

## Impact of Body Mass Index (BMI) and Gestational Weight Gain on Term Pregnancy Outcome in Rwanda

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### ABSTRACT

**BACKGROUND:** There is limited data on the consequences of obesity and gestational weight gain on pregnancy outcomes in developing countries.

This study aimed at evaluating BMI and gestational weight gain in Rwanda and their effects on pregnancy outcomes.

**METHODS:** Prospective cross-sectional study of women with a singleton gestation who entered antenatal care in the 1st trimester and delivered at term. Only patients with accurate gestational age assignments were included. All participants were admitted to 1 of 3 maternity units in Kigali, Rwanda from June to December 2016 and were weighed at the entry to care and at the time of delivery to calculate gestational weight gain.

**RESULTS:** Of the 1000 participants, 3.1% were underweight, 64.1% had a normal BMI, 26.1% were overweight and 6.7% were obese. Most women (68%) had less weight gain than recommended. Overweight and obese women were at increased risk of hypertension ( $p < 0.0001$ ). Obese women were at increased risk of cesarean section ( $p < 0.0001$ ). Excessive weight gain increased the risk of hypertensive disorders and cesarean section ( $p < 0.0001$ ). Large for gestational age infants were more common in overweight and obese women (OR=3.3,  $p = 0.008$  vs OR= 5.3,  $p = 0.007$ ). Underweight women had a 3.5-fold increased risk of low birth weight ( $p = 0.05$ ) and insufficient weight gain significantly increased the risk for a small for gestational age infant (OR=2.5,  $p < 0.0001$ ).

**CONCLUSIONS:** BMI and gestational weight gain have significant impacts on the term pregnancy outcome in Rwanda. The findings of this study highlight the need for nutritional education and support to improve pregnancy outcomes.

**Keywords:** Gestational Weight Gain, Obesity, Developing Country, Rwanda

### INTRODUCTION

Inappropriate gestational weight gain patterns have been shown to be associated with abnormal

obstetric and neonatal outcomes [1,2,3]. Inadequate weight gain is associated with fetal growth restriction and preterm birth, whereas excessive weight gain and obesity are associated

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with macrosomia, traumatic birth, cesarean section, diabetes, preeclampsia and hypertension [2]. Both low and high birth weight are also associated with significant risk factors for obesity and cardiovascular disease in later life [4,5,6]. Excessive maternal weight gain and obesity have also been associated with long term cardiovascular disease, hypertension and diabetes [7].

The recommendations regarding the ideal weight gain for pregnancy have been widely debated. The World Health Organization (WHO) recommends a total weight gain according to the pre-pregnancy body mass index (BMI) as guided by the Institute Of Medicine (IOM) [8]. Many studies have been conducted worldwide, including Africa, to evaluate the impact of pre-pregnancy body mass index and gestational weight gain on pregnancy outcome [9-20]. However, information on the relationship between maternal BMI and total gestational weight gain on pregnancy outcomes in Rwanda does not exist.

**Objectives:** The aims of this study were to evaluate how pregnant Rwandan women are gaining weight compared to IOM gestational weight gain (GWG) guidelines and to assess the influence of maternal body mass index and gestational weight gain on birth outcomes.

## METHODS

**Study design:** The current study is a prospective cross-sectional study.

**Study sites:** Pregnant women admitted for delivery for a period of 6 months (June to December 2016) at the three largest maternity hospitals in Kigali, Rwanda. Kigali University Teaching Hospital (KUTH) is a large public referral hospital with a maternity unit that performs 2500 deliveries per year. Muhima and Kacyiru Hospitals are large public hospitals in Kigali with over 10,000 and 7,200 annual deliveries, respectively.

