The impact of maternal weight gain during pregnancy on perinatal outcomes

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Background. Weight gain during pregnancy is a physiological event related to fetal tissue growth and maternal metabolic modifications with the addition of adipose tissue reserves. Maternal nutritional status before and during pregnancy has a considerable influence on the course of pregnancy, fetal development, the health status of the newborn, as well as outcomes for the child.
Objectives. To evaluate the impact of maternal weight gain during pregnancy on the occurrence of maternal and neonatal morbidity in the Moroccan population.
Methods. A study was carried out over one year in the maternity ward of the provincial hospital of Benslimane between 1 October 2020 and 1 October 2021, using data collected from a descriptive cross-sectional study. We included mothers delivering singletons from 37 completed weeks up to 42 weeks' gestation, while those with diabetes or hypertension were excluded. We divided the mothers into three groups based on weight gain during pregnancy: group I gained <8 kg; group II gained 8 -16 kg; and group III gained >16 kg. A validated questionnaire was used to analyse maternal and neonatal outcomes.
Results. Data were collected from 1 408 pregnancies. Gestational hypertension, macrosomia, dystocia, and caesarean sections were more common among women who gained >16 kg ($p<0.05$).
Conclusion. Weight gain during pregnancy has been associated with maternal-fetal complications, hence the need to establish guidelines for prevention and control of high-risk pregnancies during the perinatal period.

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Weight gain during pregnancy is a physiological event. It is related to fetal tissue growth and maternal metabolic modifications with the addition of adipose tissue reserves. Usually, weight gain is low during the first trimester and more marked in the second and third trimesters.[1] In addition, maternal nutritional status before and during pregnancy has a considerable influence on its course, fetal development, the health status of the newborn, as well as the outcomes of the child. Indeed, being overweight has become an important public health problem worldwide.[1] Several studies suggest an increase in maternal complications is associated with being overweight, i.e. postpartum haemorrhage, gestational diabetes and preeclampsia There is also a positive correlation between newborn weight and maternal weight, explaining the increased risk of macrosomia or fetal growth restriction in overweight women.[2] In 1990, the Institute of Medicine (IOM) proposed recommendations for optimal weight gain during pregnancy which was dependent on pre-pregnancy body mass index,[2] with a minimum of 7 kg and a maximum gain of 18 kg.

These recommendations have been discussed widely, especially the fixed limits that are considered to be either too strict to optimise the good course of pregnancy or neonatal outcomes,[3] or too liberal, risking an increase in overweight and obesity.[4]

Several studies have specifically addressed the effects of excessive weight gain on neonatal growth.[5] However, most of these are studies are of North American and European populations whose anthropometric characteristics differ from those of the Moroccan population, for whom data are limited.

The present study aimed to generate new data on weight gain during pregnancy in Moroccan women, determine maternal and neonatal morbidity in our cohort, compare our results with currently published recommendations and to assess if our results were similar to theoretical data or if they imply an exception in our country, as Morocco is undergoing a food transition which affects urban and rural environments. Urbanisation, economic development and globalisation are at the core of changes in nutritional habits. This diversification is especially evident in urban and wealthier households, where foods are rich in micronutrients.

Methods

Type and location of study

We conducted a prospective study at the maternity ward of the provincial hospital of Benslimane over a 12-month period from 1 October 2020 to 1 October 2021. Benslimane is a province located in the northwest of Morocco ~60 km south of the capital city, Rabat. This district covers an area of 2 760 km^2 and has a population of 220 000.

Inclusion criteria

A total of 2 000 pregnant mothers living in Benslimane were admitted to the hospital and 1 408 (70.4%) who met the following criteria were included in the study: singleton pregnancy; delivered during the study period; knew their weight before pregnancy; and had prenatal care before 12 weeks' gestation. Pregnancy weight data were obtained from interviewing the mother (in the delivery room) and from the medical records.

The pregnancy weight gain was classified into classes as defined according to IOM recommendations[2] and were calculated as the difference between maternal weight at birth and maternal weight recorded at the first visit to the hospital before 12 weeks' gestation. The weight measurement during the consultation was used to confirm the weight before pregnancy as reported by the women.

Several studies[3-5] indicate that the mean total gestational weight gain of normal-weight adult women giving birth to term infants ranges from 10.0 kg to 16.7 kg.

Our study aimed to define healthy weight gain in pregnancy. Based on Cedegren's findings,[3] we classified pregnancy weight gain into three groups: group I gained <8 kg; group II gained 8 - 16 kg; and group III gained >16 kg. Body mass index (BMI) in kg/m^2 was used to assess and classify maternal corpulence according to the recommendations of the World Health Organization (WHO).[2]

Trained female investigators administered questionnaires every day, including weekends, and obtained the following data: age; marital status; income; years of education; number of previous births; date of birth; and date of last menstrual period. The questionnaires also assessed prenatal care and medical records during the period of hospitalisation for delivery. We derived the demographic and socioeconomic data from obstetric files (age of mothers, marital status, place of residence, level of education, occupation of mother and head of household, monthly income, number of previous births, date of birth, and date of last menstruation.

