

Weight gain in pregnancy

Stephan Rössner

Karolinska Institute, Obesity Unit and Health Behaviour Research, Karolinska Hospital,
S-171 76 Stockholm, Sweden

Pregnancy and body weight development are intertwined in complicated patterns. Of the obese patients at our Obesity Unit, 73% had retained >10 kg in connection with a pregnancy. For the general population the effect of a pregnancy on future weight development is surprisingly difficult to predict. In the Stockholm pregnancy and weight development study the estimated mean weight retention associated with a pregnancy and estimated 1 year after delivery was 0.5 kg but ranged from -12 to +26 kg. Weight increase during pregnancy was the strongest predictor for sustained weight retention 1 year later. Pre-pregnancy weight did not predict the weight development outcome. The lactation pattern had only a minor influence on weight development. Smoke cessation was an important predictor for sustained weight increase. More weight retention was observed in those women who reported an unfavorable change in lifestyle as regarded eating habits, meal patterns and physical activity. The eventual body weight after pregnancy seems to be more determined by the changes associated with that particular pregnancy than with the lifestyle before.

Key words: eating behaviour/lactation/obesity/pregnancy/smoking

Introduction

The Obesity Unit at the Karolinska hospital has been in operation for 15 years, developing long-term treatment programmes for subjects who are extremely overweight (Björvell and Rössner, 1985,

1992). Our observations suggest that a common cause for female increase in weight was linked to their pregnancy-related weight history. Approximately 40–50% of our female patients reported that pregnancies had been important trigger events in their development of obesity.

Pregnancy can be viewed as a biological cause of weight cycling and increased interest has been focused on the behavioural and metabolic consequences of such repeated body weight cycling (Rodin *et al.*, 1990). Generally, weight cycles have been caused by initial weight loss during dieting programmes with subsequent regains after relapse. Recently, interest has been focused on the possible role of repeated changes in body weight as a risk factor for coronary heart disease and all cause mortality (Lissner *et al.*, 1988).

Some authors have discussed pregnancy-associated weight changes in terms of weight cycling and risk, but mainly in women of normal weight and in relation to the fat distribution pattern (Rodin *et al.*, 1990). We therefore undertook a retrospective pilot study to obtain an impression of the role of pregnancy on body weight development in 113 severely obese women (Rössner, 1992). The data are representative of the typical female patients at the Obesity Unit with a mean age of 47.8 ± 10.7 years (SD) and a body mass index (BMI) of 37.8 ± 5.5 kg/m² (mean weight 104.4 ± 16.6 kg, mean height 166 ± 6 cm). The mean age of the women at the birth of their first child was 24.1 ± 5.1 years. The pregnancies resulted in considerable weight increases which were retained 1 year post-partum. Of these women, 78% (83/113) retained >10 kg in association with the pregnancy period and for up to 1 year after

delivery. All women but three reported weight cycling episodes of >10 kg apart from pregnancies, and many of them had undergone numerous such weight cycling events.

Although it has been well documented that the body weight of women increases with parity and that many women have a higher body weight at the beginning of a subsequent pregnancy compared with the previous one (Billewicz and Thomson, 1970; Heliövaara and Aromma, 1981; Rookus *et al.*, 1987), there is little information concerning the importance of pregnancies in the development of obesity. Our simple retrospective approach documented that pregnancy is indeed a high-risk situation for women who may later become severely obese. In spite of several methodological limitations, it seems reasonable to assume that for many women, pregnancy has resulted in pronounced and sustained weight gain.

Previous studies on pregnancy and weight development

The mean body weight and the prevalence of obesity increases with each pregnancy. Since body weight also increases with age in the fertile age groups, it has been necessary to analyse weight increase, parity and age separately. Such studies demonstrate that the weight increase associated with pregnancy is age independent.

