Pregnancy: A risk factor for social inequalities in overweight and obesity?

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Obesity and overweight are not randomly distributed in the population, and strong disparities according to socioeconomic status and racial/ethnic origin exist. In the search for the causes of this epidemic, pregnancy-related weight gain has begun to receive growing attention.

Objectives: 1. Estimate the average time to return to pre-pregnancy BMI, and/or reach a “healthy” BMI (18.5-24.9) post-pregnancy. **2.** Identify socioeconomic and ethnic characteristics placing women at risk of not returning to a healthy and/or their pre-pregnancy BMI.

Methods. Data come from the National Longitudinal Survey of Youth (NLSY79). This prospective cohort is nationally representative of the U.S. population of individuals aged 14 to 22 years in 1979. Having followed for 23 cycles of data collection and over 27 years these respondents’ lives, it constitutes one of the richest sources for repeated, prospective information on socioeconomic, fertility and pregnancy-related weight dynamics. Indeed, out of the 4926 women aged 14-22 included in the sample in 1979, we considered 1890 parous women (excluding adolescent mothers and births with information collected retrospectively prior to 1983) who were followed over the bulk of their reproductive lives.

Results: Following their first birth, 68.6% of women returned to their pre-pregnancy BMI after 1.9 years on average, and more broadly, 89.9% returned to their pre-pregnancy BMI category after 1.5 years on average. Similarly, we found that 81.2% were able to reach a healthy BMI after 1.7 years on average. However, given that 18.8% of women who returned to their pre-pregnancy BMI were overweight or obese, this suggests that the high proportion of women reaching a “healthy” BMI post-partum is due in part to underweight women transitioning into this “healthy” category. Moreover, the proportion of women who returned to their pre-pregnancy BMI was higher among Whites (70.0%) than Blacks (62.1%) or Hispanics (57.4%) and increased with these women’s mothers’ education.

Conclusions: These analyses highlight the existence of social disparities in the likelihood of returning to pre-pregnancy and/or healthy BMI. Next, we will rely on multivariate survival analysis to estimate this likelihood according to socioeconomic status and ethnicity, controlling for parity, psychosocial factors and prenatal care service use.

BACKGROUND AND RATIONALE

According to the WHO, obesity and overweight have reached epidemic proportions globally, posing serious risks for a range of circulatory diseases and certain forms of cancer and thus resulting in increased morbidity and premature mortality [2]. In North America, rates have risen so dramatically over the past two decades such that the majority of American and Canadian women (respectively 61.6% and 53.4%) are now considered to be overweight or obese [3, 4].

To compound the problem, this growth has not occurred within populations, such that strong disparities exist according to racial/ethnic origin and socioeconomic status (SES) [5-12]. Finally, while the specific determinants may differ by gender [10], one of the obvious differences that has not always been taken into account in general population studies is one potentially recurrent lifecourse event that is specific to women, namely pregnancy.

Pregnancy-related weight gain has indeed dramatically risen over the past several decades in the U.S.[13]. Entering pregnancy overweight or obese, gaining inadequate amounts of weight during gestation, and post-partum retention of the weight gained during pregnancy can all increase the risk of long term obesity and chronic diseases for women and their children.

This brief background highlights our proposal's timeliness and relevance for public health. In this project, we will respond to this need for information by examining the social dynamics of weight gain and loss related to pregnancy by using data collected prospectively on a cohort of women throughout most of their reproductive lifecourse. In the next section, we present the results of a systematic review of the literature (see summary of progress for details). We will then expound the research questions stemming from these results, as well as the analytic plan we developed to tackle these questions. Finally, we will give further details about the timeline of our deliverables and the team involved in this project.

LITERATURE REVIEW: PREGNANCY AND WEIGHT GAIN

While there is high agreement in the literature that multiple pregnancies increase the risk of and obesity among women, results so far have been mixed with regards to the effects of related determinants: pre-pregnancy BMI (or pre-BMI), gestational weight gain (GWG), postpartum weight retention (PPWR), parity (number of live births), ethnicity, socioeconomic status (SES) and other psychosocial factors. In this section, we will summarize the main results of our systematic literature review on population statistics, and the determinants and health consequences potentially involved in the process that links pregnancy to overweight/obesity.

We have organized our review according to the three main time periods conceptually relevant to pregnancy-related weight dynamics: 1/ general trends in pre-pregnancy overweight/obesity; 2/ gestational weight gain (GWG); and 3/ postpartum weight retention (PPWR). We will then synthesize these and highlight inconsistencies and gaps in the scientific literature that need further investigation.

PRE-PREGNANCY OVERWEIGHT AND OBESITY

Figures & Determinants. As previously shown, 26.0% and 35.3% of American women [14] and 30.2% and 23.2% of Canadian women [3] are respectively overweight or obese. Given the size of the literature concerning the determinants of overweight and obesity, we have focused our search and this sub-section on SES and mediating factors among women. Recent reviews [10, 11] indicate that most studies have found an inverse relationship between overweight and obesity and **respondents'** [10-12] or **parental SES** [11]. As such, obesity can be up to six times more likely in women of low SES than in women of high SES [11]. Studies suggest this inverse relationship may in part be due to better **material circumstances** and **health behaviors**, such as safe neighbourhoods facilitating exercise and access to nutritious foods [6-8, 15].

Health consequences. Obesity in women before pregnancy has been found to have short- and long-term impacts on both child and mother outcomes. Aside from increasing the risk of infertility and complications during pregnancy and delivery, of paramount importance to the study at hand, pre-pregnancy BMI is also known to be a determinant of GWG*and PPWR*.

Gestational Weight Gain (GWG)

Recommendations regarding the weight women should gain during pregnancy have been widely debated over the course of the 20th century [27]. In the U.S., the IOM developed weight gain guidelines in 1990 [28] and reviewed these in 2009 to follow international WHO BMI's categories [29] (see Table 2 and Table 3 in Appendix).

Figures. Many studies found that women's GWG does not conform to these guidelines [16, 30-32]. A systematic review of the literature assessed that 1/3 of all women and 2/3 of overweight women in particular, gain more than the recommended amount of weight during pregnancy [16]. Moreover, a secular trend towards over-gaining is also emerging in the U.S.[32].

Determinants. Not surprisingly and as was previously mentioned, one of the most significant determinants of GWG is **pre-pregnancy BMI***. Indeed, women with higher pre-pregnancy BMIs tend to gain more weight, while the current IOM guidelines recommend that they should gain the least weight, or, when obese, could even lose weight (under medical supervision). Some studies found that **younger** women [31, 33, 34] and those who **smoke** during pregnancy [31] are more likely to gain less than the recommended range. Conversely, **parity** seems to be associated with excessive weight gain*. However, these results should be qualified, as some studies have found non-significant [35] or contradictory results [32, 36], especially among minority groups [32, 33, 35-37].

