Postpartum weight trajectories in overweight and lean women

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Abstract

Background: Overweight and obesity in women of reproductive age are increasing and are often linked with excessive weight gain in pregnancy and weight retention after birth. Studies on spontaneous maternal weight trajectory after delivery are scarce.

Objective: We describe women's spontaneous weight trajectory during the first six weeks of the postpartum period and its relationship between Body Mass Index and socio-demographical, behavioural and psychological variables.

Design: Data from 212 women who gave birth in three regional hospitals were collected prospectively between December 2015 and February 2016. Potential determinants were examined during pregnancy and the postpartum period at four and six weeks after delivery. Descriptive statistics and a linear multivariate regression model were used. Early postnatal weight retention (PWR) was defined as the difference between the maternal weight six weeks after delivery and the pre-pregnancy weight (kg).

Measurements and findings: Mean PWR at six weeks after delivery was 3.3kg (SD 4.1), with a range between -7 and +16.2 kg; 81% reported some weight retention (PWR > 0kg), and 36% showed a high weight retention (PWR ≥ 5 kg). Women with a BMI <25kg/m² showed a significantly higher mean PWR six weeks after delivery compared to women with a BMI ≥25kg/m² (4.0kg vs. 1.6 kg, *p* = 0.002). There was a significant correlation between maternal weight retention and gestational weight gain (GWG) (B = 0.65, p<0.001) and pre-pregnancy body mass index <25kg/m² (B = 1.12, p=0.017), six weeks after delivery.

Key conclusions: Weight retention six weeks after delivery is associated with pre-pregnancy BMI and GWG, but contrary to expectations, lean women with excessive GWG tended to retain most weight after delivery. No significant associations with several socio-demographical, behavioural and psychological variables were found.

Implications for practice: Weight management strategies around pregnancy should not be limited to overweight and obese mothers. Women with pre-pregnancy BMI <25 kg/m² require equal attention to prevent postnatal weight retention.

Keywords: postpartum; maternal weight trajectory; postpartum weight retention; weight management; obesity

Introduction

Since 1980, the incidence of overweight and obesity has doubled worldwide. With more than 1.5 billion overweight adults, at least 500 million of whom are obese, obesity has become a disease of pandemic proportions (James, 2008). Paralleling the global epidemic of obesity figures in the general population, the incidence of maternal obesity (BMI>30kg/m² at the start of pregnancy) has been rising, ranging from 7% to 25% (Devlieger et al., 2016). Data on the prevalence of maternal obesity from 34 UK maternity units show a significant increase of first trimester maternal obesity, rising from 7.6% (1989) to 15.6% (2007) (Heslehurst, 2010). It has been estimated that around half the women of reproductive age are overweight or obese. A Belgian national health survey reported that 48% of the general population was either overweight (body mass index (BMI) ≥25kg/m², 34%), or obese (BMI≥30kg/m², 14%) (Gisle, 2014). A regional representative analysis of 65 maternity units in Flanders (the Northern part of Belgium), showed a significantly increase in the prevalence of maternal obesity between 2009 (10,2%) and 2014 (11,4%); and more than one in three pregnant women is overweight (Devlieger et al., 2016).

The largest increase in overweight and obesity in women occurs in childbearing age (Martin et al., 2015). Obesity in women is often linked with weight gained during and retained after pregnancy (Vahratian, 2009; van Poppel et al., 2012). Approximately one third of the gestational weight gain (GWG) is attributable to the weight of the growing fetus, amniotic fluid and placenta, which means that two thirds are related to maternal factors (Institute of Medicine, 2009) ~~(Walter et al., 2015)~~. The Institute of Medicine (IOM) has published recommendations for ranges of GWG by pre-pregnancy BMI. To prevent the long term development of maternal obesity, it is recommended that underweight women (BMI <18.5kg/m²) gain 12.5 to 18kg, normal weight women (BMI 18.5 - 24.9kg/m²) 11.5 to 16kg, overweighed women 7 to 11.5kg and obese women 5 to 9kg (Institute of Medicine, 2009). Despite the IOM recommendations, most studies report an excessive GWG in one third of women (Bogaerts et al., 2012; Gore et al., 2003; Institute of Medicine, 2009). Obesity during pregnancy is a major public health concern because of the increased risks for both the mother and child. Complications are even higher when maternal obesity is combined with excessive GWG, especially the increased risk of caesarean section, macrosomia and postpartum weight retention (Bogaerts et al., 2012; Nohr et al., 2008).

The postpartum period is most often defined as the period after delivery up to six weeks or even up to one year postpartum (Schmitt et al., 2007). Many women fail to lose their pregnancy weight during this period. According to the IOM, about 50% of all mothers reach their pre-conceptional weight six weeks after delivery. However, one year after delivery, 25% are still struggling with an excess of at least 5kg in comparison with their pre-pregnancy weight. A high postpartum weight retention (PWR) of 5kg or more is a major risk factor for long-term illhealth, including continuous weight gain and increased risk for life-long obesity, metabolic syndrome, cardiovascular diseases and Type 2 diabetes (Althuizen et al., 2011; Gould Rothberg et al., 2011; Lipsky et al. 2012; Phelan et al., 2015; Walker, 2007). Moreover, the risk of pregnancy and birth complications increases in the next pregnancy if women fail

to lose the added weight between pregnancies (Bogaerts et al., 2013c; Villamor and Cnattingius, 2006).