The average reported weight increase associated with pregnancies ranges from 0.4 to 3.8 kg compared with pre-pregnancy weights. However, as many authors point out, there are several methodological complications that have to be taken into account when these data are compared and evaluated: firstly, women generally do not have recorded weight data available from the time of conception and so it is difficult to obtain a reliable initial body weight; secondly, weight increase during pregnancy consists of several component and for obvious technical and ethical reasons it is not possible to analyse all of these compartments in larger studies; thirdly, post-pregnancy body weight is difficult to define. Many women change weight over a considerable period of time after delivery. If their weight is measured soon after delivery, this figure may not be representative of the entire weight development associated with the pregnancy

as such. If, on the other hand, the weight after delivery is recorded at a late stage, numerous other life changes, including a new pregnancy, may have taken place.

Weight increase during pregnancy

Generally a mean weight increase of ~12.5 kg is considered normal during an entire pregnancy. In various studies reported by Ash *et al.* (1989), the mean increase has been in the range 10.7–15.2 kg. For obvious reasons, the weight increase in developing countries is generally considerably lower.

Body weight increases with age, whether women have children or not. There is an increase with age which is more pronounced in women than in men. A further steep increase can be observed during onset of the menopause. It should be kept in mind that the basal metabolic rate normally decreases by ~1% per year. For an individual who maintains an identical lifestyle with regard to eating habits and exercise, this implies a weight increase of about 4.7 kg per 10 years.

Pregnancy and lactation

On theoretical grounds it can be assumed that the energy requirement for an entire pregnancy is ~80 000 calories or ~300 calories per day covering the needs for fetal growth and adipose tissue storage. Lactation has been assumed to facilitate weight loss, in particular if the period of lactation exceeds 2 months. Lactation has been calculated to increase the energy requirements by ~500 calories per day which also takes into account that production of milk is an energy requiring process.

Studies by Rebuffé-Scrive *et al.* (1985) and others have demonstrated that the characteristics of the adipose tissue change dramatically during pregnancy. Adipose tissue lipolysis in the femoral region is limited during pregnancy, but can easily be stimulated hormonally during lactation. This seems to be a functional adaptation of the adipose tissue to the needs of the mother and the child.

However, the relationships between lactation, energy needs and energy balance are not fully clarified. In some studies no difference in energy intake was found between lactating and non-lactat-

ing women. Other studies suggests that lactation plays a minor role in weight reduction after delivery (Illingworth *et al.*, 1987; Öhlin and Rössner, 1990).

From a theoretical viewpoint, weight changes after delivery could also depend on changes in basal metabolic rates. The three mechanisms which could explain the lack of weight loss after delivery are: firstly, reduced basal metabolism; secondly, impaired thermogenesis; and thirdly, reduced physical activity (Prentice and Prentice, 1988). These mechanisms could account for a reduction in energy requirements of up to ~240 calories per day. Thus it is possible that the energy need during lactation can be provided from different sources such as a combination of an increased energy intake, utilization of adipose tissue in storage and a metabolic adaptation.

Smoking and pregnancy

Smoking increases the basal metabolic rate by ~10% (Rössner, 1986). The weight development pattern in pregnancy is confounded by the fact that many women smokers give up this habit when they learn of their pregnancy. In this situation, the weight gain is influenced by an additional factor apart from the growth of the fetus. Smokers gain less weight during pregnancy than non-smokers, whereas those who give up smoking before delivery increase more in weight.

The Stockholm pregnancy and weight development study

In order to analyse further the relationships between body weight, weight development, pregnancy, lactation, socio-demographic factors and weight retention the Stockholm pregnancy and weight development study was carried out (Öhlin and Rössner, 1990, 1994; Öhlin, 1991). The overall aims of the study were: (i) to analyse retrospectively the weight development pattern during pregnancy; (ii) to monitor prospectively the body weight changes up to one year after delivery; (iii) to identify risk factors for sustained weight retention.