Aside from these observations, the two determinants that have been the most systematically assessed are SES and ethnicity. Higher **SES** women (assessed by respondents' income and/or educational level) are the most likely to gain within the recommended range [22, 36]. In contrast, a U-shaped risk curve appears to exist among low SES populations, where both the highest risks for over-gaining* or under-gaining* weight during pregnancy co-exist. In other words, low SES populations are the least likely to meet recommended GWG guidelines. The same U shape seems to occur regarding **ethnicity,** as minorities are at increased risk of either under-gaining* or over-gaining*weight during pregnancy.

An important proximal mechanism through which some of these determinants operate could reside in **physicians' advice regarding weight gain** [16, 38, 39]. Further investigation is obviously needed to understand the potential interactions and confounding effects between GWG and access to prenatal care, because of SES or race/ethnicity stratification. Indeed, minorities [40] and low-SES individuals [21] are less likely to have adequate access to prenatal care.

Health consequences. We will see how GWG will have consequences on PPWR in the next sub-section, but here too, inadequate GWG can increase perinatal complications [18, 41] as well as affect children's health [18, 41-45 47-49].

In conclusion, among women belonging to low SES or ethnic minority groups, GWG is more likely to fall outside the recommended range. Under- and over-gaining GWG could co-exist within the same SES and ethnic groups, thus nullifying a total effect of these categories. More work is therefore needed to understand how these trends play out through the interactions between SES, race, prenatal services use and weight outcomes.

Postpartum Weight Retention

In this section, we will use a strict definition of 'postpartum weight retention' to refer to weight changes occurring 12-18 months after birth [50]. Subsequently, we will present the results of longer-run studies that assess weight dynamics from 5 up to 15 years post-pregnancy.

While postpartum (PP) weight loss due to the expulsion of the infant, placenta and amniotic fluid does not show much social variation, the loss of fat gained during pregnancy seems to pose a greater challenge. Two phenomena can potentially occur in this PP period: 1/ the *retention* of fat accumulated during the gestational period and 2/ the *gaining* of weight that occurs after the birth of a child.

Figures. Between 14 to 20% of women retain weight from pregnancy [51]. According to a recent review, the steepest decrease in PPW occurs during the first three months after delivery; at about 6 weeks, when most of the fluids associated with pregnancy are indeed lost [50]. In the absence of changes in health behaviors from the pre-pregnancy period, the weight loss should then continue until 12 months PP. Thus, weight gain that occurs during that period is usually attributable to increases in body fat, that result from lifestyle changes after the birth such as eating patterns and decreases in physical activity [50].

Determinants. Many factors are associated with PPWR, the firsts being pregnancy-related. **Pre-pregnancy BMI*** is a determinant of PPWR as it was for excessive GWG*. **GWG** itself is strongly and positively correlated with average retained weight *. Yet, as we will see later, very little research has assessed the pathways between these three phases in the same study. Conclusions on the impact of **breastfeeding** on PP weight loss are still debated [53-55], but two reviews found limited evidence that breastfeeding is associated with a faster return to pre-pregnancy BMI [43, 56]. Similarly, findings on the impact of **parity** on PPWR are also mixed*.

Other determinants pertain to demographics and SES characteristics. To begin, PPWR has generally been found to increase with **age** [52, 56-58] . Regarding **SES**, many studies found that low-SES women are more likely to retain more weight after pregnancy than women of higher SES*. Regarding **ethnicity**, minority women*, and especially African American women* are more likely to retain weight or to be obese after pregnancy than white women. In sum, the U-shaped relationship found amongst minority women for GWG (i.e. the fact that they tend to either under- or over-gain relative to official recommendations) does not seem to hold for PPWR. However, this difference in trends during and after pregnancy has not been reconciled in the literature, primarily because of the lack of studies combining observations through all relevant periods.

Finally, PPWR is also highly related to **health behaviors**. More precisely, a higher frequency of exercise is related to less PPWR*, while smoking cessation during or after pregnancy is a significant weight gain contributor* (though this may not be specific to pregnancy). Lifestyle habits can also change during both pregnant and postpartum life [26, 50, 63, 64], and thus impact future weight gain and lead to obesity.

Health consequences of PPWR. The consequences of PPWR include long-term obesity in women* and health problems such as diabetes and heart disease later in life [51, 74]. On the other hand, mothers' BMI and health behaviours can also have intergenerational effects, since the social environment in which children grow seems to have an impact on children's own perception of their weight[76]**.**

Due to a dearth of studies spanning different periods of the pregnancy, the contradictory trends in the impact of SES and ethnicity during (GWG) and after (PPWR) pregnancy have not been reconciled in the literature. Some of these trends could have to do with the impact of postnatal health behaviors and parity on PPWR.

Long-term Studies of Weight Gain or Loss Following Pregnancy

Studies described in this section go beyond the strict definition of PPWR mentioned above and follow women beyond 18 months post-delivery.
Seminal research in this area used administrative data to longitudinally follow more than 7300 married women weighed during their first pregnancy between 1949 and 1954 in the UK [77]. Other major contributions in this area are based on the National Health and Nutrition Examination Survey (NHANES), which followed women for 10 years [59, 78] and the Stockholm Pregnancy and Women's Nutrition (SPAWN) survey, which followed women at six months, one year and 15 years PP [79-82]. Most of these studies uncovered an association between pregnancy and both PPWR and long-term obesity. However, these results are limited in that these studies generally measured women's weight discontinuously over several year intervals and they rarely addressed the pathways between pre-BMI, GWG and PPWR [74, 79]. As such, none of these analyses could take into account the dynamic evolution of weight gain and loss between these distant points or had information on the entire reproductive life. Finally, these studies could not ensure that women were all nulli- or primi-parous at the time of inclusion.
A recently published study used the National Longitudinal Survey of Youth 1979 (NLSY79), which could have overcome many of these limitations [5]. In comparisons between multiparous, primiparous, and nulliparous women, the authors found parity to be a risk factor for 5-year incident obesity, especially among minority women. However, the study used an aggregated outcome (5-year incidence of obesity) that does not assess the dynamic process of pregnancy (time between pregnancies, number of pregnancies) and of weight (gained or lost, related to pregnancy or not). Finally, this study only looked at a short, five-year period of time during the reproductive lifecourse of these women, rather than follow them through most of this period, which the data allow.

Conclusions of the systematic literature review

The mixed, but not necessarily discordant, results exposed above can be attributed to many methodological divergences in terms of the sample selection and the population of reference, measurement and definition of variables and study design[50, 61]
First, few of these studies relied on samples that are representative of the general population. Secondly, seldom were women interviewed until the end of their reproductive lives. Thus, the bulk of these studies can only offer partial conclusions. Finally, in addition to mixed results found on the impact of diverse determinants (and among them socioeconomic factors) potentially due to these methodological variations, one important gap in the literature is the complete absence of dynamic studies of the potential impact of repeated pregnancies on later obesity.
In sum, our review of the literature found that pre-pregnancy BMI has an impact on GWG and PPWR, and that GWG is also associated with PPWR. Yet, scant studies have examined these processes in relation to one another. Moreover, there is a dearth of studies assessing in its longitudinal and dynamic dimensions the potential cumulative impact of multiple pregnancies on later obesity. Finally, we found very little research that assesses the time required to regain initial weight [61]. Our review therefore highlights the significant knowledge gaps in these important areas that could shed more light on the pathways and cumulative impact of these processes.

