Interpregnancy Changes in Maternal Weight and Body Mass Index

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Abstract

Objective This longitudinal study compared changes in maternal weight and body mass index (BMI) in early pregnancy in the time interval between when a woman first attended for antenatal care with her first child and when she next attended for antenatal care.

Study Design We studied women with a singleton pregnancy who delivered their first baby weighing $\geq$ 500 g in 2009 and who attended again for antenatal care with an ongoing pregnancy before January 1, 2012. Maternal weight and height were measured before 18 weeks' gestation in both pregnancies and BMI was calculated.

Results Of the 3,284 primigravidas, the mean weight at the first visit in 2009 was 66.4 kg (standard deviation [SD] 12.7). The mean BMI was 24.5 kg/m^2 (SD 4.6), and 11.3% ($n = 370$) were obese. Of the 3,284 women, 1,220 (37.1%) re-attended for antenatal care before 2012 after sonographic confirmation of an ongoing pregnancy. Of the 1,220 women who re-attended, 788 (64.6%) had gained weight (mean 4.6 kg [SD 3.9]), 402 (33%) had lost weight (mean 3 kg [SD 2.9]), and 30 (2.4%) had maintained their weight.

Conclusion The birth of a first baby was associated with an increase in maternal weight in two-thirds of women when they next attended for antenatal care.

Keywords
- maternal obesity
- body mass index
- interpregnancy weight gain

Maternal obesity has emerged as a common, serious, and clinically challenging problem in contemporary obstetrics.[1–3] Based on the World Health Organization (WHO) body mass index (BMI) categorization $>$ 29.9 kg/m^2, epidemiological studies have reported an increase in adult obesity, particularly in developed countries.[4,5] About one in six women booking for antenatal care in our hospital are obese.[6]

Maternal obesity is associated with an increase in pregnancy complications such as gestational diabetes mellitus (GDM), preeclampsia, and aberrant intrauterine fetal growth.[1–3] It is also associated with an increase in obstetric interventions such as induction of labor and cesarean section (CS).[2,7] Obesity has lifelong implications for both the mother and her offspring.[1,8] Not surprisingly, maternal obesity is associated with an increase in health care costs, for example, due to increased bed stay after CS and increased antenatal medication usage.[2,9,10]

Concerns about maternal obesity have led the Institute of Medicine in the United States of America in 2009 to revise downward their recommendations for gestational weight gain (GWG) in obese women.[2,11] The Workshop Report on the Influence of Pregnant Weight on Maternal and Child Health, however, acknowledged that there are gaps in our knowledge about GWG and that information on postpartum weight retention, in particular, is limited.[12] Furthermore, epidemiological studies to date have been predominantly cross-sectional and have been based on self-reporting of weight to calculate BMI, which has serious limitations.[13]

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The objective of this longitudinal study was to compare the interpregnancy changes in maternal weight, and, thus, BMI in early pregnancy in the time interval between when a woman attended for antenatal care for her first child and when she next attended for her second child.

Study Design

We studied primigravidas who delivered a baby weighing $\geq$ 500 g in a large university maternity hospital in 2009 and who attended again for antenatal care before January 1, 2012. To reduce confounding variables, women with multiple pregnancies, women aged $<$ 18 years, or women who booked for antenatal care in pregnancy after 18 weeks gestation were excluded. We used a cutoff of 18 weeks because we have previously observed that mean maternal weight starts to increase after 18 weeks and few women attend for antenatal care after 18 weeks.[14]

The hospital is publicly funded and approximately one in three women are covered by private health insurance. The hospital is a large university maternity hospital that delivers over 9,000 annually. About one in eight women nationally deliver in the hospital and it accepts women without differentiation from all socioeconomic groups, both urban and rural. The women studied, therefore, are a good representation of the country's population.

It is hospital policy to confirm gestational age by ultrasound at the first antenatal visit. If a healthy ongoing pregnancy is confirmed, the woman's height and weight are measured accurately and BMI is calculated at the same visit. Clinical and socio-demographic details are collected on the hospital's computerized database at the first antenatal visit and again after delivery. The information collected for the 2009 delivery was linked with the information collected for the second pregnancy after an ultrasound had confirmed a healthy ongoing second pregnancy. All data collected were anonymized and retained within the University College Dublin Centre in the hospital.

