ORIGINAL PAPER

Implications of Gestational Weight Gain as A Modifiable Risk Factor for Obesity in Mother and Child

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Abstract

Background: Obesity is a growing public health concern in the United States with 17.1% and 33.2% of children and women obese and many more at risk for becoming obese. Many obese women have regarded pregnancy as the onset of extreme weight gain, thus efforts to identify the relationship between pregnancy and obesity have been made.
Objective: The purpose of this paper was to examine the relationship between gestational weight gain and maternal obesity, as well as offspring birthweight and subsequent obesity. Method: An online search was performed through Pubmed and Academic Search Premiere for relevant articles. Retrieved articles were assessed based on their relevance to the paper.
Results: This review of the literature determined that the larger the gestational weight gain, the higher the risk for obesity in the mother and child. This is especially true with reference to the gestational weight gain guidelines, and is mostly consistent regardless of limitations in the research. With improvement in many methodological areas, future research can identify the relationship and mechanism explaining the relationship between gestational weight gain to obesity.
Conclusion: These results have a large clinical implication, where more emphasis on education of gestational weight gain guidelines, and exercise and nutritional considerations should be implemented to improve in this area of public health. Gestational weight gain is a potential risk factor for maternal and child obesity and should be examined further due to its long term relevance to obesity.

Key words: obesity, overweight, gestational weight gain, perinatal, birthweight, child, mother, pregnancy

Introduction

Obesity is defined as a body mass index (BMI) above the 95th percentile or greater than 30 for children and adults respectively. It has become a growing health concern within the United States due to its prevalence in all ages and genders. In the United States, 17.1% of children between the ages of 2 and 19 are obese along with 33.2% of adult women, according to results of the National Health and Nutrition Examination Survey (NHANES) (Ogden et al., 2006). Not only is there a large obesity concern, many women and children are overweight and at risk for becoming obese. Overweight groups are defined as a BMI above the 85th percentile or greater than 25 for children and adults respectively. These at-risk groups consist of 33.6% of children ages 2 to 19 and 61.8% of adult women. Not only does obesity affect a large portion of the population, the prevalence is increasing

yearly (Ogden et al., 2006). Obesity decreases the quality of life, and is a large risk factor for chronic diseases such as metabolic syndrome, cardiovascular disease, type II diabetes mellitus, hyperlipidemia, and hypertension, which ultimately all increase risk of mortality (Crawford et al., 2010).

Among many contributing factors for obesity, many obese women associate onset of their long term excessive weight gain with pregnancy (Bradley, 1985). This has been documented anecdotally and has stimulated research on pregnancy and its long term effects on weight status (Bradley, 1985; Rössner, 1992). Due to the speculation that weight gained during pregnancy, known as gestational weight gain, may be related to the development of obesity, guidelines have been set to optimize fetal growth and maternal health. The Institute of Medicine's (IOM) guidelines for gestational weight gain were published in 1990 and suggest a continuum of the effects of weight gain on the mother and child. Gaining too little weight is associated with increased pregnancy complications such as premature delivery, small for gestational age infants, and low birthweight. Gaining too much weight is related to a higher risk of preeclampsia, gestational diabetes, increased risk of cesarean delivery, difficulty in postpartum weight loss, and large for gestational age infants (Rasmussen & Yaktine, 2009). Due to these known risks, there has been more research on the relationship between gestational weight gain and long term health of the mother and child (Rössner & Öhlin, 1995).

If gestational weight gain can be determined as one starting point for obesity, improving communication about guidelines and methods of controlling gestational weight gain may be a probable preventative measure for obesity. The objective of this review is to discuss the current literature on the effects of gestational weight gain on the short and long term weight status of the mother along with its relationship to birthweight and long term weight status of the child and the clinical implications of this health phenomenon.

Methods

Relevant publications were identified by the online databases, Pubmed and Academic Search Premiere and retrieved publications were searched for relevant citations. Search terms used were 'pregnancy', 'postpartum', 'mother', 'maternal', 'child', 'obesity', 'long-term', 'short-term', 'weight retention', 'gestational weight gain', and 'birthweight'. Included papers were published after 1990 with gestational weight gain as an independent variable. Other desired variables were short term weight retention or long term weight gain in the mother, and birthweight or obesity risk in the child. A total of 16 studies were included in this review.

Gestational Weight Gain and Postpartum Weight Retention

Weight gain during pregnancy is necessary to ensure proper growth and development of the fetus, accounting for the growth of the child and breasts, increasing protein and fat stores, placenta and uterus growth, amniotic fluid, and increased blood volume and body fluids (ACOG Ed. Pamphlet AP001, 2008). Although these aspects of growth are standard, underweight and overweight women are at risk for pregnancy complications such as gestational diabetes, preeclampsia, or delivery emergencies (Weissgerber et al., 2006). Weight gain ranges optimize fetal growth and minimize the obstetric risks associated with excessively high or low weight gain (Rasmussen & Yaktine, 2009)

Table 1: Demographic characteristics of the sample

Weight Category	BMI (kg • m^{-2})	Suggested Gain (lb.)
Underweight	<18.5	28-40
Normal Weight	18.5- 24.9	25-35
Overweight	25-29.9	15-25
Obese	>30	11-20

Aside from the importance of gestational weight gain for proper growth and outcome of the pregnancy, it has also been related to weight retention postpartum and has been examined with respect to short term weight retention and long term weight gain postpartum (Gore et al., 2003).