Changes in maternal behaviour that lead to a healthy lifestyle during the postnatal period are possible but challenging (Bertz et al., 2012). The effects of breastfeeding on maternal weight change are not clear. In a recent systematic review, the majority of studies reported little or no association between breastfeeding and weight change (Neville et al., 2014). However some publications found that breastfeeding can contribute to reducing long-term weight retention (Brown et al., 2012; Kirkegaard et al., 2015; Ostbye et al., 2012; Stang and Huffman, 2016; Wiklund et al., 2012). Results from systematic reviews and meta-analysis about effects of lifestyle interventions to limit PWR show positive effects on weight loss; however, the optimal setting and approach remains unclear (van der Pligt, et al., 2013). The most effective interventions in reducing weight in postpartum women were exercise programmes with objectively defined goals, such as the use of heart rate monitors or pedometer (Mean Difference of −4.09kg, 95% CI −4.94 to −3.25, I^2=0%) and exercise combined with intensive dietary intervention (Mean Difference of −4.34 kg, 95% CI −5.15 to −3.52, I^2=0%) (Nascimento et al., 2014; van der Pligt et al., 2013).

Prior to developing a targeted lifestyle programme to limit short and long term PWR, it is important first to describe the spontaneous postnatal weight trajectory, as this information is scarce in the current literature. An older American study (Gunderson et al., 2001) with 985 healthy women who had two consecutive births showed that early PWR (<6/8 weeks after delivery) does not vary according to maternal pre-pregnancy BMI, and that in the longer run (median of two years), obese women showed a slower weight loss. A more recent study describing weight change patterns in six sites of the World Health Organization (WHO) Multicentre Growth Reference Study (MGRS) at weeks 1, 2, 4, 6, then monthly from two to 12 months and finally bimonthly until 24 months after delivery, indicated that lactation intensity and duration explained little of the variation in weight change patterns and that ethno-cultural contexts should be taken into account to explain differences in weight change patterns (Onyango et al., 2011).

An earlier epidemiological analysis in nearly 8000 women with two consecutive pregnancies, showed that approximately 50% of women with excessive GWG in the previous pregnancy had not returned to their pre-pregnancy BMI at start of the next pregnancy (Bogaerts et al., 2013c). The spontaneous weight trajectory in the immediate postpartum period however has not yet been studied. This is needed to differentiate GWG retention from weight fluctuation in the late postpartum period. The aim of this study was therefore to conduct a cohort study to investigate the spontaneous weight trajectory between the second day and the sixth week postpartum and to describe the influencing variables on PWR in the early postpartum (up to six weeks).

Methods

Study design & setting

We performed a prospective longitudinal cohort study to investigate the spontaneous weight trajectory after delivery and to identify the variables that could predict PPWR up to six weeks after delivery. From December 2015 until February 2016, mothers were recruited in the maternity wards of three Antwerp Hospitals: the University Hospital of Antwerp, Sint-Augustinus and Sint-Vincentius. The study design was approved by the Central Medical Ethics Committee of the University Hospital of Antwerp and by the local Ethics Committees of the collaborating hospitals. All participants provided written informed consent upon entry in the study two or three days after delivery.

Participants

Mothers (age ≥18 years) of singletons born at term and with a good knowledge of the local language (Dutch) were included into the study at random week and weekend days two or three after delivery. All women were in possession of a digital weight scale at home. Women with diabetes, pregnancy induced hypertension, or (pre)eclampsia were excluded because weight changes could be associated with these pathologies.

Variables

GWG was calculated as the last measured maternal weight in pregnancy minus a self-reported pre-pregnancy weight. If the last measured weight dated from more than two weeks before delivery, the self-reported final weight at delivery was used. PWR was calculated as self-reported maternal weight six weeks after delivery minus self-reported pre-pregnancy weight. Pre-pregnancy weight was reported by the participants at the time of study entry (day 2/3). Women were weighed at study entry with a calibrated SECA 803 scale and their height was measured with a SECA 213 ruler. Weekly maternal weights after delivery were self-reported and uploaded by the women on an online weblink (Qualtrics software 2014). Socio-demographic (maternal age, ethnicity, marital status, education, job, parity), behavioural (maternal smoking behaviour, duration of sleep, duration of watching television, breastfeeding frequency, physical activities and nutritional habits) and psychological data (sense of coherence (SOC), anxiety and depressed mood) were obtained through an interview at the time of study inclusion (baseline) followed by two self-administered questionnaires by email four and six weeks after delivery. Sense of coherence was assessed three times: at entry, week 4 and week 6. Levels of anxiety and depressed mood were assessed twice: at week 4 and 6 after delivery. SOC, a stress-resistance construct, refers to lifetime comprehensibility, manageability and meaningfulness and was measured with SOC-3. SOC-3 is a simplified version of SOC-29 that is sufficiently reliable and valid to use in adults (Lundberg and Peck, 1995). Lower SOC values were correlated to a higher sense of coherence. The SOC-3 Cronbach's alfa in our study population was 0.60 which was considered adequate. Levels of anxiety were measured with the State-Trait Anxiety Inventory (STAI, Spielberger) and feelings of depression were measured by using the Edinburgh Postnatal Depression Scale (EPDS). Both scales were also used and explained to use in women of reproductive age in our other studies (Bogaerts et al., 2013a; Bogaerts et al., 2013d). Because STAI and EPDS are less

sensitive around the period of delivery, they were only used at four and six weeks after delivery (Huizink et al., 2004).

Statistical analysis

The data were analyzed using IBM SPSS statistics version 23. A two-sided level of significance of 0.05 was used. Chi squared tests were used for categorical variables, Fisher Exact for categorical variables with small cells, independent-T-test for normally distributed continuous variables and Mann-Whitney-U if the continuous variables were not normally distributed. Furthermore, Wilcoxon Signed-Rank and Friedman Anova tests were used for the analyses of the different moments of follow-up. Normal distribution was evaluated by Shapiro-Wilk tests. To distinguish the different categories of categorical variables, we created dummy variables. A multivariate linear regression was performed for the prediction of the continuous variable PWR. The model was constructed using the stepwise-forward method and the significant predictors (p <.05) from the univariate analysis: GWG, pre-conception BMI<25kg/m², bachelor-master degree, breastfeeding frequency at inclusion, week 4 and week 6, hours of watching television at week 4, SOC-score at week 4 and 6 and EPDS-score at week 4 were used to build the model. In our sample, six underweight women reported a BMI between 17.6 and 18.4 kg/m². These women were included in the normal weight group because of small numbers and an acceptable 'normal' BMI.