Statistical analysis was performed using SPSS version 18.0 (SPSS Inc., Chicago, IL). Relevant descriptive statistics (mean, standard deviation, and percentages) were obtained for the study population. All the variables were checked for normality using the Kolmogorov–Smirnov test. Independent sample *t*-tests and a paired sample *t*-tests were used to evaluate differences in continuous variables between the groups. Chi-square tests were used for categorical variables. The relationship between early pregnancy maternal weight changes and a range of possible explanatory variables was investigated using Pearson correlation coefficients and multiple regression models. The 5% level of significance was used throughout. The national guidelines of the Data Protection Commissioner were followed and written approval from the Hospital's Research Ethics Committee was not required because this was a hospital-based clinical audit.

Results

Of the 8,652 women delivered in 2009, 3,368 were primigravidas. Analysis was performed on 3,284 women with a singleton pregnancy who booked for antenatal care before 18 weeks' gestation and who had their weight and height measured accurately before calculating the BMI. Of the 3,284 women, 70.6% were Irish born and 8.8% were unemployed. The BMI categories of the primigravidas in 2009 are shown in ►**Table 1**. Overall, 11.3% women were obese and 0.8% ($n = 27$) were class III obese. There were 44 primigravidas who booked after 18 weeks' gestation and 40 primigravidas where either height or weight had not been measured.

Table 1 BMI categories of primigravidas who delivered in 2009

BMI category (kg/m^2)	*N*	%
Underweight ($<$ 18.5)	103	3.1
Normal (18.5–24.9)	2,001	60.9
Overweight (25.0–29.9)	810	24.7
Obese class I (30.0–34.9)	257	7.8
Obese classes II–III ($\geq$ 35.0)	113	3.5
Overall	3,284	100

Abbreviation: BMI, body mass index.

Of the 3,284, 1,220 (37.1%) booked for antenatal care again before January 1, 2012 and 2,064 (62.9%) did not. Women who re-attended were on an average 2 years older than those who did not and were less likely to be smokers. The characteristics of those who did and did not re-attend for antenatal care are shown in ►**Table 2**. The mean duration between delivery in 2009 and re-attending was 546 days (18 months) with a range of 79 to 1,071 days (2.6 to 35.2 months). Of the 1,220 women who re-attended for antenatal care, 4% ($n = 49$) miscarried and 1,171 delivered another baby weighing $\geq$ 500 g. Of the 1,220 women who re-attended, 60.5% ($n = 738$) breastfed after their first pregnancy for a mean of 4.9 months (SD 4.3).

Overall, women gained a mean of 2 kg (SD 5.1; $p < 0.001$) by the start of the second pregnancy. However, between the two pregnancies 788 (64.6%) of women gained weight, 402 (33%) lost weight, and 30 (2.4%) maintained their weight. The mean weight gain was 4.6 kg (SD 3.9) and the mean weight loss was 3 kg (SD 2.9). As a result, 20.2% ($n = 247$) were now in a higher BMI category and 4.8% ($n = 58$) had become obese (►**Table 3**). In contrast, 5.8% ($n = 71$) moved down a BMI category and 1.2% ($n = 15$) were no longer obese. We found no relationship between early pregnancy weight changes and the duration of interpregnancy interval.

The mean weight gain and mean weight loss analyzed by BMI category are shown in ►**Table 4**. Maternal early pregnancy weight changes negatively correlated with maternal age ($r = -0.11$; $p < 0.001$). However, maternal early pregnancy weight change did not correlate with maternal BMI, interpregnancy interval, maternal smoking habits, and breastfeeding after the first pregnancy. To identify whether maternal age continued to correlate with interpregnancy weight change after controlling for the above variables, we performed a multivariate linear regression analysis. In the resulting regression equation, maternal age continued to be

Table 2 Characteristics of primigravidas in 2009 who re-attended for antenatal care before 2012 compared with those who did not

	Re-attended ($n = 1,220$)	Did not re-attend ($n = 2,064$)	p Value
Mean age (y)	29.5 (SD 4.9)	27.5 (SD 5.8)	< 0.001
Smoker	8.5% ($n = 104$)	16.1% ($n = 333$)	< 0.001
Mean weight (kg)	66.6 (SD 12.1)	66.3 (SD 13.1)	NS
Mean BMI (kg/m^2)	24.5 (SD 4.2)	24.5 (SD 4.8)	NS
Obese	11.0% ($n = 134$)	11.4% ($n = 236$)	NS
Mean birth weight (g)	3,426.9 (SD 563.5)	3,384.8 (SD 561.3)	0.04
Mean GAD (wk)	39.4 (SD 2.0)	39.3 (SD 2.0)	NS
Instrumental	431 (35.3%)	679 (32.9%)	NS
Cesarean section	302 (24.8%)	528 (25.6%)	NS

Abbreviations: BMI, body mass index; GAD, gestational age of infant at delivery; SD, standard deviation.