**Inclusion criteria** were pregnant women of any parity, with a single live fetus, who attended their first prenatal visit in the first trimester and who presented for delivery at 37 weeks 0 day to 42 weeks. Only patients with an accurate gestational age assignment were included. Gestational age was determined by the last menstrual period correlating with either first-trimester examination or ultrasound before 20 weeks. All women with a known disease before pregnancy (hypertension,

diabetes mellitus, cardiac, renal disease, or HIV), hypertension or diabetes in the current pregnancy prior to 20 weeks and malaria were excluded. All scheduled cesarean sections were also excluded. Procedures: All patients who fulfilled criteria were enrolled prospectively in the study after written informed consent was obtained.

**Variables:** Pre-pregnancy BMI was calculated from weight and height recorded at the first-trimester visit (before 13 weeks) and was used to estimate GWG. This was done because the predominance of patients is not weighed until they are pregnant. The main outcomes of interest were infant birth weight, birth weight percentile, pregnancy-induced hypertension, cesarean section and gestational diabetes. Birth weight percentile was established by the Alexander curve [21]. Low birth weight (LBW) was defined as less than 2,500 gm while macrosomia as more than 4,500 gm. Small for gestational age (SGA) was defined as less than 10th percentile and large for gestational age (LGA) as greater than the 90th percentile by the Alexander curve. The main independent variable was BMI classified as normal weight, overweight and obese with normal weight as the reference. GWG was also an independent variable. Maternal demographic and socioeconomic variables were also collected.

### Data collection, management and analysis:

Descriptive statistics such as frequency mean and standard deviation were used to describe the study variables. Chi-square test was used to describe qualitative variables among groups and t-test was used for comparing quantitative variables. Data were analyzed using SPSS version 21.

**Ethical clearance:** The study received ethics approval from each of the hospitals and the Institutional Research Board of the College of Medicine and Health Sciences/University of Rwanda (Ref. No: 138/CMHS IRB/2016).

## RESULTS

A total of 1000 women met the inclusion criteria during the study period. Demographic characteristics are presented in Table 1. Mean age of the participants was 28.3 ± 5.6 years. The predominance of participants was multiparous (60.3%) and married (88.6%). Only 17.3% of the cohort was below 21 years of age or above 35. Twelve per cent of women acknowledged using traditional medicine during their pregnancy; only

0.3% used tobacco and 4.2% used alcohol. Fifty-two per cent of the neonates were male. Severe anemia was present in only 0.5%. There was a significant increase in the women who were overweight or obese pre-pregnancy compared to weight at delivery (32.8% vs 63.7%,  $p < 0.001$ ).

There was a significant increase in adverse maternal outcomes based on pre-pregnancy BMI and GWG, as illustrated in Table 3. Hypertension was significantly more common in obese (16.4%) and overweight women (10.3%) than the normal weight population (2.8%,  $p < 0.0001$ ).

**Table 1: Sociodemographic characteristics (N=1000)**

		N	(%)
Age categories	< 21 years	58	(5.8)
	21-35 years	827	(82.7)
	>35 years	115	(11.5)
Education	None	140	(14.0)
	Primary	322	(32.2)
	Secondary	371	(37.1)
	Tertiary	167	(16.7)
Pre-pregnancy BMI	Underweight	31	(3.1)
	Normal	641	(64.1)
	Overweight	261	(26.1)
	Obese	67	(6.7)
BMI at Delivery	Underweight	1	(0.1)
	Normal	362	(36.2)
	Overweight	458	(45.8)
	Obese	179	(17.9)

Table 2 illustrates the trends of weight gain within BMI groups. The majority of participants (68%) gained less than recommended weight gain. Only 12.9% of underweight women gained weight according to IOM recommendations. Overweight and obese women were more likely to have excessive weight gain when compared to underweight and normal weight women ( $p < 0.001$ ).