Results

Of the 212 available mothers, 44 did not respond to both questionnaires at four and six weeks after delivery (20.7%) (figure 1). These non-responders were more likely to be younger, from non-Belgian background, with a lower level of education and more likely to be unemployed. They also reported lower levels of physical activity during pregnancy (~~tabel 1~~ data not shown).

In the group of 212 women, the mean age was 30.8 year (SD 4.8) and the mean pre-pregnancy BMI 23.5 kg/m² (SD 4.1); 152 (72%) had a normal BMI and 57 (27%) were overweight or obese. Mean GWG was 14.3 kg (SD 4.9) (table 1). Overweight and obese women showed a significantly lower GWG compared to normal weight/underweight women (12.9kg vs. 14.8 kg, p=0.01); but more than half of them (30 (69.8%) in overweight women, 8 (57.1%) in obese women) showed excessive GWG according to IOM guidelines compared to 53 (34.9%) in normal weight women (p<.001). From the mothers who initiated breastfeeding (n = 162, 76.4 %), only 95 (58.6%) was breastfeeding four weeks after delivery.

Six weeks after delivery, 115 (81%) women showed weight retention (>0kg), and 51 (36%) had a high weight retention (≥ 5 kg). Mean postnatal weight retention was 3.3kg (SD 4.1) with a range between -7 and +16.2 kg. Women with a BMI <25kg/m² showed a significantly higher mean weight retention at six weeks after delivery compared to women with a BMI ≥25kg/m² (4.0kg versus 1.6 kg, p = 0.002) (figure 2); and 43 (41.7%) of them had high weight retention (≥5kg) compared to 8 (20.5%) in overweight/obese women (p= 0.02). From week 2 after delivery, normal weight women reported a significantly slower weight loss compared to overweight/obese women (table 2). Similarly, women with an excessive GWG showed a more rapid weight loss during the six weeks after delivery compared to

those without an excessive GWG ($p<0.001$) (table 3), but at six weeks, they showed a significantly higher weight retention compared to those without an excessive GWG (5.2kg versus 1.9kg; $p= 0.001$) (figure 3). Figure 4 shows the patterns of weight change (in kg) among women from preconception to six weeks after delivery and demonstrates a higher mean GWG in normal weight women with a slower weight loss up to six weeks after delivery compared to overweight/obese women. The change in BMI at six weeks after delivery compared to the pre-pregnancy BMI was an increase of 1.4 in normal weight women vs. 0.6 in overweight/obese women ($p=0.002$).

Univariate associations with PWR were significant ($p<0.05$) for GWG, pre-pregnancy BMI, level of education, breastfeeding frequency at inclusion, at week 4 and week 6, time spent watching television, sense of coherence at week 4 and 6, and EPDS scores at week 4 (table not shown). The variance inflation factor (VIF) and tolerance statistic in the correlation matrix of the predictor variables showed no problem for multicollinearity. The final multivariate analysis showed that six weeks after delivery, only the GWG ($\beta= 0.779$, $p<0.001$) and the pre-pregnancy BMI <25kg/m² ($\beta=0.123$, $p=0.017$) were significantly associated with maternal weight retention. For each kg weight gained during pregnancy, there was a risk of approximately 0.650 kg increase in weight retention six weeks after delivery (95% CI [0.57 – 0.73]). If the pre-pregnancy BMI was less than 25kg/m², women had an increased risk of 1.12 kg weight retention six weeks after delivery (95% CI [0.21 – 2.04]). This model explained 65.6% of the variance in PWR six weeks after delivery (table 4).

Discussion

This study shows that normal weight women and those without excessive GWG report a slower weight loss during the six weeks after delivery compared to overweight/obese women and those with an excessive GWG. Weight retention six weeks after delivery was significantly higher in normal weight women compared to overweight/obese (4 kg versus 1.6kg). This sounds reassuring as women with excessive GWG lost weight faster during the first six weeks, but they retained a worrying mean weight of 5.2kg compared to 1.9kg in those without excessive GWG. After taking into account several socio-demographic and lifestyle related variables, only the pre-pregnancy BMI (negative effect) and GWG (positive effect) were predictors for PWR six weeks after delivery.

The positive association between GWG and PWR is supported by other studies, but mostly correlated in longer timeframes after delivery (Althuizen et al., 2011; Ashley-Martin and Woolcott, 2014; Biesmans et al, 2013; Bogaerts et al., 2013d; Kirkegaard et al, 2014; Nohr et al, 2008; Phillips et al., 2014; Ronnberg et al., 2016). In an earlier epidemiological analysis, we showed that half of the women with an excessive weight gain during their first pregnancy had not returned to their pre-pregnancy BMI at start of their next pregnancy. Overall, 42% of women with excessive weight gain during the first pregnancy had at least one of the four major pregnancy and birth-related complications (pregnancy-induced hypertension, gestational diabetes, caesarean section or large-for-gestational age infant) in their next pregnancy. Furthermore, and in addition to the effect of the pre-pregnancy BMI and an excessive GWG, a study showed that weight retention between the first and second pregnancy is associated with a significantly increased risk for gestational diabetes, pregnancy-induced hypertension, and cesarean delivery during the second pregnancy (Bogaerts et al., 2013c). This was also shown in another large Swedish study (Villamor and Cnattingius, 2006). These findings illustrate the importance of trying to return to the pre-pregnancy weight after childbirth. Failing to lose weight gained during pregnancy is an indicator for excess weight gain and obesity in midlife (Lipsky et al., 2012; Phelan et al., 2015; Rooney BL, 2005).