Table 3 The change in BMI categorization in primigravidas who attended for antenatal care soon after delivery

	BMI second booking (kg/m^2)							
			< 18.5	18.5–24.9	25.0–29.9	30.0–34.9	> 35	Total
BMI first booking (kg/m2)	< 18.5	*N*	7	20	1	0	0	28
		%	25.0	71.4	3.6	0.0	0.0	100
	18.5–24.9	*N*	9	588	150	5	0	752
		%	1.2	78.2	19.9	0.7	0.0	100
	25.0–29.9	*N*	0	40	213	52	1	306
		%	0.0	13.1	69.6	17.0	0.3	100
	30.0–34.9	*N*	0	1	14	70	18	103
		%	0.0	1.0	13.6	68.0	17.4	100
	> 35.0	*N*	0	0	0	7	24	31
		%	0.0	0.0	0.0	22.6	77.4	100

Abbreviation: BMI, body mass index.

Table 4 Weight changes between pregnancies analyzed by BMI category in the first pregnancy (% weight gain)

BMI category (kg/m^2)	*N*	Mean gain (kg)	SD
Underweight (< 18.5)	25	4.4	4.0
	2	−1.9	0.2
Normal (18.5–24.9)	486	4.2	3.7
	246	−2.7	2.4
Overweight (25–29.9)	188	5.4	4.0
	111	−3.1	3.0
Class I Obese (30–34.9)	68	5.5	4.1
	33	−3.8	3.8
Class II–III Obese (> 35.0)	21	5.9	3.6
	10	−6.9	6.4
Total	788	4.6	3.9
	402	−3.0	2.9

Abbreviations: BMI, body mass index; SD, standard deviation.

Table 5 Early pregnancy weight change between first and second children: regression analysis

Age	$r = -0.113$	$p < 0.001$
Body mass index	$r = 0.003$	NS
Interpregnancy interval	$r = -0.026$	NS
Smoking	$r = 0.018$	NS
Breastfeeding	$r = 0.016$	NS

Abbreviation: NS, nonsignificant.

inversely correlated with early pregnancy weight changes ($r^2 = 0.014$; $p = 0.002$) (►**Table 5**).

Discussion

This longitudinal observational study found that within an average of 18 months of delivery, two-thirds of first-time mothers gained an average of 4.6 kg when they booked for antenatal care a second time. As a result, 20.2% were now in a higher BMI category and 4.8% had become obese. One-third of mothers had lost weight and, thus, 1.2% were no longer obese. These findings have implications for a woman's future obstetric and medical well-being.

There is a paucity of longitudinal studies on postpartum weight changes because such studies are challenging to conduct.[14,15] There is no standardization about the time points at which maternal weight is measured. In many studies, weight is self-reported which is unreliable and leads to BMI miscategorization.[13] In obese women, self-reporting is even more unreliable.[16] Some studies use prepregnancy weight, but about half of pregnancies are unplanned which militates against longitudinal studies and is a potential source of epidemiological bias.[17] Other studies have used longer intervals between measurements, which increase the risk of a large proportion of women being lost to follow-up.[18] There is also difficulty in separating changes in weight and BMI due to childbirth from those due to advancing age.[19]

Our study has the advantages of a longitudinal study in that a cross-sectional study can only measure the overall average changes. Thus, our finding that one-third of women do not gain weight within an average of 18 months after delivery would not be evident in a cross-sectional study. Another strength of the study is that the measurements were made before 18 weeks in both pregnancies. Previous studies based on self-reporting suggested that women gain a small amount of weight in the first trimester.[12] However, weight gain in pregnancy is not linear and studies based on measurement show that, on average, maternal weight or body composition does not change in early pregnancy.[14,15]

A weakness in our study is that we do not have information on the women who attended elsewhere; either in Ireland or abroad, for antenatal care subsequently. However, we were surprised at the large proportion of women who did re-attend so soon after their first baby. Another potential weakness is that the interpregnancy interval varied from woman to woman but, in reality, such standardization of measurement is impractical and we also found no relationship between the interpregnancy interval and weight changes. This suggests that lifestyle behavior soon after delivery may be more important in the short term than the duration between pregnancies. Further longitudinal studies are required to determine whether the weight gain occurs during or after the pregnancy and what influence breastfeeding has on weight trajectories over time.

This increase in maternal weight, and, thus, BMI in the majority of women after the birth of their first child is of concern clinically. A large Swedish epidemiological study of 151,080 women found that on an average women gained over half a BMI unit (median 0.7) during a mean interpregnancy interval of 24 months between first and second pregnancies.[20] Interpregnancy weight gain was strongly associated with an increased risk of maternal and perinatal complications independently of whether the woman was overweight or not. However, the method of BMI calculation was uncertain and the researchers did not have information on the gestational age at the first antenatal visit. Also, the range of interpregnancy intervals ranged from less than 1 to 10 years, so the researchers were unable to differentiate the effect of early postpartum weight changes from later weight changes.