OBJECTIVES

Based on the knowledge gaps highlighted above, we argue that it is not sufficient to simply assess weight changes from pre-pregnancy to a later point in life, as was done in many previous studies. Instead, we need to assess the **dynamic evolution of weight over time**, taking into account successive gains and losses, thanks to repeated measurements and by tracking their trajectories. Moreover, it is also absolutely paramount to come as close as possible to **covering a woman's entire reproductive life** in order to understand the processes associating weight retention with the potential cumulative effect of pregnancies.

Drawing from a lifecourse perspective, we argue here that early life and adolescence characteristics may affect SES and health status in adulthood, which may themselves affect pregnancy-related weight gain. Each subsequent pregnancy may be influenced by the previous ones until the end of childbearing years and it is this dynamic process that can contribute to long-term obesity.

More specifically, our research pursues the following objectives:

1. Estimate the average time and determinants for reaching a BMI of less than 25 post-pregnancy;
2. Identify those socioeconomic, ethnicity, parity, psychosocial factors and prenatal care service use that can affect the processes above and lead to social inequalities in BMI.

METHODS

DATA SOURCE AND SAMPLE

The National Longitudinal Survey of Youth 1979 (NLSY79) [89] is an ideal source of information for answering the objectives above. Indeed, this dataset provides a unique opportunity to examine a large part of the reproductive lives of a nationally representative cohort of women with annual or biennial repeated measurements of SES, marital status, health conditions along with fertility history, weight before, during and after each pregnancy.

These data consist of a nationally representative cohort of 12,686 young Americans aged 14 to 22 years at baseline in 1979. They were collected by the U.S. Bureau of Labor Statistics with the original intent of examining the transition from school to work of these youth. This **cohort was followed prospectively to this day through 22 rounds of interviews**, with annual personal paper-assisted personal interviews (PAPI) until 1994 and since then, biennial personal computer-assisted personal interviews (CAPI). **In 2006, the retention rate for 27 years of collection was a remarkable 76.8%** [90].

The NLSY79 sample was initially composed of three sub-samples: 1. Non- institutionalized youth living in the U.S. and born between 1957 and 1964; 2. Oversample of minorities and disadvantaged youth; 3. Youth enrolled in the military forces. As the military and the disadvantaged samples were not followed up after 1984 and 1990 respectively, we will only keep the 9,763 youths that were non-institutionalized and oversampled minorities in 1979. In sum, **4,926 women were initially recruited, among whom 1,472 (19.9%) were African-American and 977 (19.8%) Hispanic.**

Finally, we will exclude from our sample women who experienced teenage (under the age of 20) pregnancies and births. Indeed, the processes may be quite different for these populations on many social and biological levels. To wit, teenage mothers seem to be more likely to gain excessively during pregnancy than older mothers [91] and the recommendations on adequate GWG are still disputed for teenagers [29]. While we could have stratified the analyses, we were concerned that the sub-sample of teenage mothers was likely to suffer from low statistical power (as only 631 women experienced their first delivery before the age of 20). In contrast, we stand to gain from this restriction in terms of minimizing the potential recall bias regarding prior pregnancies for the other 3,389 women who had their first birth at 20 or later. Indeed, as we discuss below, the full fertility (and associated weight) history was only collected beginning in 1983.

VARIABLES

The survey's original focus was on labor force experiences, labor market attachment, and investments in education and training: that information (along with sociodemographic characteristics) was therefore collected at each survey cycle. From the outset, the NLSY79 was also designed to allow for the reconstruction of a detailed fertility history. However, it is only beginning in 1983 that an expanded fertility module was fielded that allows for the calculation of self-reported weight gain during pregnancy. Table 4 in the appendix summarizes the type of information collected by cycle and table 5 describes more explicitly the expanded fertility history section.

Fertility history. First, we can consider that this survey has effectively covered the bulk of its female respondents' *adult* reproductive lives. Indeed, women were aged between 14 and 22 years old at inclusion (mean age: 17.9 ± 2.3 s.d. years old), and thus, our exclusion criteria of teenage pregnancies ensures that this survey prospectively captures pregnancy experiences for many of these women. At the other end of the reproductive lifecourse, in 2006 (latest available data), women were 41 to 49 years old. Only 1% of births occur to women above 40 in the U.S. [92]. Accordingly, the number of birth stated during the last rounds was very low in the sample (125 births were stated in 2002, 75 in 2004 and 36 in 2006). Finally, our analyses will make use of the 2008 release of data (scheduled for the spring 2010), which arguably will ensure that these data will have captured most of these women's reproductive lives.

Second, we will be able to reconstruct (either prospectively or retrospectively) the whole pregnancy history of women followed since 1979. The NLSY79 is also quite aggressive in tracking down non-respondents, and will reintegrate them when found, with retrospective information provided to fill in the survey gaps (this is what contributes to its remarkable retention rate of 76.8%). For each pregnancy, the month and year the women became pregnant as well as the birth date of the child were recorded. We assume minimal recall bias here, but we will confirm the information by triangulating this information with another variables that records the number of weeks of delay when then the delivery occurred (before or after expected date).

Third, information regarding pregnancies that did not end in a live birth was also recorded at every cycle (number, date of the end of pregnancy, number of months were pregnant), as well as abortions (number and time) and hysterectomy. We will use this information as covariates when appropriate.

Prenatal and postnatal behavior history. Beyond number of children and timing, additional details were collected regarding each pregnancy: multiple birth, wantedness, caesarean section, initiation and duration of breastfeeding. This provides valuable information to adjust our quantitative analysis. In addition, health behaviors during pregnancy were assessed starting in 1983. Women were asked to state when they had their first visited a doctor or nurse for prenatal care (which month of the pregnancy), their quantity of alcohol and tobacco consumption, if they reduced or stopped, and their diet intake during pregnancy. If any change occurred in their health behaviors, women were asked whether this was based on a doctor's or nurse's suggestion.

This dataset will therefore allow us to validate some hypotheses about mixed results observed in the literature, though obviously with some limitations. For instance, the impact of physician counselling on GWG was highlighted in the literature: here, while we cannot assume that women who had access to these services were appropriately counselled, we will at least be able to control for this factor, something that was not possible in many of the longer-term longitudinal studies. Moreover, we will use the evidence of a behavioural modification in response to physician counselling as indirect evidence that at least some of these issues were discussed during the clinical encounter. Questions on postnatal infant healthcare and feeding will also allow us to see whether: 1. there is a positive effect of postnatal care on PPWR and 2. whether breastfeeding is related to PPWR. Finally, the repeated measurement (among all women at each cycle) of health behaviors such as the use of birth control pills, physical activity, cigarette and alcohol use will allow us to assess the effects of these practices on GWG and PPWR.