Studies evaluating maternal weight after delivery are scarce. The recent study in six sites of the World Health Organization (WHO) Multicentre Growth Reference Study (MGRS) looked at patterns of weight change and explored variables that explain variations in weight change within and between sites (Onyango et al., 2011). Median BMI values in all sites declined sharply between one and two weeks post-partum. Afterwards different weight change patterns between the six sites were influenced by the women's pre-pregnancy BMI, parity and ethno-cultural background. The sharply decreased mean PWR during the first two weeks after delivery in the MGRS study was also shown in our analysis and can be explained by the stabilization of fluid retention and fluctuations in body composition during the early postpartum period. The average weight of our study participants decreased further week by week. Compared with the weight at study inclusion, mothers lost an average of 5,5 kg after six weeks. Those with a normal pre-pregnancy BMI had more often (43 (42%) versus 8 (20.5%)) a higher PWR (≥ 5kg) than overweight/obese women at six weeks after delivery.

Gunderson et al. (Gunderson et al., 2001), however, did not find differences in PWR between normal

weight and obese women during the first six weeks after delivery. In the longer term (median of two years after delivery), they found obese women tended to have a higher weight retention compared to normal weight women, indicating confounding by other lifestyle related variables on late postpartum weight changes (Gunderson et al., 2001).

The difference in weight change patterns during the first six weeks after delivery between overweight/obese and normal weight women is of clinical interest. Our results suggest that overweight/obese women have lost most of the weight gained during pregnancy in the first six weeks after delivery, but a longer follow-up of maternal weight is needed to determine the possible long terms effects of ethno-cultural and lifestyle related behaviours, including breastfeeding patterns. A period of six weeks is relatively short to determine influencing variables (Onyango et al., 2011). Breastfeeding rates in our cohort were very low; approximately half (n = 77, 53%) of the women were breastfeeding exclusively six weeks after delivery. A significant association between breastfeeding rates and PWR was only seen in our univariate analysis, but this association disappeared in the final multivariate model. Although the effect of breastfeeding on maternal weight changes is not yet clear (Neville, 2013), some studies report on a positive effect of breastfeeding on postpartum weight reduction if women breastfeed exclusively for at least six months and if they had a reasonable GWG (Baker et al., 2008; Krause et al., 2010).

Drop-out rates during postpartum follow-up studies are, like in ours, typically around 30%. Stendell-Hollis et al. (2011) demonstrated that maintaining an on-going dialogue between researchers and study participants increases the continuation of study participation, adherence to study protocol and completion of all aspects of the intervention if any. They also showed that recruitment of women from local hospitals immediately postpartum was highly successful for supporting a follow-up. Therefore, the six week postnatal visit can be an interesting starting point for a weight management programme (Stendell-Hollis et al., 2011). Further follow-up studies are required to ascertain time points during the first post-partum year where intervention is most likely to be of benefit in the prevention of obesity and related complications in the long run.

We know from a recent meta-analysis that postpartum weight loss is achievable. However, the optimal setting and recruitment approach remains unclear (van der Pligt et al., 2013) and women are eager to lose weight after delivery (Wilkinson et al., 2015). A recent study regarding predictors of engagement in postpartum weight self-management behaviours in the first 12 weeks after birth, showed that women who are experiencing a difficult transition into motherhood are less likely to engage in postpartum weight self-management. This highlights the postpartum period of approximately six weeks after delivery as an important window of opportunity where contacts with healthcare providers can make a difference in motivating and supporting weight management programmes in the long run (Ohlendorf et al., 2015).

Earlier studies showed a positive association between PWR at minimum six months postpartum and levels of anxiety (Bliddal et al., 2015; Bogaerts et al., 2013d; Pedersen et al., 2011). Although anxiety was also positively related to PWR in an earlier postpartum weight retention analysis in obese women

only six months after delivery, no association between psychological state (levels of anxiety and depression) and PWR was found in this cohort. A recent analysis aimed at exploring the relationship between post-partum psychological distress and the PWR nine months after delivery showed less influence of post-partum depression, stress and anxiety, but indicated that post-partum body dissatisfaction at three and six months was positively associated with the PWR at nine months (Phillips et al., 2014). In a randomized controlled lifestyle intervention study of obese pregnant women, a significant reduction in GWG and levels of anxiety were observed after four psycho-education sessions during pregnancy (Bogaerts et al., 2013b). A possible interdependence between behavioural changes in terms of weight reduction and psychological factors is probable. Interventions targeting the maternal psychological state and wellbeing may therefore play a key role in the prevention of weight retention.

The study strengths include the prospective and longitudinal study design, the inclusion of women with a broad range of pre-pregnancy BMI and the fact that several socio-demographic and lifestyle related variables including psychological state were taken into account. The limitations to address are the possible differences in maternal weight retrieved on day 2 or day 3, as a consequence of differential fluid accumulation due to an increased cardiac output of approximately 25-50% during pregnancy (Van Kesteren et al., 2009). This study uses mainly self-reported data. Other studies have investigated the differences between measured and self-reported weight values. A general trend of underreporting was detected. Obese individuals are significantly more likely to underreport than groups with lower BMI values. Although there is a potential for self-report bias, studies conclude that self-reported data are sufficiently accurate and reliable to be used in research (Conde et al., 2013; Hattori and Sturm, 2013; Neville et al., 2014; Yoong et al., 2013). Moreover, for preliminary and exploratory work, it might be the easiest or only way to collect such data. Furthermore, the different characteristics between responders (n=168) and non-responders (n=44) supports the fact that younger, less active mothers with a lower socio-economic background need special attention for continuous postnatal follow-up. This study gives a first unique view of the direct and spontaneous postpartum weight trajectory from mothers in our region up to week 6 postpartum. Future research should follow-up mothers for a longer period because a period longer than six weeks was needed for spontaneous weight recovery. Similarly, exploring the multifactorial influences of lifestyle, psychological and socio-demographical characteristics on postpartum weight change in different groups of women needs a longer follow-up. Given the strong associations between GWG, pre-pregnancy BMI and postpartum weight retention, observational studies should start at the pre-conception period with a monitoring up to the postnatal period to map the true trajectories of maternal weight change.