We noted the following outcomes: dystocia; infections; delivery method; pregnancy blood pressure (≥140/100 mmHg); postpartum haemorrhage (defined as blood loss >500 mL in the first 24 hours after delivery) which, left untreated, may be sufficient to cause haemorrhagic shock and death in some instances.[6]

Infant birthweight was recorded in grams (g) and it was categorised into three groups: low (<2 500 g); appropriate (2 500 - 3 999 g) and high or macrosomia (≥4 000 g).

We excluded twin pregnancies, mothers with irregular menstrual cycles or who did not remember the date of their last menstrual period, mothers with autoimmune diseases, endocrine diseases and diabetes.

Statistical analysis

Data were analysed using SPSS version 13.0 software (SPSS Inc., USA). Quantitative variables were expressed as means with standard deviation (SD) and qualitative variables as number and percentage. The ANOVA and Chi-square tests were used to compare means and frequencies between the groups, respectively. A *p*-value <0.05 was considered significant.

Results

Of the 2 000 pregnant women giving birth during the study year, 1 408 were included in the study (Fig. 1) and divided into three groups according to weight gain during pregnancy.

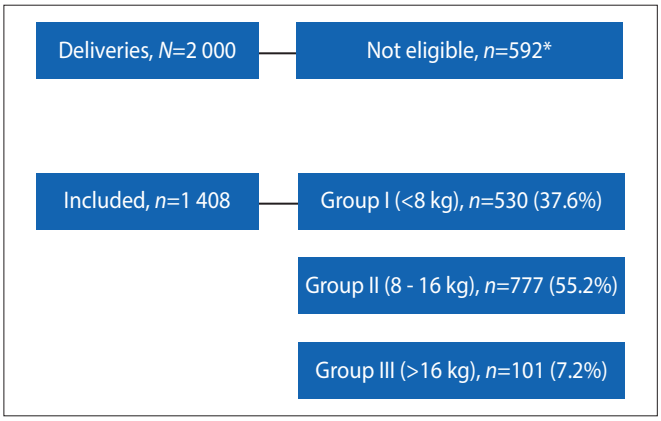

*Fig. 1. Sampling process flowchart. (*Missing the date of their last menstrual period or missing weight, had diabetes or hypertension, gestational age <37 weeks.)*

Maternal characteristics

The anthropometric parameters of participants are reported in Table 1. Of the 1 408 women, 22 (1.5%) were single. The mean (SD) age was 27.2 (6.4) years, with a mean weight of 62.9 (9.4) kg, height of 160 (0.5) cm and BMI of 24.1 (3.4) kg/m^2.

Nearly two-thirds of the women in group I (65.5%) (<8 kg weight gain) were from rural backgrounds compared with groups II (8 - 16 kg weight gained) and III (>16 kg weight gained) at 56.1% and 57.4%, respectively, with a significant statistical difference (p=0.003).

Women with >8 kg weight gain (groups II and III) were taller than those in group I, with mean (SD) heights of 165 (5.2) cm for participants in group III, 161 (5.6) cm for participants in group II and 160 (5.9) cm for those in group I (p<0.001).

The mean (SD) pre-pregnancy BMI was significantly higher for participants in group III (>16 kg weight gained) at 24 (4.4) kg/m^2 compared with 23 (3.2) kg/m^2 for those in group II (8 - 16 kg weight gained) (p<0.05).

Significant quantitative variables were expressed as averages with SDs and qualitative variables were expressed as numbers and percentages (Table 2). The average (SD) newborn weight was 3 782 (595) g for group III, 3 435 (540.4) g for group II, and 3 201 (566.7) g for group I (<8kg). The difference was significant between the different groups (p<0.05).

The prevalence of low birthweight was higher in group I at 6.2%, compared with 2.4% and 1% for groups II and III, respectively (p<0.05).

The prevalence of macrosomia rose progressively from group I (7.9%) to group III (45.5%) (p<0.05).

Maternal complications according to weight gain

Analysis of maternal data (Table 3) revealed that there was an increase in the incidence of gestational hypertension (10.9%) in mothers who gained >16 kg (p<0.05).

Caesarean section delivery was most common in women who gained >16 kg (21.8%) (p=0.006), as were significant haemorrhage, dystocia, perineal trauma and infections (p<0.05).

Discussion

Excessive weight gain during pregnancy increases the risk of obstetric and neonatal complications, particularly hypertension, caesarean section and macrosomia.