Women were recruited to this study through the Stockholm County maternity health care service system, in connection with the standard examina-

tion at the maternity clinic 6–15 weeks after delivery. At this follow-up the staff also invited the women to take part in our study. Women who accepted filled out of a number of questionnaires and reappeared for two additional weigh-in sessions 6 and 12 months after delivery. The corresponding records from the maternity units and the obstetric units for these women were also analysed.

The women represented a mixture of the southern Stockholm metropolitan area, Stockholm suburbs and countryside for ~40 miles from the city centre. A total of 2342 women agreed to participate in this study; 47 were excluded for reasons such as twin pregnancy, insulin-requiring diabetes mellitus, severe nutritional problems or lack of pre-pregnancy weight reports. Of the 2295 women who agreed to participate in the study at the maternity unit check up, 872 dropped out during the following year. This corresponded with an overall drop-out figure of 38% of the 2295 women. Further analyses failed to reveal that the salient results of the study could be explained by a selective drop-out mechanism.

From the obstetric records and the questionnaires administered at follow-up, data were computed regarding the following: body weight, age, parity, nationality, occupation, living site, marital status, smoking habits, contraceptive practices, duration of lactation and lactation intensity, weight losing practices, return to salaried work, eating and exercise habit.

For obvious reasons, the pre-pregnancy weight had to be accepted from the patients' own reports. All ensuing weights were recorded in a standardized way in each of the 14 participating maternity clinics.

The validity of the pre-pregnancy reported weight constitutes an important methodological problem. We compared the data with results obtained from a subgroup of 49 women, who were excluded from the 12 months follow-up because of a new pregnancy. This gave us an unforeseen opportunity to compare their reported weight with the weight that was recorded as the starting level for their next pregnancy. The reported mean weight was 0.92 kg lower at the onset of pregnancy than the latest recorded weight obtained under our study

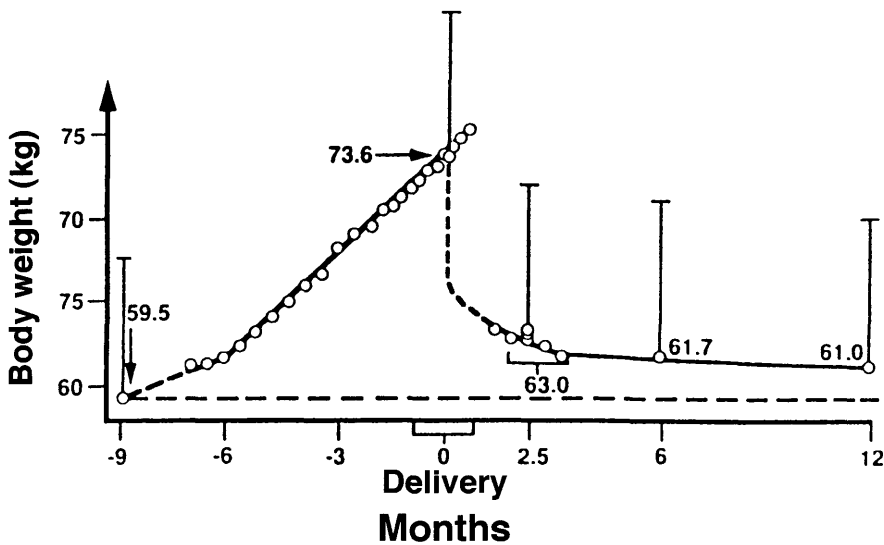


Figure 1. Body weight development of 1423 women in the Stockholm pregnancy and weight development study from onset of pregnancy until 12 months post-partum. Data for mean values \pm SD at conception, delivery and 2.5, 6 and 12 months post-partum are shown, \circ = mean data from women, weighed that particular week. From Öhlin and Rössner (1990).

conditions. The mean weight loss 6–12 months after delivery was calculated as 0.12 kg from data from the entire study. If we subtract this weight from 0.92 kg, we can estimate that these women have reported an initial body weight at onset of the new pregnancy which was on average 0.8 kg lower than their true body weight.