Conclusion

Postnatal weight trajectories are influenced by both the maternal BMI as well as the GWG. This information should be taken into account when counselling women regarding weight management and when designing intervention studies to limit the effects of PWR on the future health of women. Weight management strategies around the time of pregnancy should not only focus on overweight and obese

mothers; women with a pre-pregnancy BMI <25 kg/m² require equal attention for the prevention of postnatal weight retention.

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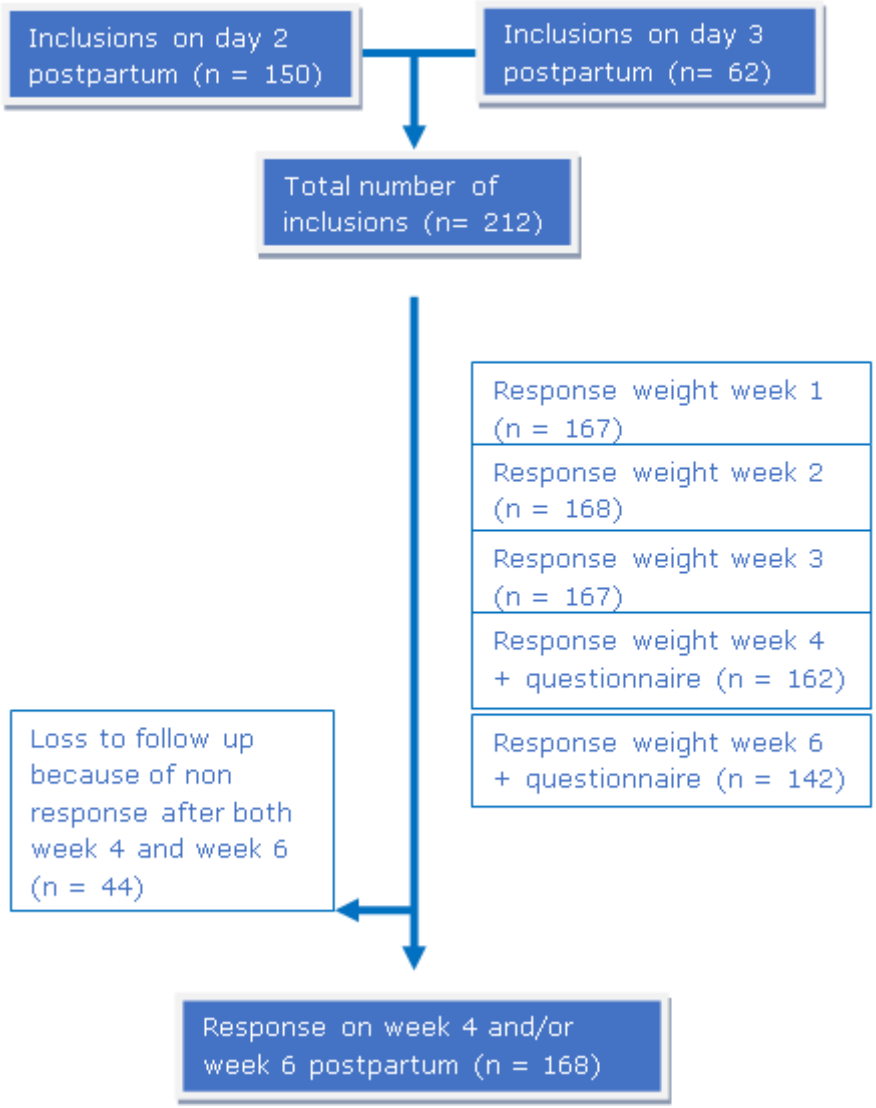

Figure 1: flow chart of inclusions

Table 1: Characteristics of the participants at inclusion (day 2-3 postpartum) (N=212).

Variables	All included mothers *(n=212)*	Mothers with data on week 4 and/or week 6 PP *(n= 168)*
Day of inclusion, n (%)		
Day 2	150 (70.8)	115(68.5)
Day 3	62 (29.2)	53 (31.5)
Age, mean in years (min-max)	30.8 (20-43)	31.2 (20-43)
Pre-BMI, mean (SD)	23.5 (4.1)	23.5 (3.8)
Underweight, n (%)	3 (1.4)	1 (0.6)
Normal weight	152 (71.7)	121 (72.0)
Overweight	43 (20.3)	35 (20.8)
Obese	14 (6.6)	11 (6.5)
GWG, mean in kg (SD)	14.3 (4.9)	14.2 (4.4)
Ethnicity, n (%)		
Belgian	152 (71.7)	128 (76.2)
Moroccan	25 (11.8)	15 (8.9)
Other	35 (16.5)	25 (14.9)
Marital status, n (%)		
Married/legally cohabiting	157 (74.1)	125 (74.4)
Factual cohabiting	47 (22.2)	37 (22.0)
Single	8 (3.8)	6 (3.6)
Education, n (%)		
Primary school	7 (3.3)	4 (2.4)
Secondary school	80 (37.7)	56 (33.3)
Bachelor	64 (30.2)	51 (30.4)
Master or higher	61 (28.8)	57 (33.9)
Employment status, n(%)		
White collar	17 (8.0)	12 (7.1)
Blue collar	114 (53.8)	95 (56.5)
Civil servant	22 (10.4)	21 (12.5)
Independent	18 (8.5)	17 (10.1)
Other	41 (19.3)	23 (13.8)
Parity, n (%)		
First child	98 (46.2)	79 (47.0)
Second child	78 (36.8)	63 (37.5)
Third child or more	36 (17.0)	26 (15.5)
Delivery method, n (%)		
Vaginal	161 (76.0)	128 (76.2)
Planned caesarean	27 (12.7)	21 (12.5)
Unplanned caesarean	24 (11.3)	19 (11.3)