Weight history. Thanks to the expanded fertility section and the general health module that recorded weight on a regular basis, we will reconstruct women's weight history since their inclusion or their first pregnancy (when it occurred at 20 years old or later, but before 1979). Starting in 1983, women were indeed asked to report their weight just before becoming pregnant and just before delivery for each live birth since the previous interview: we will therefore be able to create the GWG for each pregnancy. While recall bias should be low regarding certain information such as age at menarche and dates of birth, it may be more important regarding pregnancy-related weight gain and lost. In total, 748 women had already given birth before 1979 (15.2% of the sub-sample of women included in 1979) and 1814 before 1983 (38.1% of the sub-sample of women interviewed in 1983). Considering only non-teenage pregnancies, these numbers fall to 314 and 1203 respectively.
However, in addition and independent from this fertility supplement, self-reports of respondents' weight were collected in 1981, 1982, 1985, 1986, 1988-1990, 1992-1994, and at every interview since then. This information will allow us to run sensitivity analyses concerning the self-reported weight before pregnancy and at the time of delivery among those women whose pregnancies either began or ended shortly after or before an interview where weight was routinely collected (see next sections for more details). Moreover, as we will perform sensitivity analyses to test the impact of BMI thresholds changes (see next sections for more details), we will explicitly test the extent to which results may or may not be influenced by measurement error or recall bias.
Finally, height was recorded in 1981, 1982, 1983, 1985 and 2006. These repeated measurements will allow us to confidently calculate a height that was reached after puberty (the younger respondents were 20 years old in 1985), and thus after adolescent growth had stopped. We will use the above information to calculate BMI, using the following formula: BMI = kg/m^2 (where 1 pound = 2.2 kg). The WHO's international classification of adult underweight, overweight and obesity according to BMI will be used (See Table 6 in Appendix) [93].
Early life and SES characteristics. Finally, we will take into account the early life SES thanks to parents' birthplace, education, and employment status. We will also consider respondents' demographics (e.g. nationality, ethnicity, year entered the U.S.), as well as marital status and socioeconomic status (educational level, class of worker, partner's occupation, individual and household income) over time.

Statistical Analyses

We previously provided raw, unweighted data to describe some characteristics of the dataset. In order to account for the complex sampling design, the NLSY79 provides cross-sectional weights for each survey round. However, cross-sectional weights are not appropriate for longitudinal analyses as they do not take attrition and mortality into account. We will therefore rely on the NLSY79 Web Investigator Custom Weights software to create our sampling weights (http://www.nlsinfo.org/old-web-investigator/custom_weights.php), and will use those whenever statistical packages allow the use of such weights.
Our **first objective**, namely to **estimate the average time and determinants for reaching a BMI<25 post-pregnancy**, will be reached with the use of **survival analyses** performed with *Stata* 11. We will first describe survival functions thanks to the Kaplan-Meier method among ***primiparous*** women (considering only the first pregnancy). We will define the starting point as the date of first pregnancy and the dependant variable as the number of months between the beginning of the first pregnancy and the first return to a "healthy" BMI of less than 25 (or last interview point). The event will therefore be either experienced (return=1) if the women has reached a BMI of less than 25 or censured (return=0) if there is either a drop out in the study, a new pregnancy or hysterectomy experienced. For ***all parous***

women then, we will describe the survival functions of time to reach to a BMI of less than 25 before the last pregnancy, comparing functions by parity. Here, we will not be able to know the exact date a woman has returned to her pre-pregnancy weight. We will assume that the weight recorded at a date of interview *t* consists of the mean weight between (*t-6 months*) and (*t+6 months*) for annual interviews (from 1983 to 1994) or between (*t-1 year*) and (*t+1 year*) for biennale interviews (from 1996 to 2006). We will run a sensitivity analysis for cases with at least one interview point between first pregnancy and event: we will estimate a model changing the date of event by the date of previous interview and see to what extent the results are sensitive to these modifications.

In a second step, we will then estimate Cox regressions regarding the first pregnancy: we will assess the association with time-invariant (parent's SES, ethnicity, age at menarche, health behaviors and healthcare during pregnancy) as well as time varying variables measured at each interview point (SES, marital status, health behaviors and non-live birth pregnancies). If the number of observed events is too small (i.e. the number of censored is too large), the power of analyses will be reduced. In that case, we will consider the time to reach a given BMI category (underweight, normal, overweight, obese) rather than using the quantitative value. To consider the whole reproductive lifecourse, we will treat repeated pregnancies as distinct observations (each women may therefore contribute to multiple observations, and more specifically to the number of biological child stated). Cluster analyses (based on the individual) will allow us to take into account the non-independent nature of repeated pregnancies.

However, Cox regression assumes that time is measured as a continuous variable and that events can occur at any time. In our study, the time lag between interviews and pregnancies may be non-negligible and therefore needs a discrete time analysis. Here, we will compare both approaches. We will create a new indicator at each interview time of interview *t*. For each women and each time unit *t*, we will code our new dependent variable as 1 if $BMI_t < 25$ (i.e. the event occurs), or 0 otherwise. We will then pool the information, reshape the database in a long format and estimate a logistic regression with time as an independent variable. In the same manner as for Cox regression, we will estimate random-effects logistic models to take into account the repeated pregnancies.

Thanks to one or other of the methods, we will build up the first survival analysis dealing with pregnancy-related weight. BMI will be used here as a categorical variable. However, if there prove to be too few cases where women reach a BMI of less than 25 post-pregnancy, we will also examine another outcome where BMI is continuous. Indeed, as it is well established that weight is more likely to increase with age than to decrease, we will assess whether women at least return to their pre-pregnancy BMI.

Finally in order to achieve our **second objective of assessing potential social inequalities**, interactions with age, SES, ethnicity and parity will be systematically tested in order to decide whether or not to stratify the analysis. For our specific purposes, stratified analyses could be performed when needed by age group, SES, ethnicity and parity.

POTENTIAL LIMITATIONS, VALIDATION & SENSITIVITY ANALYSES

We have addressed many of the limitations of this project (and our response) in the course of our description of the sample, data and analyses above, but some of these merit further consideration here. A major limitation of the NLSY79 data is that it features only self-reported height and weight that could lead to error measurement and be influenced by recall bias. Many studies indeed found that this self-reported information is often biased. Fortunately however, these biases have been examined and found to stem from two sources: 1. the underestimation of weight, with the difference between self-reported and professionally measured weight found to range between -0.85 and -1.64 kg [85-88]; and 2. the overestimation of height, where the between self-reported and measured height was found to range between + 0.40 and +0.79 cm [85-87]. These biases in estimation tend to result in the underestimation of BMI and thus, of obesity. As such, while studies found very high specificity (>0.90), the sensitivity was lower: for instance, only 55% to 77% of obese women were correctly identified [85-87]. As a result, based on European data, some authors have proposed to reduce the BMI cut-off of obesity from 30.0 to 29.2 kg/m^2 when using self-reported information [95]. In our research, we will try to take into account this misestimation and misclassification through several strategies.