These results fit reasonable well with studies of a group of Swedish women where true pre-pregnancy weight data could be obtained since these women were studied and weighed at a time when their intrauterine device was removed before a planned pregnancy (Sadurskis *et al.*, 1988).

Results from the Stockholm pregnancy and weight development study

The overall weight development in the Stockholm study is shown in Figure 1. The mean weight increase 1 year after delivery compared with the reported weight at the time of conception was 1.5 kg. When we corrected for the estimated under-reporting of weight at conception from our parallel studies (0.8 kg plus the estimated mean weight increase over 21 months of time 0.2 kg) the net mean weight increase induced by a pregnancy was calculated as 0.5 kg. However, the range was very wide: 1.5% of the women had a mean weight

increase of at least 10 kg and 13% had a weight increase of 5–10 kg. The majority (56%) had a weight increase of up to 5 kg, but 30% lost weight.

Women with a weight retention of >5 kg differed from the other women in several respects. Whereas women with a small net increase in weight lost a mean of 2.3 kg between 2.5 and 12 months after delivery, women with larger weight retention increased 0.4 kg during the same time period. Those who retained more weight had a larger initial body weight, increased more during pregnancy, were lactated slightly less and stopped smoking during pregnancy to a larger extent. We also found less well-structured eating patterns before, during and after pregnancy. Those women who increased in body weight reported that their energy intake had increased after delivery, since they ate larger portions and snacked more frequently. They had less regular eating habits and did not eat breakfast and lunch as regularly as women who put on less weight. Age and parity did not differ between women who retained >5 kg and those who retained less.

Factors significantly associated with the net weight increase after pregnancy are summarized in Table I. Weight increase during pregnancy was the most important factor explaining weight retention, and the weight increase during the first

Table I. Statistically significant risk factors for sustained weight gain after pregnancy. Data from the Stockholm pregnancy and weight development study (from Öhlin and Rössner, 1990)

| Factors associated with sustained weight gain after pregnancy | |
|---|------------------|
| Weight increase during pregnancy | $r = 0.36^{***}$ |
| Lactation | $r = -0.09^{**}$ |
| Age | $r = 0.06^*$ |
| Irregular eating habits after delivery | $r = -0.07^*$ |
| Leisure time physical activity after delivery | $r = -0.05^*$ |
| Factors associated with major weight retention 1 year after delivery | |
| Smoke cessation | +3.4 kg** |
| Marked weight changes (± 6 kg) in previous pregnancy | +2.5 kg* |
| Factors not significantly affecting body weight 1 year after delivery | |
| Initial body weight | |
| Number of children | |
| Previous contraceptive pill | |
| Social class | |
| Occupation | |
| Marital status | |
| Nationality | |
| Dietary advice during pregnancy | |

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

trimester was the most important explanatory variable. Weight retention increased only slightly with age and not with parity. Women who gave up smoking when they became pregnant increased in weight more than others. In this group 45% of the women retained > 5 kg.

Lactation played a small role in weight control after delivery. Although there was a significant relationship between the lactation score and weight retention, the r value was low ($r = 0.05$, $P < 0.01$). However, there was a difference with time, in that women with a high lactation score lost more weight during the first half year after delivery. Towards the end of the year, the differences between the groups were limited. Only in a small subset of subjects, who had been lactating for a whole year was a reduction of body weight (compared with pre-pregnancy weight) found.

The small importance of lactation in weight loss after delivery is surprising, but has been reported previously by Rookus *et al.* (1987) and was also described by others, as cited in their review.

In clinical practice, women are often instructed to try to breast feed as much as possible to revert to normal weight after delivery. This seems logical, since full lactation requires ~ 500 calories per day, which may constitute ~ 20 – 25% of the daily energy requirement of women in this age group. However, it is possible that the changes in eating behaviour and in life style affect women in such a way that they only use their adipose tissue storage when food is not readily available, as has been suggested by Prentice and Prentice (1988).