Table 1 (continued).

Variables	All included mothers *(n=212)*	Mothers with data on week 4 and/or week 6 *(n= 168)*
Dietary advice during pregnancy, n (%)	13 (6.1)	11 (6.5)
Nutrition baby, n (%)		
Breastfeeding	162 (76.4)	123 (73.2)
Bottle feeding	44 (20.8)	39 (23.2)
Mixed feeding	6 (2.8)	6 (3.6)
Smoking before pregnancy n (%)	40 (18.9)	32 (18.9)
Smoking during pregnancy, n (%)	14 (6.6)	11 (6.5)
Smoking at inclusion, n (%)	8 (3.8)	6 (3.6)
Hours of sleep at inclusion, mean (SD)	4.7 (1.7)	4.8 (1.5)
Sport before pregnancy, n (%)	99 (46.7)	77 (45.8)
Sport during pregnancy, n (%)	45 (21.2)	41 (24.4)
Diet in past, n (%)	81 (38.2)	67 (39.9)
Fastfood pregnancy ≥ 1x/week, n (%)	94 (44.3)	70 (41.7)
Soft drinks pregnancy ≥ 4x/week, n (%)	118 (55.6)	132 (78.6)
No daily fruit during pregnancy, n (%)	46 (21.7)	38 (28.6)
No daily vegetables during pregnancy, n (%)	39 (18.4)	32 (19)
Sense of coherence, n(%)		
High	83 (39.2)	64 (38.1)
Mid	119 (56.1)	95 (56.5)
Low	10 (4.7)	9 (5.4)

PP = postpartum, pre-BMI = preconceptional Body Mass Index in kg/m², GWG = gestational weight gain. ~~Significant differences (p) between both subgroups were determined with Mann-Whitney-U-test for the continuous variables (not normally distributed according to Shapiro-Wilk-test) and χ^2-test for categorical variables.~~

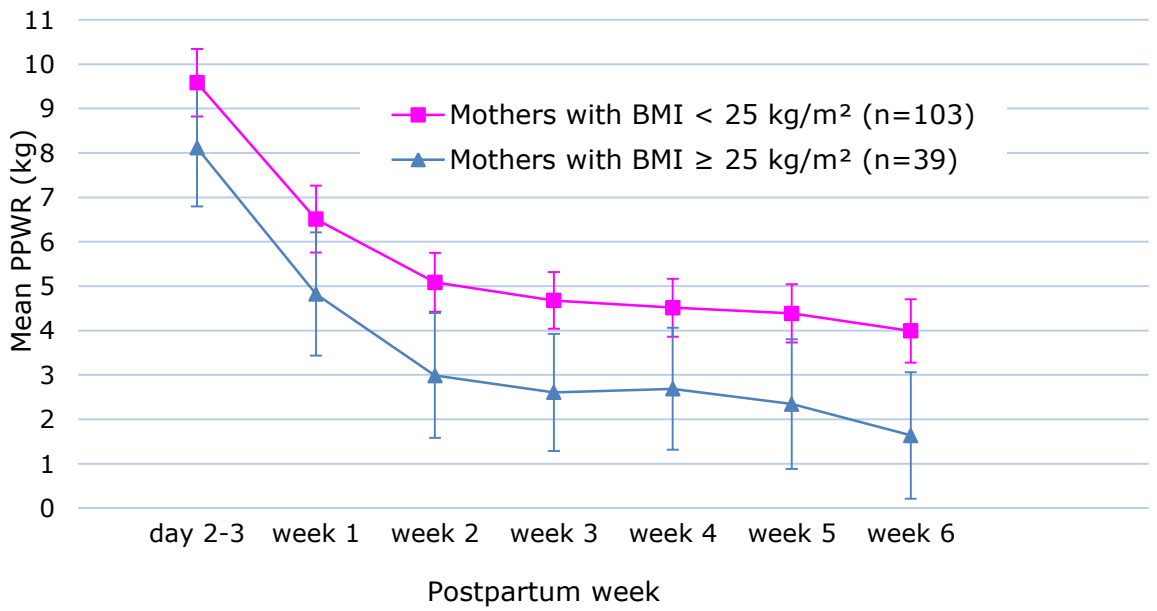

Figure 2: Evolution of mean PPWR from day 2-3 to week 6 postpartum; PPWR was calculated as weight postpartum minus weight before pregnancy. The difference between and was significant ($p < .05$), except on day 2-3 postpartum. n = numbers on week 6.