We will first perform a thorough internal check for data consistency (over and above what the NLSY79 has already performed, where each question about pregnancy related weight was validated and a flag created when values were deemed unrealistic). We will then validate results through the following set of sensitivity analyses. On the one hand and thanks to the repeated measurement of both height and weight, we will be able to confront data from one wave to another, as well assess the validity of recalled weight pre-pregnancy or post-delivery with routinely collected weight at any interview. Indeed, when a pregnancy occurred in the interval between two survey cycles where weight was collected, we will be able to assess the difference between routine weight information, and the information collected retrospectively as the pre-pregnancy weight or post-delivery weight. Given that we have full information on pregnancies and date of birth, we can assess approximately when these retrospective measurements referred to a period that occurred close in time to an interview. These analyses will allow us to identify potential outliers and discrepancies and assess the extent of bias involved with retrospective weight reports. With this information, we hope to be able to propose a method of adjustment. On the other hand and as previously mentioned, we will use multiple definitions of BMI to ensure that a change in the BMI definition or measurement errors (due to recall or reporting bias) will not dramatically change the direction or the significance of our analysis. Therefore, we intend to validate our analyses by using the following specifications of BMI:

1. Using data calibration: based on the NHANES III, researchers proposed a method to redress the bias of self-reported BMI [96];
2. Implement different cut-offs for BMI categories based on previous recommendations (going further than suggested for obesity [95] and testing all cut-offs ± 1 kg/m^2);
3. Use BMI as a continuous variable.

RESULTS AND DISCUSSION

In progress.

REFERENCES

1. Closing the gap in a generation: Health equity through action on the social determinants of health. Final Report of the Commission on Social Determinants of Health. Geneva: World Health Organization2008.
2. Obesity and overweight. World Health Organization; 2003 [Accessed: Sept 7 2009]; Available from: http://www.who.int/dietphysicalactivity/publications/facts/obesity/en/.
3. Health Canada. Canadian Community Health Survey Cycle 2.2, Nutrition Focus, 2004. Ottawa2006.
4. Statistics related to overweight and obesity. Wieght-control Information Network; 2007 [Accessed: Sept 7 2009]; Available from: http://win.niddk.nih.gov/statistics/#preval.
5. Davis EM, Zyzanski SJ, Olson CM, Stange KC, Horwitz RI. Racial, Ethnic, and Socioeconomic Differences in the Incidence of Obesity Related to Childbirth. Am J Public Health. 2009;99:294-9.
6. Evenson KR, Sarmiento OL, Tawney KW, Macon ML, Ammerman AS. Personal, social, and environmental correlates of physical activity in North Carolina Latina immigrants. American Journal of Preventive Medicine. 2003;25:77-85.
7. Eyler AA, Baker E, Cromer L, King AC, Brownson RC, Donatelle RJ. Physical Activity and Minority Women: A Qualitative Study. Health Educ Behav. 1998;25:640-52.
8. Kuipers YM. Focusing on obesity through a health equity lens: A collection of innovative approaches and promising practices by health promotion bodies in Europe to counteract obesity and improve health equity. Brussels: EuroHealth Net; 2009. Available from: http://www.eurohealthnet.eu/images/stories/DocumentFolder/kuipers_ym_focusing_on_obesity_through_a_health_equity_lens.pdf.
9. Mack KA, Anderson L, Galuska D, Zablotsky D, Holtzman D, Ahluwalia I. Health and Sociodemographic Factors Associated with Body Weight and Weight Objectives for Women: 2000 Behavioral Risk Factor Surveillance System. Journal of Women's Health. 2004;13:1019-32.
10. McLaren L. Socioeconomic Status and Obesity. Epidemiol Rev. 2007;29:29-48.
11. Sobal J, Stunkard AJ. Socioeconomic Status and Obesity - A Review of the Literature. Psychological Bulletin. 1989;105:260-75.
12. Wardle J, Waller J, Jarvis MJ. Sex Differences in the Association of Socioeconomic Status With Obesity. American Journal of Public Health. 2002;92:1299-304.
13. Frischknecht F, Bruhwiler H, Raio L, Luscher KP. Changes in pre-pregnancy weight and weight gain during pregnancy: retrospective comparison between 1986 and 2004. Swiss Med Wkly. 2009;139:52-5.
14. National Center for Health Statistics. Health, United States, 2008. Hyattsville, MD: U.S. Department of Health and Human Services. Centers for Disease Control and Prevention.2009.
15. Wardle J, Griffith J. Socioeconomic status and weight control practices in British adults. J Epidemiol Community Health. 2001;55:185-90.
16. Cogswell ME, Perry GS, Schieve LA, Dietz WH. Obesity in women of childbearing age: risks, prevention, and treatment. Primary Care Update for OB/GYNS. 2001;8:89-105.
17. Yilmaz N, Kilic S, Kanat-Pektas M, Gulerman C, Mollamahmutoglu L. The Relationship between Obesity and Fecundity. Journal of Women's Health. 2009;18:633-6.
18. Ehrenberg HM, Dierker L, Milluzzi C, Mercer BM. Prevalence of maternal obesity in an urban center. American Journal of Obstetrics and Gynecology. 2002;187:1189-93.