The relationship between interpregnancy weight or BMI changes and the risk of CS has been studied.[21] In a retrospective Missouri cohort study, there were a total of 100,828 women with a live singleton infant born between 1989 and 2005 where siblings were linked to their biological mothers using a unique identifier.[22] All the women had a vaginal delivery in the first pregnancy. The study found that women who had a normal BMI and became obese for their second pregnancy had a 1.41 odds ratio (OR) (95% confidence interval [CI], 1.26–1.57) of CS compared with women whose BMI remained normal. They also had an increased risk of hypertensive disorders and GDM.

However, BMI was based on self-reporting of prepregnancy weight and not measurement in early pregnancy. Also, the interpregnancy interval and degree of weight gain were not stated. A long interpregnancy interval may, for example, be significant given the steep rise in American CS rates between 1989 and 2005. Other studies using the Missouri database found that an increase in BMI from normal to obese between pregnancies increased the risk of a large-for-gestational age baby by 1.6 OR (CI, 1.6–2.0), increased the risk for developing diabetes mellitus (OR, 3.2; CI, 2.8–3.7), and increased the risk of stillbirth (OR, 1.4; CI, 1.2–1.7).[21–23]

In a longitudinal study of 795 women who delivered in Wisconsin during 1988 and 1990, 61% ($n = 484$) were followed up for 15 years.[24] The first measurement was made at an average of 10.3 weeks' gestation. The study included all parities but was confined to women with an uncomplicated pregnancy. The average length of follow-up was 14.7 years (range, 10.1–16.3). The average weight gain was 9.7 kg and was greatest in the obese category. Excess weight gain was associated with an increased risk of diabetes mellitus and coronary heart disease nearly 15 years later. Confining the study to women with no pregnancy complications may have

underestimated the risks associated with excessive weight gain during or after pregnancy.

In an epidemiological review of body weight changes after pregnancy, the evidence from observational studies was that body weight at 6 to 18 months postpartum is 1 to 2 kg greater than preconception weight.[25] However, at least 14 to 20% of women in national surveys were > 5 kg heavier by 6 to 18 months postpartum. This review published in 2000 included studies that are now more than 20 years old and may not reflect short-term postpartum weight changes in wealthy countries presently. It is also too early to assess whether the revised recommendations on GWG for obese women have altered postpartum weight changes in the United States or elsewhere.[11,12]

Although there are considerable individual variations, an increase in weight associated with childbearing is well described.[19,26] Indeed, childbearing may increase visceral adipose tissue independently of an overall increase in body fat.[27] However, little attention has been paid to the chances of becoming overweight or obese after a first child. The development of obesity with parenthood may have consequences not only for future pregnancies and deliveries but also lifelong consequences for the woman herself.

Women who smoked in their first pregnancy were less likely to re-attend for antenatal care than women who did not smoke (►**Table 2**). This is consistent with previous reports, which found an increase in infertility in women who smoked.[28] Women who re-attended were on an average 2 years older (►**Table 2**). This may be explained by the fact that older women were more likely to have another baby sooner to avoid the pregnancy risks associated with advancing age.

Our study found that within an average of 18 months after delivering their first baby, two-thirds of women gained weight, 1 in 5 moved into a higher BMI category, and 1 in 20 became obese. Further studies are required to identify whether changes in maternal diet and/or physical activity are responsible for these weight changes after the birth of a first child. If there are lifestyle differences, the advice women get about healthy eating and physical activity before and during pregnancy may need to be reinforced after delivery.

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Conflict of Interest

The authors have no conflict of interest to disclose.