Table 2. Mean weight difference between weight at inclusion (day 2-3) and weekly follow-up of maternal postpartum weight between mothers with BMI less versus as or more than 25kg/m²

	All mothers *(N = 212)*	Mothers with BMI < 25 kg/m² *(N = 155)*	Mothers with BMI ≥ 25 kg/m² *(N = 57)*	p
Week 1	-3.0 (1.7)	-2.9 (1.5)	-3.3 (2.2)	.105
Response n(%)	*n=167 (78.8)*	*n=122 (78.7)*	*n=45 (78.9)*	
Week 2	-4.3 (2.1)	-4.1 (1.8)	-4.9 (2.8)	**.023**
Response n(%)	*n=168 (79.2)*	*n=126 (81.3)*	*n=42 (73.7)*	
Week 3	-4.7 (2.3)	-4.5 (2.1)	-5.4 (2.8)	**.007**
Response n(%)	*n=167 (78.8)*	*n=125 (80.6)*	*n=42 (73.7)*	
Week 4	-5.0 (2.4)	-4.7 (2.0)	-5.9 (3.2)	**.004**
Response n(%)	*n=162 (76.4)*	*n=119 (76.8)*	*n=43 (75.4)*	
Week 5	-5.2 (2.7)	-5.0 (2.3)	-5.9 (3.4)	**.004**
Response n(%)	*n=157 (74.1)*	*n=115 (74.2)*	*n=42 (73.7)*	
Week 6	-5.5 (2.8)	-5.3 (2.3)	-6.3 (3.7)	**.028**
Response n(%)	*n=142 (67.0)*	*n=103 (66.5)*	*n=39 (68.4)*	

Mean in kg (SD). Significance was calculated for the difference in weight change between the groups BMI < 25 kg/m² and BMI ≥ 25 kg/m² with Mann-Whitney-U-test (because of no normal distribution according to Shapiro-Wilk)

Table 3. Mean weight difference between weight at inclusion (day 2-3) and weekly follow-up of maternal postpartum weight between mothers with excessive versus without excessive GWG

	All mothers (N = 212)	Mothers with excessive GWG (N = 92)	Mothers without excessive GWG (N = 120)	p
Week 1	-3.0 (1.7)	-3.5 (1.7)	-2.7 (1.7)	**.002**
Response n(%)	*n=167 (78.8)*	*n=72 (78.3)*	*n= 95 (79.2)*	
Week 2	-4.3 (2.1)	-5.0 (1.9)	-3.8 (2.1)	**<.001**
Response n(%)	*n=168 (79.2)*	*n=68 (73.9)*	*n=100 (83.3)*	
Week 3	-4.7 (2.3)	-5.6 (2.0)	-4.0 (2.3)	**<.001**
Response n(%)	*n=167 (78.8)*	*n=70 (76.1)*	*n=97 (80.8)*	
Week 4	-5.0 (2.4)	-6.0 (2.2)	-4.3 (2.3)	**<.001**
Response n(%)	*n=162 (76.4)*	*n=70 (76.1)*	*n=92 (76.7)*	
Week 5	-5.2 (2.7)	-6.3 (2.5)	-4.5 (2.5)	**<.001**
Response n(%)	*n=157 (74.1)*	*n=69 (75.0)*	*n=88 (73.3)*	
Week 6	-5.5 (2.8)	-6.6 (2.7)	-4.7 (2.6)	**<.001**
Response n(%)	*n=142 (67.0)*	*n=62 (67.4)*	*n=80 (66.7)*	

Mean in kg (SD). GWG was excessive (according to IOM-guidelines) if >18kg for underweight women, if >16kg for normal weight women, if >11.5kg for overweight women and if >9kg for obese women. Significance was calculated for the difference in weight change between mothers with and without excessive GWG with Mann-Whitney-U-test (because of no normal distribution according to Shapiro-Wilk).

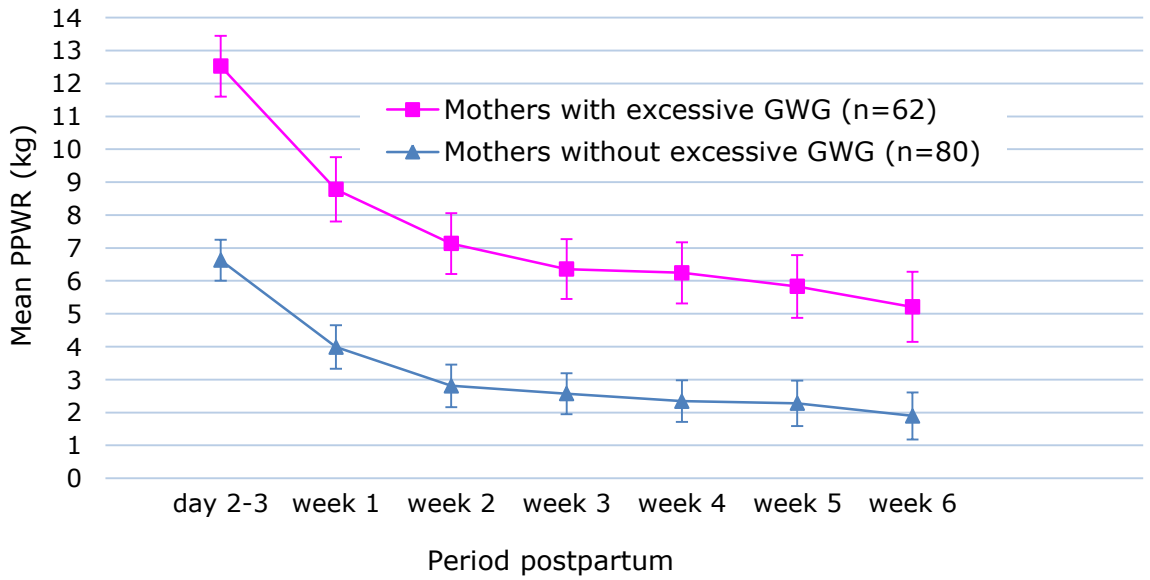

Figure 3: Evolution of mean PPWR from day 2-3 to week 6 postpartum
PPWR was calculated as weight postpartum minus weight before pregnancy. The difference between and was significant (p < .05) everywhere. n = numbers on week 6.