19. Guelinckx I, Devlieger R, Beckers K, Vansant G. Maternal obesity: pregnancy complications, gestational weight gain and nutrition. Obesity Reviews. 2008;9:140-50.
20. Heslehurst N, Simpson H, Ells LJ, Rankin J, Wilkinson J, Lang R, et al. The impact of maternal BMI status on pregnancy outcomes with immediate short-term obstetric resource implications: a metaanalysis.
Obes Rev. 2008;9:635-83.
21. Olson CM, Strawderman MS. Modifiable behavioral factors in a biopsychosocial model predict inadequate and excessive gestational weight gain. Journal of the American Dietetic Association. 2003;103:48-54.
22. Wells C, Schwalberg R, Noonan G, Gabor V. Factors Influencing Inadequate and Excessive Weight Gain in Pregnancy: Colorado, 2000–2002. Maternal and Child Health Journal. 2006;10:55-62.
23. Walker LO, Timmerman G, Sterling BS, Kim M, Dickson P. Do low-income women attain their pre-pregnant weight by the 6th week postpartum? Ethnicity & Disease. 2004;14:161-2.
24. Harris HE, Ellison GTH, Richter LM, De Wet T, Levin J. Are overweight women at increased risk of obesity following pregnancy? British Journal of Nutrition. 1998;79:489-94.
25. Rooney BL, Schauberger C. Excess Pregnancy Weight Gain and Long-Term Obesity: One Decade Later. Obstetrics & Gynecology. 2002;100:245-52.
26. Rössner S, Ohlin A. Pregnancy as a risk factor for obesity: lessons from the Stockholm Pregnancy and Weight Development Study. Obes Res. 1995;3 267s-75s.
27. Abrams B. Prenatal weight gain and postpartum weight retention: a delicate balance. Am J Public Health. 1993;83:1082-4.
28. Institute of Medicine. Nutrition During Pregnancy. Washington, D.C.: National Academy Press; 1990.
29. Institute of Medicine. Weight Gain During Pregnancy: Reexamining the Guidelines2009: Available from: http://www.iom.edu/?ID=68004.
30. Brawarsky P, Stotland NE, Jackson RA, Fuentes-Afflick E, Escobar GJ, Rubashkin N, et al. Pre-pregnancy and pregnancy-related factors and the risk of excessive or inadequate gestational weight gain. International Journal of Gynecology & Obstetrics. 2005;91:125-31.
31. Caulfield LE, Witter FR, Stoltzfus RJ. Determinants of gestational weight gain outside the recommended ranges among black and white women. Obstetrics and Gynecology. 1996;87:760-6.
32. National Research Council, Institute of Medicine. Influence of Pregnancy Weight on Maternal and Child Health. Workshop Report. Washington: The National Academies Press; 2007. Available from: http://www.nap.edu/catalog.php?record_id=11817.
33. Chasan-Taber L, Schmidt MD, Pekow P, Sternfeld B, Solomon CG, Markenson G. Predictors of Excessive and Inadequate Gestational Weight Gain in Hispanic Women. Obesity. 2008;16:1657-66.
34. Abrams B, Carmichael S, Selvin S. Factors Associated With the Pattern of Maternal Weight-Gain during Pregnancy. Obstetrics and Gynecology. 1995;86:170-6.
35. Hickey CA. Sociocultural and behavioral influences on weight gain during pregnancy. Am J Clin Nutr. 2000;71:1364S-70.
36. Davis EM, Olson C. Obesity in Pregnancy. Primary Care: Clinics in Office Practice. 2009;36:341-56.
37. Hickey CA, Uauy R, Rodriquez LM, Jennings LW. Biosocial predictors of maternal weight near term among low-income black and hispanic women. Nutrition Research. 1992;12:337-52.
38. Cogswell ME, Scanlon KS, Fein SB, Schieve LA. Medically Advised, Mother's Personal

Target, and Actual Weight Gain During Pregnancy. Obstetrics & Gynecology. 1999;94:616-22.
39. Strychar IM, Chabot C, Champagne F, Ghadirian P, Leduc L, Lemonnier M-C, et al. Psychosocial and Lifestyle Factors Associated with Insufficient and Excessive Maternal Weight gain during Pregnancy. Journal of the American Dietetic Association. 2000;100:353-6.
40. Hickey CA, Uauy R, Rodriguez L, Jennings L. Maternal weight gain in low-income black and Hispanic women: evaluation by use of weight-for-height near term. Am J Clin Nutr. 1990;52:938-43.
41. Helms E, Coulson CC, Galvin SL. Trends in weight gain during pregnancy: a population study across 16 years in North Carolina. Am J Obstet Gynecol. 2006;194.
42. Cogswell ME, Serdula MK, Hungerford DW, Yip R. Gestational Weight-Gain Among Average-Weight and Overweight Women - What Is Excessive? American Journal of Obstetrics and Gynecology. 1995;172:705-12.
43. Johnston EM. Weight Changes During Pregnancy and The Postpartum Period. Progress in Food and Nutrition Science. 1991;15:117-57.
44. Schieve LA, Cogswell ME, Scanlon KS. An empiric evaluation of the institute of medicine's pregnancy weight gain guidelines by race. Obstetrics and Gynecology. 1998;91:878-84.
45. Thorsdottir I, Birgisdottir B. Different weight gain in women of normal weight before pregnancy: Postpartum weight and birth weight. Obstetrics & Gynecology. 1998;92:377-83.
46. Galtier-Dereure F, Boegner C, Bringer J. Obesity and pregnancy: complications and cost. Am J Clin Nutr. 2000;71:1242S-8.
47. Hutcheon JA, Platt RW. The impact of past pregnancy experience on subsequent perinatal outcomes. Paediatr Perinat Epidemiol. 2008;22:400-8.
48. Hutcheon JA, Platt RW, Meltzer SJ, Egeland GM. Is birth weight modified during pregnancy? Using sibling differences to understand the impact of blood glucose, obesity, and maternal weight gain in gestational diabetes. Am J Obstet Gynecol. 2006;195:488-94.
49. Mesman I, Roseboom TJ, Bonsel GJ, Gemke RJ, van der Wal MF, Vrijkotte TG. Maternal prepregnancy
body mass index explains infant's weight and BMI at 14 months: results from a multi-ethnic birth cohort study. Arch Dis Child. 2009.
50. Schmitt NM, Nicholson WK, Schmitt J. The association of pregnancy and the development of obesity - results of a systematic review and meta-analysis on the natural history of postpartum weight retention. International Journal of Obesity. 2007;31:1642-51.
51. Walker LO. Managing Excessive Weight Gain During Pregnancy and the Postpartum Period. Journal of Obstetric, Gynecologic, & Neonatal Nursing. 2007;36:490-500.
52. Ohlin A, Rössner S. Maternal body weight development after pregnancy. Int J Obes. 1990;14:159-73.
53. Dugdale AE, Eaton-Evans J. The Effect of Lactation and Other Factors on Post-Partum Changes In Body-Weight and Triceps Skinfold Thickness. British Journal of Nutrition. 1989;61:149-53.
54. Walker LO, Freeland-Graves J. Lifestyle Factors Related to Postpartum Weight Gain and Body Image in Bottle- and Breastfeeding Women. Journal of Obstetric, Gynecologic, & Neonatal Nursing. 1998;27:151-60.
55. Walker LO, Freeland-Graves JH, Milani T, George G, Hanss-Nuss H, Kim M, et al. Weight and Behavioral and Psychosocial Factors Among Ethnically Diverse, Low-Income Women After Childbirth: II. Trends and Correlates. Women & Health. 2004;40:19-34.

