in China. *Int. J. Clin. Exp. Med.* **8**, 2881–2886 (2015).

[19] Hannaford, K.E., Tuuli, M.G., Odibo, L., Macones, G.A. & Odibo, A.O. Gestational Weight Gain: Association with Adverse Pregnancy Outcomes. *Am. J. Perinatol.* **34**, 147–154 (2017).

[20] Maier, J.T., Schalinski, E., Gauger, U. & Hellmeyer, L. Antenatal body mass index (BMI) and weight gain in pregnancy - its association with pregnancy and birthing complications. *J. Perinat. Med.* **44,** 397–404 (2016).

[21] Kominiarek, M.A. & Peaceman, A.M. Gestational weight gain. *Am. J. Obstet. Gynecol.* **217**, 642–651 (2017).

[22] Dong, B., et al. The effect of pre- pregnancy body mass index and excessive gestational weight gain on the risk of gestational diabetes in advanced maternal age. *Oncotarget* **8**, 58364–58371 (2017).

[23] Brunner, S. et al. Excessive gestational weight gain prior to glucose screening and the risk of gestational diabetes: a meta-analysis. *Diabetologia* **58**, 2229–2237 (2015).

[24] Kominiarek, M.A. et al. Association between Gestational Weight Gain and Perinatal Outcomes. *Obstet. Gynecol.* **132**, 875–881 (2018).

[25] Hypertension in pregnancy. Report of the American College of Obstetricians and Gynecologists' Task Force on Hypertension in Pregnancy. *Obstet. Gynecol.* **122**, 1122–1131 (2013).

Tables

Table 1: Maternal demographics and characteristics

	Gestational weight gain			
Variables	**Below (n = 3045)**	**Within (n = 3993)**	**Above (n = 7326)**	**P value**
Age	28.87 ± 5.32	29.72 ± 6.74	29.2 ± 6.52	<0.001[a]
Nulli-parous	1020 (33.5%)	1598 (40.02%)	3465 (47.3%)	<0.001[b]
Pre-pregnancy BMI	26.92 ± 6.83	25.42 ± 5.42	27.34 ± 6.25	<0.001 [a]
Underweight	195 (6.4%)	200 (5.0%)	117 (1.6%)	
Normal	1425 (46.8%)	2232 (55.9%)	3282 (44.8%)	
Overweight	502 (16.49%)	847 (21.2%)	2336 (31.9%)	
Obese	923 (30.3%)	714 (17.9%)	1591 (21.7%)	
Prior cesarean delivery	583 (19.2%)	659 (16.5%)	1267 (17.3%)	0.013 [b]
Smoking	314 (10.3%)	244 (6.1%)	718 (9.8%)	< 0.001 [b]
GA at delivery (weeks)	38.63 ± 3.3	38.52 ± 4.6	38.9 ± 4.5	< 0.001 [a]

IOM, Institute of Medicine; BMI, body mass index; GA, gestational age.

Data are mean ± standard deviations or number (percent).

[a] One Way ANOVA test was used; [b] Chi-square test was used.

P value< 0.05 is significant.

Table (2): Maternal outcomes according to the institute of medicine gestational weight gain categories

Maternal outcome	Below (n = 3045)	[a] Adjusted OR (95% CI)	P value	Within(Referent) (n = 3993)	Above (n = 7326)	[a] Adjusted OR (95% CI)	P value
Hypertensive disease of pregnancy	215 (7.1%)	1.107 (0.92 - 1.113)	0.411	240 (6.0%)	901 (12.3%)	2.07 (1.314 – 3.535)	< 0.001
Gestational diabetes	165 (5.4%)	1.019 (0.824 - 1.252)	0.84	212 (5.3%)	473 (6.5%)	1.227 (1.038 -1.448)	0.019
Labor induction	231 (7.6%)	1.082 (0.901 -1.298)	0.362	280 (7.0%)	618 (8.4%)	1.219 (1.051 -1.409)	0.011
Failure of labor induction	57 (24.7%)	1.128 (0.742 - 1.692)	0.571	63 (22.5%)	182 (29.4%)	1.432 (1.03 -1.992)	0.038
Cesarean delivery	837(27.5%)	0.9285 (0.829 - 1.028)	0.164	1157 (29%)	2657 (36.3%)	1.34 (1.279 - 1.512)	<0.001
Postpartum hemorrhage	82 (2.7%)	1.332 (0.989 – 2.432)	0.061	60 (1.5%)	125 (1.7%)	1.031 (0.877 – 1.124)	0.315
3rd or 4th degree laceration in vaginal delivery only [b]	68 (3.1%)	0.82 (0.59 - 1.169)	0.117	102 (3.6%)	193 (4.0%)	1.127 (0.881 to 1.439)	0.32
Postpartum infection	21 (0.7%)	1.125 (0.819 – 1.245)	0.628	20 (0.5%)	41 (0.6%)	1.031 (0.895 – 2.314)	0.098

OR, odds ratio; CI, confidence interval.

[a] Odds ratio were adjusted for maternal age, pre-pregnancy BMI, prior delivery type, smoking and GA at delivery.

[b] The denominator for the 3rd or 4th degree laceration outcome varies from the total sample size because it was limited to women with vaginal deliveries (n= 2208 below; n= 2863 within; n= 4813 above).

P value < 0.05 is significant.