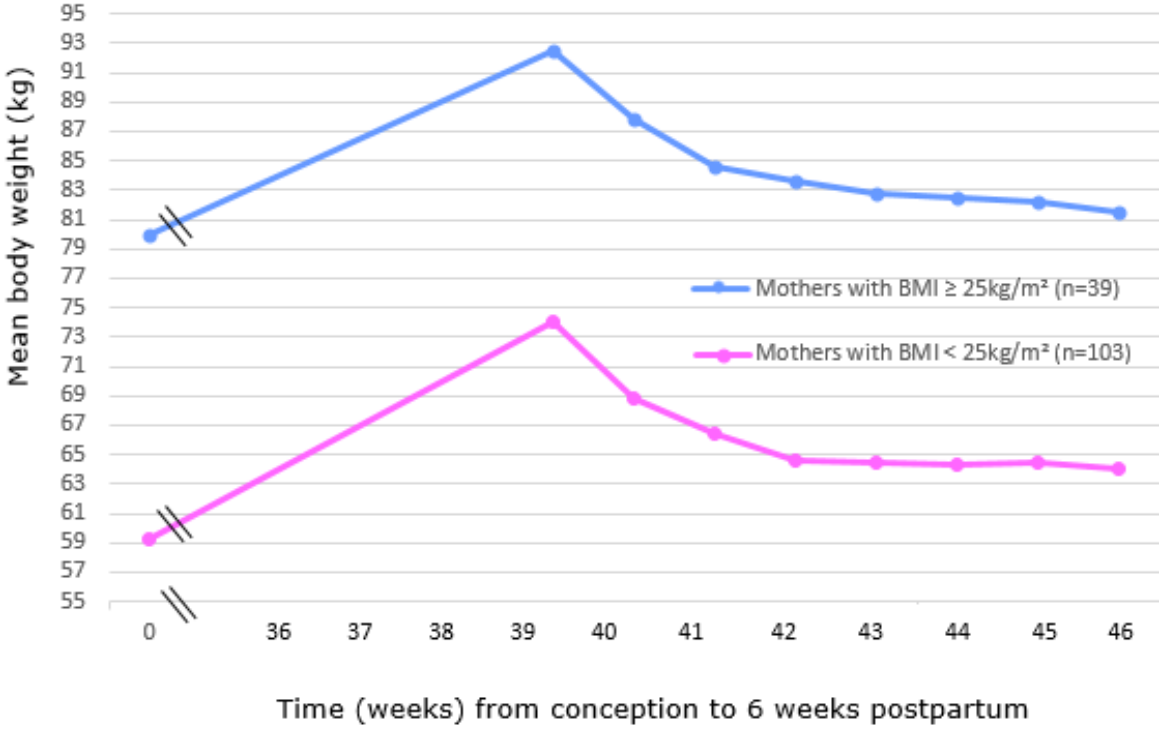

Figure 4. Patterns of weight change among mothers from preconception to 6 weeks postpartum The difference between and was significant everywhere ($p < .05$). n = numbers on week 6 postpartum.

~~**Tabel 4.** Univariate regression analysis: significant correlations with PWR at week 6 postpartum~~

~~Variables~~	~~B~~	~~95% CI of B~~	~~p~~	~~R^2~~
~~**GWG**~~	~~.668~~	~~.585 .752~~	~~<.001~~	~~.641~~
~~**Pre-BMI < 25kg/m²**~~	~~2.373~~	~~.894 3.852~~	~~.002~~	~~.067~~
~~**Bachelor or master level**~~	~~-1.633~~	~~-2.986 -.280~~	~~.018~~	~~.039~~
~~**Number of breastfeedings day 2-3**~~	~~-.350~~	~~-.691 -.010~~	~~.044~~	~~.038~~
~~**Number of breastfeedings week 4**~~	~~.393~~	~~.061 .725~~	~~.021~~	~~.055~~
~~**Number of breastfeedings week 6**~~	~~.470~~	~~.132 .808~~	~~.007~~	~~.080~~
~~**Hours of tv week 4**~~	~~.366~~	~~.064 .668~~	~~.018~~	~~.041~~
~~**Sense of coherence week 4**~~	~~.680~~	~~.095 1.265~~	~~.023~~	~~.038~~
~~**Sense of coherence week 6**~~	~~.717~~	~~.147 1.282~~	~~.014~~	~~.044~~
~~**Depression week 4**~~	~~.189~~	~~.037 .340~~	~~.015~~	~~.044~~

~~GWG = gestational weight gain, Pre-BMI = BMI before pregnancy.~~

Table 4. Multivariate linear regression analysis: influencing factors for PWR at 6 weeks postpartum.

PWR	B	SE	ß	95% CI for B		R^2	Adjusted R^2
Model 1*						64.1%	63.9%
Constant	-6.22	0.64		-7.48	-4.96		
GWG	0.67	0.04	0.80	0.59	0.75		
Model 2*						65.6%	65.1%
Constant	-6.78	0.67		-8.10	-5.46		
GWG	0.65	0.04	0.78	0.57	0.73		
Pre-BMI<25kg/m²	1.12	0.46	0.12	0.21	2.04		

GWG = gestational weight gain, Pre-BMI = Body Mass Index before pregnancy.
Adjusted for significant variables from the univariate analysis: GWG, pre-conception BMI<25kg/m², bachelor-master degree, breastfeeding frequency at inclusion, week 4 and week 6, hours of watching television at week 4, SOC-score at week 4 and 6 and EPDS-score at week 4
Variables entered with stepwise-forward-method. Significance of the model: $p < .001$. B = regression coefficient, β = standardized regression coefficient.