56. Crowell DT. Weight change in the postpartum period: A review of the literature. Journal of Nurse-Midwifery. 1995;40:418-23.
57. Gunderson EP, Abrams B, Selvin S. The relative importance of gestational gain and maternal characteristics associated with the risk of becoming overweight after pregnancy. International Journal of Obesity. 2000;24:1660-8.
58. Lederman SA. Pregnancy weight gain and postpartum loss: avoiding obesity while optimizing the growth and development of the fetus. J Am Med Womens Assoc. 2001;56:53-8.
59. Wolfe W, Sobal J, Olson C, Jr EF, Williamson D. Parity-associated weight gain and its modification by sociodemographic and behavioral factors: a prospective analysis in US women. International Journal of Obesity. 1997;21:802-10.
60. Greene GW, Scholl TO. Postpartum weight change: How much of the weight gained in pregnancy will be lost after delivery? Obstetrics & Gynecology. 1988;71:701-7.
61. Gunderson EP, Abrams B. Epidemiology of Gestational Weight Changes After Pregnancy. Epidemiol Rev. 2000;22:261-74.
62. Herman A, Yu K. Adolescent age at first pregnancy and subsequent obesity. Paediatric and Perinatal Epidemiology. 1997;11:130-41.
63. Harris HE, Ellison GTH, Clement S. Do the psychosocial and behavioral changes that accompany motherhood influence the impact of pregnancy on long-term weight gain? Journal of Psychosomatic Obstetrics and Gynecology. 1999;20:65-79.
64. Ohlin A, Rössner S. Trends in eating patterns, physical-activity and sociodemographic factors in relation to postpartum body-weight development. British Journal of Nutrition. 1994;71:457-70.
65. Clarke KK, Freeland-Graves J, Klohe-Lehman DM, Bohman TM. Predictors of Weight Loss in Low-Income Mothers of Young Children. Journal of the American Dietetic Association. 2007;107:1146-54.
66. George GC, Milani TJ, Hanss-Nuss H, Freeland-Graves JH. Compliance with Dietary Guidelines and Relationship to Psychosocial Factors in Low-Income Women in Late Postpartum. Journal of the American Dietetic Association. 2005;105:916-26.
67. Klohe-Lehman DM, Freeland-Graves J, Anderson ER, McDowell T, Clarke KK, Hanss-Nuss H, et al. Nutrition Knowledge Is Associated with Greater Weight Loss in Obese and Overweight Low-Income Mothers. Journal of the American Dietetic Association. 2006;106:65-75.
68. Nuss H, Freeland-Graves J, Clarke K, Klohe-Lehman D, Milani TJ. Greater Nutrition Knowledge Is Associated with Lower 1-Year Postpartum Weight Retention in Low-Income Women. Journal of the American Dietetic Association. 2007;107:1801-6.
69. Murphy SP, Abrams BF. Changes in energy intakes during pregnancy and lactation in a national sample of US women. Am J Public Health. 1993;83:1161-3.
70. Hinton PS, Olson CM. Postpartum Exercise and Food Intake: The Importance of Behavior-Specific Self-efficacy. Journal of the American Dietetic Association. 2001;101:1430-7.
71. Shrewsbury VA, Robb KA, Power C, Wardle J. Socioeconomic differences in weight retention, weight-related attitudes and practices in postpartum women. Matern Child Health J. 2009;13:231-40.
72. Wilkinson S, Huang C-M, Walker LO, Sterling BS, Kim M. Physical Activity in Low-Income Postpartum Women. Journal of Nursing Scholarship. 2004;36:109-14.
73. Jordan KC, Freeland-Graves JH, Klohe-Lehman DM, Cai G, Voruganti VS, Proffitt JM, et al. A nutrition and physical activity intervention promotes weight loss and enhances diet attitudes in lowincome

mothers of young children. Nutrition Research. 2008;28:13-20.
74. Rooney BL, Schauberger CW, Mathiason MA. Impact of perinatal weight change on long-term obesity and obesity-related illnesses. Obstetrics and Gynecology. 2005;106:1349-56.
75. Rookus M, Rokebrand P, J. B, Deurenberg P. The effect of pregnancy on the body mass index 9 months postpartum in 49 women. Int J Obes. 1987;11:609-18.
76. Maximova K, McGrath JJ, Barnett T, O'Loughlin J, Paradis G, Lambert M. Do you see what I see? Weight status misperception and exposure to obesity among children and adolescents. Int J Obes (Lond). 2008;32:1008-15.
77. Billewicz WZ. Body weight in parous women. Br J Prev Soc Med. 1970;24:97-104.
78. Williamson D, Madans J, Pamuk E, Flegal K, Kendrick J, Serdula M. A prospective study of childbearing and 10-year weight gain in US white women 25 to 45 years of age. International Journal of Obesity & Related Metabolic Disorders. 1994;18:561-9.
79. Amorim AR, Rossner S, Neovius M, Lourenco PM, Linne Y. Does Excess Pregnancy Weight Gain Constitute a Major Risk for Increasing Long-term BMI? Obesity. 2007;15:1278-86.
80. Linné Y, Dye L, Barkeling B, Rössner S. Long-Term Weight Development in Women: A 15-Year Follow-up of the Effects of Pregnancy. Obesity. 2004;12:1166-78.
81. Linné Y, Rössner S. Interrelationships between weight development and weight retention in subsequent pregnancies: the SPAWN study. Acta Obstetricia et Gynecologica Scandinavica. 2003;82:318-25.
82. Linné Y, Dye L, Barkeling B, Rössner S. Weight development over time in parous women--the SPAWN study--15 years follow-up. Int J Obes Relat Metab Disord. 2003;27:1516-22.
83. Gore S, Brown D, West D. The role of postpartum weight retention in obesity among women: A review of the evidence. Annals of Behavioral Medicine. 2003;26:149-59.
84. Harris HE, Ellison GTH. Do the changes in energy balance that occur during pregnancy predispose parous women to obesity? Nutrition Research Reviews. 1997;10:57-81.
85. Bostrom G, Diderichsen F. Socioeconomic differentials in misclassification of height, weight and body mass index based on questionnaire data. Int J Epidemiol. 1997;26:860-6.
86. Spencer EA, Appleby PN, Davey GK, Key TJ. Validity of self-reported height and weight in 4808 EPIC-Oxford participants. Public Health Nutr. 2002;5:561-5.
87. Niedhammer I, Bugel I, Bonenfant S, Goldberg M, Leclerc A. Validity of self-reported weight and height in the French GAZEL cohort. Int J Obes. 2000;24:1111-8.
88. Kuczmarski MF, Kuczmarski RJ, Najjar M. Effects of age on validity of self-reported height, weight, and body mass index: Findings from the third National Health and Nutrition Examination Survey, 1988-1994. J Am Diet Assoc. 2001;101:28-34.
89. Quesnel-Vallee A, Taylor M, editors. Pathways from parental education to adult trajectories of depressive symptoms2006: Oxford Univ Press Inc.
90. Center for Human Resource Research. NLSY79 USER'S GUIDE. A Guide to the 1979-2006 National Longitudinal Survey of Youth Data,. 2008; Available from: http://www.nlsinfo.org/nlsy79/docs/79html/79text/front.htm.
91. Howie LD, Parker JD, Schoendorf KC. Excessive maternal weight gain patterns in adolescents. Journal of the American Dietetic Association. 2003;103:1653-7.
92. Quesnel-Vallee A, Morgan P. “Missing the target? Correspondence of Fertility Intentions and Behavior in the U.S. Population Research and Policy Review. 2004;22:497-525.
93. World Health Organization. Global database on body mass index. 2009; Available from:

http://apps.who.int/bmi/index.jsp.
94. Platt RW, Schisterman EF, Cole SR. Time-modified confounding. Am J Epidemiol. 2009;170:687-94.
95. Dauphinot V, Wolff H, Naudin F, Gueguen R, Sermet C, Gaspoz JM, et al. New obesity body mass index threshold for self-reported data. J Epidemiol Community Health. 2009;63:128-32.
96. Cawley J, Burkhauser RV. BEYOND BMI: THE VALUE OF MORE ACCURATE MEASURES OF FATNESS AND OBESITY IN SOCIAL SCIENCE RESEARCH. Cambridge, MA: NATIONAL BUREAU OF ECONOMIC RESEARCH. Working Paper 122912006.
97. Cresson G. Les soins profanes et la division du travail entre hommes et femmes. In: Aïach et al, editor. Femmes et hommes dans le champ de la santé. Rennes: ENSP; 2001.
98. Lederman SA, Alfasi G, Deckelbaum RJ. Pregnancy-Associated Obesity in Black Women in New York City. Maternal and Child Health Journal. 2002;6:37-42.
99. Boardley D, Sargent R, Coker A, Hussey J, Sharpe P. The relationship between diet, activity, and other factors, and postpartum weight change by race. Obstetrics & Gynecology. 1995;86:834-8.
100. Olson CM, Strawderman MS, Hinton PS, Pearson TA. Gestational weight gain and postpartum behaviors associated with weight change from early pregnancy to 1 y postpartum. International Journal of Obesity & Related Metabolic Disorders. 2003;27:117-27.
101. Gunderson EP, Abrams B, Selvin S. Does the pattern of postpartum weight change differ according to pregravid body size? International Journal of Obesity. 2001;25:853-62.
102. Gunderson EP, Murtaugh MA, Lewis CE, Quesenberry CP, West DS, Sidney S. Excess gains in weight and waist circumference associated with childbearing: The Coronary Artery Risk Development in Young Adults Study (CARDIA). International Journal of Obesity. 2004;28:525-35.
103. Rosenberg L, Palmer JR, Wise LA, Horton NJ, Kumanyika SK, Adams-Campbell LL. A Prospective Study of the Effect of Childbearing on Weight Gain in African-American Women. Obesity. 2003;11:1526-35.
104. Parker JD. Postpartum Weight Change. Clinical Obstetrics and Gynecology. 1994;37:528-37.
105. Polley BA, Wing RR, Sims CJ. Randomized controlled trial to prevent excessive weight gain in pregnant women. International Journal of Obesity. 2002;26:1494-502.
106. Siega-Riz AM, Evenson KR, Dole N. Pregnancy-related weight gain - A link to obesity? Nutrition Reviews. 2004;62:S105-S11.
107. Walker LO, Sterling BS, Timmerman GM. Retention of Pregnancy-Related Weight in the Early Postpartum Period: Implications for Women's Health Services. JOGNN: Journal of Obstetric, Gynecologic, & Neonatal Nursing. 2005;34:418-27.
108. Siega-Riz AM, Hobel CJ. Predictors of poor maternal weight gain from baseline anthropometric, psychosocial, and demographic information in a Hispanic population. Journal of the American Dietetic Association. 1997;97:1264-8.
109. Konno SC, Benicio MHD, Barros AJD. Factors associated to the evolution of gestational weight of pregnant women: a multilevel analysis. Revista De Saude Publica. 2007;41:995-1002.
110. Arroyo P, Avila-Rosas H, Fernández V, Casanueva E, Galván D. Parity and the prevalence of overweight. International Journal of Gynecology & Obstetrics. 1995;48:269-72.
111. Lederman SA. The effect of pregnancy weight gain on later obesity. Obstetrics & Gynecology. 1993;82:148-55.
112. Olsen LC, Mundt MH. Postpartum weight loss in a nurse-midwifery practice. Journal of Nurse-Midwifery. 2005;31:177-81.

113. Parker JD, Abrams B. Differences in postpartum weight retention between black and white mothers. Obstetrics & Gynecology. 1993;81:768-74.
114. Baker C, Carter A, Cohen L, Brownell K. Eating attitudes and behaviors in pregnancy and postpartum: Global stability versus specific transitions. Annals of Behavioral Medicine. 1999;21:143-8.
115. Walker LO, Sterling BS, Kim M, Arheart KL, Timmerman GM. Trajectory of Weight Changes in the First 6 Weeks Postpartum. Journal of Obstetric, Gynecologic, & Neonatal Nursing. 2006;35:472-81.
116. Smith DE, Lewis CE, Caveny JL, Perkins LL, Burke GL, Bild DE. Longitudinal Changes in Adiposity Associated With Pregnancy: The CARDIA Study. JAMA. 1994;271:1747-51.
117. Hickey CA, Kreauter M, Bronstein J, Johnson V, McNeal SF, Harshbarger DS, et al. Low Prenatal Weight Gain Among Adult WIC Participants Delivering Term Singleton Infants: Variation by Maternal and Program Participation Characteristics. Maternal and Child Health Journal. 1999;3:129-40.
118. Schauberger C, Rooney B, Brimer L. Factors that influence weight loss in the puerperium. Obstetrics & Gynecology. 1992;79:424-9.
119. Ellison GTH, Harris HE. Gestational weight gain and 'maternal obesity'. Nutrition Bulletin. 2000;25:295-302.
120. Downs DS, Hausenblas HA. Women's exercise beliefs and behaviors during their pregnancy and postpartum. Journal of Midwifery & Women's Health. 2004;49:138-44.
121. Devine CM, Bove CF, Olson CM. Continuity and change in women's weight orientations and lifestyle practices through pregnancy and the postpartum period: the influence of life course trajectories and transitional events. Social Science & Medicine. 2000;50:567-82.
122. Blum JW, Beaudoin CM, Caton-Lemos L. Physical Activity Patterns and Maternal Well-Being in Postpartum Women. Maternal and Child Health Journal. 2004;8:163-9.
123. Chang M-W, Nitzke S, Guilford E, Adair CH, Hazard DL. Motivators and Barriers to Healthful Eating and Physical Activity among Low-Income Overweight and Obese Mothers. Journal of the American Dietetic Association. 2008;108:1023-8.
124. Records K, Keller C, Ainsworth B, Permana PA. Overweight and obesity in postpartum Hispanic women. Health Care for Women International. 2008;29:649-67.
125. Thornton PL, Kieffer EC, Salabarría-Peña Y, Odoms-Young A, Willis SK, Kim H, et al. Weight, Diet, and Physical Activity-Related Beliefs and Practices Among Pregnant and Postpartum Latino Women: The Role of Social Support. Maternal & Child Health Journal. 2006;10:95-104.
126. Ayanian JZ, Weissman JS, Schneider EC, Ginsburg JA, Zaslavsky AM. Unmet health needs of uninsured adults in the United States. JAMA. 2000;284:2061-9.