For obese women, this represents a 7.2-fold increased risk (95% CI 3.22 -16.1,  $p < 0.001$ ) and for overweight women a 4.2-fold risk (95% CI 2.27-7.9,  $p < 0.001$ ) compared to normal-weight women. Hypertension and cesarean section also had a high prevalence in women with excessive GWG (37.5% and 40%,  $p < 0.0001$ ). Obese women had an increased cesarean section rate (44.8%) compared to the normal population (20.4%). This represents

**Table 2. Weight gain trends based on pre-pregnancy BMI**

Pre-pregnancy BMI	Weight gain		
	Adequate	Low	Excessive
Underweight (n=31)	4 (12.9%)	24 (77.4%)	3 (9.7%)
Normal (n=641)	112 (17.5%)	508 (79.3%)	21 (3.3%)
Overweight (n=261)	85 (32.6%)	122 (46.7%)	54 (20.7%)
Obese (n=67)	24 (35.8%)	26 (38.8%)	17 (25.4%)*
Total (n=1000)	225 (22.5%)	680 (68%)	95 (9.5%)

\* $p < 0.001$

a 3.2-fold increased risk over normal-weight women (95% CI 1.92-5.41,  $p < 0.00001$ ). Women with excessive GWG have a 4.3 fold increased risk of hypertension (95% CI 2.07-8.84,  $p < 0.00001$ ) and a 2.6 fold increased risk of a cesarean compared to adequate weight gain (95% CI 1.54 – 4.4,  $p < 0.00001$ ).

infant (OR=3.3, CI=1.369-8.186,  $p = 0.008$  vs OR= 5.3, CI=1.577-17.803,  $p = 0.007$ ) compared to normal BMI. When characterizing GWG as low or excessive, only low weight gain was significantly associated with an abnormal growth pattern. Low weight gain was associated with a 2.5 fold risk of SGA (95% CI, 1.567-4.076,  $p < 0.00001$ ).

**Table 3: Maternal adverse outcomes based on pre-pregnancy BMI and GWG**

Pre-pregnancy BMI	n	Hypertension	Diabetes	Cesarean Section
Underweight	31	0	0	3 (9.7%)
Normal	641	18 (2.8%)	5 (0.8%)	131 (20.4%)
Overweight	261	27 (10.3%)	1 (0.4%)	63 (24.1%)
Obese	67	11 (16.4%)*	0	30 (44.8%)**
Gestational Weight Gain				
Adequate	225	14 (6.2%)	3 (1.3%)	47 (20.9%)
Low	680	21 (3.1%)	2 (0.3%)	142 (20.9%)
Excessive	95	21 (37.5%)*	1 (1.1%)	38 (40%)*

\* $p < 0.0001$ , \*\* $p < 0.00001$

Fetal adverse outcomes based on pre-pregnancy BMI and gestational weight gain are shown in Table 4. The majority of low birth weight babies have been observed in the underweight category (9.7%,  $p = 0.003$ ).

This group represents two-thirds of the cohort patients with only 9.5% of the cohort having excessive weight gain.

**Table 4. Fetal adverse outcomes based on pre-pregnancy BMI and Gestational Weight Gain (hypertensive and diabetic cases excluded)**

BMI	Birth weight category			Birth weight percentile		
	LBW	Normal	Macrosomia	Normal	SGA	LGA
Underweight (n=31)	3 (9.7%)*	28 (90.3%)	0	24 (77.4%)	7 (22.6%)	0
Normal (n=617)	18 (2.9%)	595 (96.4%)	4 (0.6%)	482 (78.1%)	126 (20.4%)	9 (1.5%)
Overweight (n=233)	8 (3.4%)	224 (96.1%)	1 (0.4%)	181 (77.7%)	40 (17.2%)	12 (5.2%) **
Obese (n=55)	1 (1.8%)	53 (96.4%)	1 (1.8%)	46 (83.6%)	5 (9.1%)	4 (7.3%) **
Gestational Weight Gain						
Adequate (n=207)	5 (2.4%)	198 (95.7%)	4 (1.9%)	175 (84.5%)	22 (10.6%)	10 (4.8%)
Low (n=657)	24 (3.7%)	632 (96.2%)	1 (0.2%)	498 (75.8%)	152 (23.1%)	7 (1.1%)
Excessive (n=72)	1 (1.4%)	70 (97.2%)	1 (1.4%)	60 (80.3%)	4 (5.6%)	25 (2.6%)