In Morocco, the prevalence of overweight and obesity is high, particularly in women from urban areas. In fact, the prevalence of overweight and obesity altogether accounted for 42% of women in urban regions and 29% in rural areas (National Survey on Population and Family Health).[7]

Numerous studies have shown a strong influence of socioeconomic status on obesity, particularly in women, causing variations in their behaviour, which changes their energy intake and expenditure and affects their body fat storage.[8]

Socioeconomic status is commonly measured by the level of education, occupational status and income[9] corresponding to different potential individual mechanisms influencing lifestyle factors, such as having a healthy diet, regular physical activity, maintaining a healthy weight, and not smoking.[10]

Some studies have suggested that height has an independent effect on pregnancy outcome, birthweight, and mortality,[11] while other studies suggest that the effect of maternal height is through its effect on maternal weight, muscle mass, and fat stores.[12]

Maternal height is associated with the growth of the child, the morphology of the pelvis and a good predictive factor of the risk of cephalopelvic disproportion, as well as dystocia.

Table 1. Patient characteristics

	Groups by weight gain (kg), *n* (%)*			
	<8, *n*=530	8 - 16, *n*=777	>16, *n*=101	*p*-value†
Age (years), mean (SD)	26.75 (6.76)	27.36 (6.12)	27.94 (5.99)	0.1
Residence				0.003
Urban	183 (32.3)	341 (60.1)	43 (7.6)	
Rural	347 (41.3)	435 (51.8)	58 (6.9)	
Married	512 (36.9)	774 (55.8)	100 (7.2)	0.01
Monthly income <5 000 MAD‡	500 (37.9)	728 (55.1)	93 (7)	0.68
Multiparity	318 (35.1)	511 (56.4)	77 (8.5)	0.05
Fundal height (cm), mean (SD)	31 (3.3)	32 (3.5)	35 (4.4)	<0.01
Maternal height (cm), mean (SD)	160 (5.9)	161 (5.6)	165 (5.2)	<0.01
BMI (kg/m^2), mean (SD)	24 (4.4)	23 (3.2)†	24 (4)	0.005

SD = standard deviation; BMI = body mass index.
*Unless otherwise specified.
†p<0.05 considered significant.
‡At the time of publication, 1 MAD = USD0.098 and ZAR1.87.

Table 2. Neonatal complications according to maternal weight gain

	Weight gain during pregnancy (kg), *n* (%)*			
Neonatal complications	<8, *n*=530	8 - 16, *n*=777	>16, *n*=101	*p*-value†
Birthweight (g), mean (SD)	3 201 (566.7)	3 435 (540.4)	3 782 (595.0)	<0.01
LBW	33 (6.2)	19 (2.4)	1 (1)	<0.01
Macrosomia	42 (7.9)	134 (17.2)	46 (45.5)	0.01*
Stillbirth	24 (4.5)	27 (3.5)	1 (1.0)	0.2
Resuscitation	15 (2.8)	16 (2.1)	4 (4.0)	0.4
Transferred to ICU	7 (1.3)	8 (1.0)	1 (1.0)	0.9
Newborn length (cm), mean (SD)	50 (1.9)	50 (2.0)	50.2 (0.8)	0.68
Cranial perimeter (cm), mean (SD)	34 (0.8)	34 (0.9)	34 (0.5)	0.76

SD = standard deviation; LBW = low birthweight; ICU = intensive care unit.
*Unless otherwise specified.
†p<0.05 considered significant.

Table 3. Maternal complications according to weight gain during pregnancy

	Weight gain during pregnancy (kg), *n* (%)*			
Maternal complications	<8, *n*=530	8 - 16, *n*=777	>16, *n*=101	*p*-value*
Gestational hypertension	33 (6.2)	42 (5.4)	11 (10.9)	<0.01
Dystocia	52 (9.8)	122 (15.7)	35 (34.7)	<0.01
Haemorrhage	44 (8.3)	95 (12.2)	23 (22.8)	<0.01
Infections	55 (10.4)	124 (16.0)	35 (34.7)	<0.01
Perineal trauma	50 (9.4)	122 (15.7)	29 (28.7)	<0.01
Mode delivery				0.006
Caesarean section	57 (10.8)	89 (11.5)	22 (21.8)	

*p<0.05 considered significant.

Macrosomia was significantly more frequent when weight gain exceeded 16 kg and, conversely, growth restriction was more associated with a weight gain of <8 kg.