Questions regarding eating habits, physical activity and life style revealed that there was a tendency for women who retained more weight to develop a more sedentary and irregular life style (Öhlin and Rössner, 1994). This can of course be explained by the new social situation and the lack of opportunity for engaging in outdoor activities, when the care of the newborn has become a first priority. Women who had received dietary guidance during pregnancy did not have a more favourable weight outcome than those who did not receive such support. We believe that weight retention after delivery can be better explained by changes in lifestyle associated by the arrival of a new family member than by metabolic, anthropometric and social factors before pregnancy.

Acknowledgements

Supported by the Söderberg Foundation, Thuring Foundation, and the Swedish dairy industries.

References

- Ash, S., Fischer, C.C., Truswell, A.S. *et al.* (1989) Maternal weight gain, smoking, and other factors in pregnancy as predictors of infant birth-weight in Sydney women. *Aust. N.Z. Obstet. Gynaecol.*, **29**, 212–219.
- Billewicz, W.Z. and Thomson, A.M. (1970) Body weight in parous women. *Br. J. Prev. Soc. Med.*, **24**, 97–104.
- Björvell, H. and Rössner, S. (1985) Long term treatment of severe obesity: follow-up of results of combined behavioural modification programme. *Br. Med. J.*, **291**, 379–382.
- Björvell, H. and Rössner, S. (1992) A ten-year follow-up of weight changes in severely obese subjects treated in a combined behaviour modification programme. *Int. J. Obesity*, **16**, 623–625.
- Heliövaara, M. and Aromaa, A. (1981) Parity and obesity. *J. Epidemiol. Comm. Health*, **35**, 197–199.

- Illingworth, P.J., Jung, R.T., Howie, P.W. and Isles, T.E. (1987) Reduction in postprandial energy expenditure during lactation. *Br. Med. J.*, **294**, 1573–1576.
- Lissner, L., Odell, R., D'Agostino, R. *et al.* (1988) Health implications of weight cycling in the Framingham Population. *Am. J. Epidemiol.*, **128**, 1180–1184.
- Öhlin, A. (1991) *Pregnancy and overweight*. PhD Thesis, Karolinska Institute, Stockholm (in Swedish).
- Öhlin, A. and Rössner, S. (1990) Maternal weight development after pregnancy. *Int. J. Obesity*, **14**, 159–173.
- Öhlin, A. and Rössner, S. (1994) Trends in eating patterns, physical activity and socio-demographic factors in relation to postpartum body weight development. *Br. J. Nutr.*, **71**, 457–470.
- Prentice, A.M. and Prentice, A. (1988) Energy costs of lactation. *Ann. Rev. Nutr.*, **8**, 63–79.
- Rebuffé-Scrive, M., Enk, L., Crona, P. *et al.* (1985) Fat cell metabolism in different regions in women. Effects of menstrual cycle, pregnancy and lactation. *J. Clin. Invest.*, **75**, 1973–1976.
- Rodin, J., Radke-Sharpe, N., Rebuffé-Scrive, M. and Greenwood, M.R.C. (1990) Weight cycling and fat distribution. *Int. J. Obesity*, **14**, 303–310.
- Rookus, M.A., Rokebrand, P., Burema, J. and Deurenberg, P. (1987) The effect of pregnancy on the body mass index 9 months postpartum in 49 women. *Int. J. Obesity*, **11**, 609–618.
- Rössner, S. (1986) Cessation of cigarette smoking and body weight increase. *Acta Med. Scand.*, **219**, 1–2.
- Rössner, S. (1992) Pregnancy, weight cycling and weight gain. *Int. J. Obesity*, **16**, 145–147.
- Sadurskis, A., Kabir, N., Wager, J. and Førsum, E. (1988) Energy metabolism, body composition and milk production in healthy Swedish women during lactation. *Am. J. Clin. Nutr.*, **48**, 44–49.