\* $p = 0.039$ , \*\* $p = 0.003$

LGA was significantly more prevalent in overweight and obese women (5.2% and 7.3%) compared to normal-weight women ( $p = 0.003$ ). When stratified by BMI categories, there was a non-significant trend for underweight to be associated with low birth weight (OR 3.6, 95% CI 0.992-12.819,  $p = 0.052$ ). Overweight and obese women had a significantly higher risk of giving birth to an LGA

**DISCUSSION**

Abnormal gestational weight gain has been associated with numerous adverse maternal and neonatal outcomes. Obesity has been increasing globally and in 2016, the WHO documented that 33.5% of Rwandan women were overweight and 9.3% were obese [22]. This represents a significant

increase from 2010 data, where only 21.4% were overweight and 4.2% were obese. The current study demonstrates that the majority of participants in a Rwandan cohort had a normal BMI and gained less than the IOM recommendations. Only 22.5% of women had normal weight gain according to the IOM guidelines. This is consistent with other investigators in Africa [15-18,23,24].

Underweight women represented only 3.1% of the total population, though they did have the highest risk for a low birth weight infant. Inadequate weight gain represented a much higher proportion of the population and was associated with an increased risk of small for gestational age infants. Pregnant Rwandan women who were overweight or obese or who gained weight in excess of IOM recommendations had a significantly higher risk of developing hypertension and delivering by cesarean section. In obese women, the risk of cesarean section increased three-fold compared to normal BMI. Excessive GWG had a 4.3 fold increased risk of hypertension and 2.6 fold increased risk of a cesarean compared to adequate weight gain. Cesarean deliveries and hypertension in sub-Saharan Africa have been demonstrated to have a significantly higher risk of maternal morbidity and mortality [25,26]. Over the course of the pregnancy in our cohort, the number of women who were overweight and obese almost doubled from 32.8% vs 63.7%. This has significant implications for reproductive-age women as the Rwandan fertility rate is 3.74 children per woman [22].

Our study's main strength is that it is the first to assess pregnancy outcome based on BMI and GWG in Rwanda. Our sample is limited to a predominantly urban setting and may not reflect nutritional habits and outcomes countrywide. It was also predominantly multiparous. In our study, underweight women represented only 3.1% of the

total population; this is less than the national data in 2016, where 7% of women were underweight. The percentage of overweight and obese in our cohort (42.8%) is consistent with national data [22]. We excluded women with chronic comorbidities which may have a significant impact on the results. Cesarean rates are also likely to vary in different parts of the country. It is unlikely that the effects seen on hypertension and birth weight would be affected by location. Pre-pregnancy BMI was calculated from anthropometric measures of the first trimester instead of prior to pregnancy as most women do not present for pre-conceptual care. The cohort was therefore limited to women with a weight in the first trimester. This may lead to overestimation of the first weight and underestimation of gestational weight gain. To fully assess the IOM recommendations, a sample representative of age, parity, environment, nutrition and social strata found in the country must be studied.

## CONCLUSION

Excessive gestational weight gain and obesity were found to significantly increase the risks of hypertension and Cesarean delivery in a Rwandan cohort. These risks are further compounded by large family size and the risk of multiple surgeries and lack of access to skilled surgeons. Though we do not have postpartum weights available for review, the reality of the gestational weight increase is supported by the national trends of obesity seen in Rwanda. Excessive weight gain in pregnancy is a major risk for future obesity and subsequent risk for chronic disease and is a significant public health concern [27]. Given increasing rates of obesity worldwide as well as food insecurity, efforts must be made to improve nutrition and maximize the number of reproductive-age women with normal pre-pregnancy BMI and adequate gestational weight gain.

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