References

1 Poston L, Harthoorn LF, Van Der Beek EM; Contributors to the ILSI Europe Workshop. Obesity in pregnancy: implications for the mother and lifelong health of the child. A consensus statement. Pediatr Res 2011;69(2):175–180
2 Heslehurst N. Identifying "at risk" women and the impact of maternal obesity on National Health Service maternity services. Proc Nutr Soc 2011;70(4):439–449
3 Norman JE, Reynolds RM. The consequences of obesity and excess weight gain in pregnancy. Proc Nutr Soc 2011;70(4):450–456
4 Kanagalingam MG, Forouhi NG, Greer IA, Sattar N. Changes in booking body mass index over a decade: retrospective analysis from a Glasgow Maternity Hospital. BJOG 2005;112(10): 1431–1433
5 Centre for Maternal and Child Enquiries (CMACE). Maternal Obesity in the UK: Findings from a National Project. London: CMACE; 2010
6 Fattah C, Farah N, O'Toole F, Barry S, Stuart B, Turner MJ. Body Mass Index (BMI) in women booking for antenatal care: comparison between self-reported and digital measurements. Eur J Obstet Gynecol Reprod Biol 2009;144(1):32–34
7 O'Dwyer V, Farah N, Fattah C, O'Connor N, Kennelly MM, Turner MJ. The risk of caesarean section in obese women analysed by parity. Eur J Obstet Gynecol Reprod Biol 2011;158(1):28–32
8 Barker DJP, Eriksson JG, Forsén T, Osmond C. Fetal origins of adult disease: strength of effects and biological basis. Int J Epidemiol 2002;31(6):1235–1239
9 Chu SY, Bachman DJ, Callaghan WM, et al. Association between obesity during pregnancy and increased use of health care. N Engl J Med 2008;358(14):1444–1453
10 Kennedy C, Farah N, O'Dwyer V, Hogan J, Kennelly MM, Turner MJ. Maternal obesity and inpatient medication usage. Clin Obes 2011; 1:147–152
11 Rasmussen KM, Abrams B, Bodnar LM, Butte NF, Catalano PM, Maria Siega-Riz A. Recommendations for weight gain during pregnancy in the context of the obesity epidemic. Obstet Gynecol 2010;116(5):1191–1195
12 Institute of Medicine. Weight Gain During Pregnancy: Reexamining the Guidelines. Washington, DC: The National Academies Press; 2009
13 Turner MJ. The measurement of maternal obesity: can we do better? Clin Obes 2011;1:127–129
14 O'Higgins AC, Doolan A, Mullaney L, Daly N, McCartney D, Turner MJ. The relationship between gestational weight gain and fetal growth: time to take stock? J Perinat Med 2013;21:1–7
15 Connor Gorber S, Tremblay M, Moher D, Gorber B. A comparison of direct vs. self-report measures for assessing height, weight and body mass index: a systematic review. Obes Rev 2007;8(4): 307–326
16 Finer LB, Henshaw SK. Disparities in rates of unintended pregnancy in the United States, 1994 and 2001. Perspect Sex Reprod Health 2006;38(2):90–96
17 Linné Y, Rössner S. Interrelationships between weight development and weight retention in subsequent pregnancies: the SPAWN study. Acta Obstet Gynecol Scand 2003;82(4):318–325
18 Umberson D, Liu H, Mirowsky J, Reczek C. Parenthood and trajectories of change in body weight over the life course. Soc Sci Med 2011;73(9):1323–1331
19 Villamor E, Cnattingius S. Interpregnancy weight change and risk of adverse pregnancy outcomes: a population-based study. Lancet 2006;368(9542):1164–1170
20 Whiteman VE, Crisan L, McIntosh C, et al. Interpregnancy body mass index changes and risk of stillbirth. Gynecol Obstet Invest 2011;72(3):192–195
21 Whiteman VE, Aliyu MH, August EM, et al. Changes in prepregnancy body mass index between pregnancies and risk of gestational and type 2 diabetes. Arch Gynecol Obstet 2011;284(1): 235–240
22 Getahun D, Ananth CV, Peltier MR, Salihu HM, Scorza WE. Changes in prepregnancy body mass index between the first and second pregnancies and risk of large-for-gestational-age birth. Am J Obstet Gynecol 2007;196(6):e1–e8
23 Rooney BL, Schauberger CW, Mathiason MA. Impact of perinatal weight change on long-term obesity and obesity-related illnesses. Obstet Gynecol 2005;106(6):1349–1356
24 Gunderson EP, Abrams B. Epidemiology of gestational weight gain and body weight changes after pregnancy. Epidemiol Rev 2000; 22(2):261–274

25 Gunderson EP. Childbearing and obesity in women: weight before, during, and after pregnancy. Obstet Gynecol Clin North Am 2009; 36(2):317–332, ix
26 Gunderson EP, Sternfeld B, Wellons MF, et al. Childbearing may increase visceral adipose tissue independent of overall increase in body fat. Obesity (Silver Spring) 2008;16(5):1078–1084
27 Augood C, Duckitt K, Templeton AA. Smoking and female infertility: a systematic review and meta-analysis. Hum Reprod 1998; 13(6):1532–1539
28 Turner MJ, Layte R. Obesity levels in a national cohort of women 9 months after delivery. Am J Obstet Gynecol 2013;209(2): e1–e7