Many studies confirmed that the risks of macrosomia were increased almost 2- and 3-fold among women who gained 0.50 kg per week or more during pregnancy.[13]

Our finding is in line with Edwards[14] *et al.*'s studyconfirming that macrosomia was significantly more frequent when weight gain exceeded 8 kg during pregnancy. Excessive maternal food intake and the presence of insulin resistance results in higher plasma levels of nutrients, including glucose and lipids, compared with women who gained the recommended amount of weight. These nutrients easily cross the placenta and induce fetal hyperinsulinaemia followed by excessive and atypical growth.[15]

We confirmed the link between hypertension and excessive weight gain, which had also been reported in a study by Huda *et al.*[16] However, it is difficult to determine whether weight gain induced the occurrence of vascular complications, or if weight gain was

the result of fluid retention which is frequently present in cases of gestational hypertension. Indeed, obesity is also strongly associated with hyperlipidaemia, which, by direct or indirect mechanisms, damages the endothelial cells, causing vasoconstriction and platelet aggregation, contributing to the gestational hypertension.[17]

Our study indicated that excessive gestational weight gain was associated with a significantly increased rate of caesarean section, which was in line with findings reported by Thorsdottir *et al*.,[18] who stated that weight gain of >20 kg increases both the frequency of assisted deliveries and caesarean sections, as excessive weight gain during pregnancy might increase the risk of several adverse outcomes, e.g. fetal distress and macrosomia, resulting in caesarean delivery. Furthermore, both Lumbiganon *et al*.[17] and Bogaerts *et al*.[19] confirmed that excessive gestational weight gain may be associated with increased adipose tissue and cholesterol deposits in the myometrium, which may in turn inhibit the myometrial contractility, thereby potentially impeding the labour process, complicating normal vaginal delivery and increasing the need for caesarean delivery.[19,20]

Our result showed that the proportion of shoulder dystocia was also higher in patients in group III (36%). This agreed with the findings of a Swedish study including 62 cases of shoulder dystocia[21] – 62% of the women in the study had gained >13.5 kg between the first and last prenatal visit, with 64.5% having a neonatal weight greater than 4 000 g.

In addition, higher incidence of postpartum haemorrhage has been reported in patients with extreme weight gain and obesity (22%).[21] In these cases, the higher incidence of macrosomia is also likely to disrupt the fascial supports of the pelvic floor and cause a stretch injury to the pelvic and pudendal nerves, leading to vaginal prolapse associated with extreme weight gain.[22]

In line with previous studies,[23,24] we established an association between excessive gestational weight gain and an increased risk of postpartum infection (34%). Obesity is a well-known risk factor for infection. However, the mechanism of susceptibility remains unclear. Similarly, the pathophysiology behind the association between excessive weight gain and increased risk of infection in morbidly obese women has yet to be described in the literature. Identifying this underlying mechanism would serve as a valuable use of resources as we continue exploring ways to reduce patient risk.

Conclusion and recommendations

Gestational weight gain was defined as weight at delivery minus weight at the initial prenatal care visit. Our results, along with data from the literature, show that the current recommendations of an average weight gain of about 12 kg seem to be well suited to optimise outcomes for mother and child.

We found an association between weight gain during pregnancy and adverse pregnancy outcomes, including higher rates of caesarean delivery, fetal macrosomia, postpartum haemorrhage and gestational hypertension. Therefore, there is a need for weight gain guidelines to avoid maternal-fetal complications; the upper limit for weight gain during pregnancy should ideally be below 16 kg. It is important that measures be implemented for dietary management to minimise obstetric risk through consistent weight loss, including: (*i*) emphasising the importance of a healthy lifestyle with a balanced diet and exercise; (*ii*) establishing professional groups to encourage and counsel women to follow a balanced diet, remain physically active and follow a healthy lifestyle; (*iii*) focusing on single women who are particularly at risk, as they often face homelessness, domestic violence and other challenges as single parents; (*iv*) protection against food-borne illnesses, physical activity before and during pregnancy, avoiding alcohol, smoking, caffeinated drinks, practising good oral and dental hygiene and the use of medicinal products; and (*v*) adjusting maternal weight to normal before pregnancy by promoting physical activity before and during pregnancy.

There is a desperate need for charitable interventions and resources specifically aimed at single women to reduce poverty, help communities by meeting basic needs, building skills, promoting economic development and improving women's access to education, asset ownership, decision-making power over children's health and education. Ideally, these interventions should also provide housing support, counselling services, refugee aid, pregnancy services and training in autonomy and education, as well as the following: vaccination recommendations for women planning a pregnancy; preparation for breastfeeding during pregnancy; and family planning and the use of contraception.

Finally, we recommend the following in weight management to reduce obstetric risk: (*i*) appropriate weight gain in pregnancy is between ~10 and 16 kg for women of normal weight; (*ii*) lower weight gain during pregnancy is desirable for overweight and obese women; and (*iii*) sufficient weight gain during pregnancy in underweight women to prevent adverse outcomes associated with suboptimal weight gain, e.g. growth restriction.

Declaration. None.

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Author contributions. ML: data collection, analysis and writing of the manuscript. CH: conceptualisation, data collection and writing of the manuscript.FLAA and MCHB: data analysis and critical revision of the manuscript. All authors reviewed and approved the final manuscript.

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