Table (3): Neonatal outcomes according to the institute of medicine gestational weight gain categories

Neonatal outcome	Below (n = 3045)	[a] Adjusted OR (95% CI)	P value	Within(Referent) (n = 3993)	Above (n = 7326)	[a] Adjusted OR (95% CI)	P value
SGA	342(11.2%)	1.202 (1.031 - 1.403)	0.021	379(9.5%)	645(8.8%)	0.918 (0.802 to 1.048)	0.229
Preterm birth	411 (13.5%)	2.03 (1.769 – 2.439)	<0.001	278 (7.0%)	542 (7.4%)	1.063 (0.913 – 1.21)	0.398
Spontaneous preterm birth	253 (8.3%)	1.981 (1.652 – 2.314)	<0.001	167 (4.2%)	278 (3.8%)	0.870 (0.542 – 1.108)	0.425
Indicated preterm birth	158 (5.2%)	1.711 (1.337 – 2.314)	<0.001	111 (2.8%)	264 (3.6%)	1.299 (1.037 – 1.490)	0.025
Shoulder dystocia in vaginal delivery only [b]	46 (2.1%)	0.896 (0.605 – 1.312)	0.498	66 (2.3%)	188 (3.9%)	1.715 (1.292 – 2.18)	0.003
Macrosomia	15 (0.5%)	0.523 (0.24 – 0.991)	0.0389	37 (0.9%)	139 (1.9%)	1.987 (1.384 – 2.725)	0.008
Treatment for neonatal hypoglycemia	25 (0.8%)	1.098 (0.591 – 1.891)	0.487	28 (0.7%)	95 (1.3%)	1.742 (1.229 – 2.506)	0.007

OR, odds ratio; CI, confidence interval; SGA, small for gestational age.

[a] Odds ratio were adjusted to maternal age, pre-pregnancy BMI, prior delivery type, smoking and GA at delivery

[b] The denominator for the shoulder dystocia outcome varies from the total sample size because it was limited to women with vaginal deliveries (n=2208 below; n=2863 within; n=4813 above).

P value< 0.05 is significant.

Figures

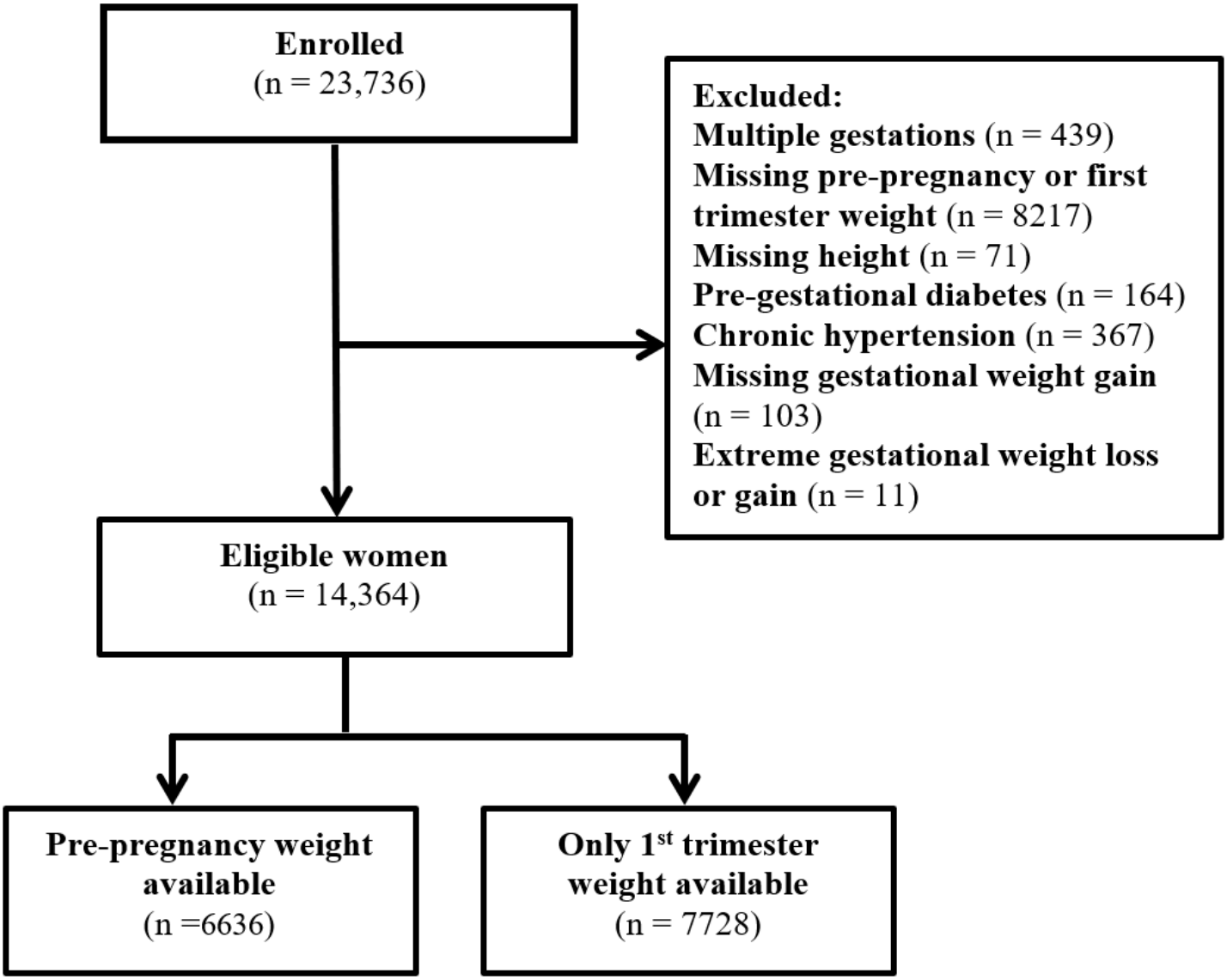

Figure 1

Patients Flow Chart