Short Term Weight Retention

Short term research examines weight retention up to one year postpartum because most weight loss happens in this first year and further loss becomes increasingly difficult (Gore et al., 2003). Due to the relevance of short term weight retention, these studies provide a foundation for the relationship between gestational weight gain and postpartum weight retention (Table 2).

Postpartum weight retention has been reported to be higher in women who gain more during pregnancy. Keppel & Taffel (1993) found that women retained 0.9 lb., 1.6 lb., and 4.9 lb. for those who gained less than, according to, or in excess of the recommendations at 10-18 months postpartum. Another study had comparable results where women retained 0.4 lb., 3.7 lb., and 13.5 lb. for gestational weight gains less than, according to, or in excess of the recommendations (Walker, 1996).

Table 2. Short Term Weight Retention

Study	N	Length of Follow- Up (months)	Average Weight Retention (lb.)	Excessive Gain (%)	Variables
Keppel &Taffel, 1993	1,592k	10-18	W: 4.9 B: 12.7	36%	GWG, weight loss, WR, race
Walker, 1996	88	6, 18	6 mo: 7.3 ± 13.2 18 mo: 5.1 ±14.6	41%	GWG, WR, demographics, reproductive variables, lifestyle
Lederman et al., 2002	47	2-6	B: 2 mo: 18.2± 15.6 6 mo: 17.2 ± 14.1	64%	GWG, WR, breast-feeding
Huang & Dai, 2007	602	6	6 mo: 5.3± 7.9	N/A	GWG, WR, demographics, lifestyle profile
Olson et al., 2003	597	6, 12	6 mo: not reported 12 mo: 3.32 ± 13.1	42%	GWG, WR, food intake, exercise, breast-feeding

W= white, B= black, GWG= gestational weight gain, WR= weight retention

An augmented relationship has been observed for obese, black, minority, and women of low income status. A study of obese women determined that up to 70% gained excessively, and weight retention was up to 98 lb. (Vesco et al., 2009). Studies have shown up to 64% of black women excessively gain and retain up to 17.2 lb. at 6 months (Lederman et al., 2002). Lederman and colleagues (2002) also reported 42% of black women gained weight between 2 and 6 months instead of losing it, with almost 20% progressing to obesity. This augmented relationship was similar to the higher retention of up to 12.7 lb. in the black participants of Keppel & Taffel (1993). Race and minority status also increased likelihood of gaining excessively during pregnancy and failing to lose the weight postpartum, according to Walker (1996).

The higher the gestational weight gain, the more weight the mother has to lose postpartum and the higher her chances of retaining and gaining more weight postpartum. This causes a risk for women becoming obese in the short term due to pregnancy. Studies determined a 9.3% increase in obesity in a Taiwanese cohort and up to 20% in a black cohort of women (Huang & Dai, 2007; Lederman et al., 2002). Although not categorized as obesity, Olson et al. (2003) reported 25.6% of their participants retained more than 10 lb. at 1 year postpartum, even though on average weight retention was only 3.32 lb.

Most short term studies identified gestational weight gain as a key factor in short term weight retention with an augmented relationship in obese, black, and minority populations (Keppel & Taffel,

1993; Walker, 1996; Lederman et al., 2002; Huang & Dai, 2007; Olson et al., 2003). If gestational weight gain has an influence on postpartum weight retention, and may confirm the reports that obesity may originate from pregnancy, gestational weight gain is an important factor when exploring obesity prevention (Bradley, 1985).

Long Term Weight Gain

Due to the potential obesity risk of excessive gestational weight gain, its impact must be examined in the long term. Although important only three studies examine these long term weight changes (Table 3). The Stockholm Pregnancy and Women's Nutrition (SPAWN) study was a 15 year follow up of women who delivered children during 1984-85 in Stockholm (Linné et al., 2003). Women were grouped according to obese or normal weight at long term follow up and their gestational weight gains were compared. Of the women who were normal weight at long term, 64% had returned to 3.3 lb. of their pre-pregnancy weight by 1 year postpartum. The women who were obese at follow up had significantly higher gestational weight gains ($p<0.0001$). A shorter 10 year study showed long-term weight was related to gestational weight gain appropriateness and short-term retention where Women who gained as recommended retained only 4.0 lb. by 6 months and 14.3 lb. over 10 years, while the excessive gainers retained 9.2 lb. over short term and gained 18.5 lb. long term (Rooney & Schauberger, 2002).

Table 3. Long Term Weight Gain

Study	N	Length of Follow- Up	Average Long Term Weight Gain (lb.)
Linné et al., 2003	**563**	**15 years**	**24.5 ± 14.3**
Rooney & Schauberger, 2002	**795**	**10 years**	**13.9**
Harris et al., 1997	**243**	**~3**	**3.4**

Harris et al. (1997) examined weight change between an index pregnancy and a second pregnancy in order to determine the effect of one pregnancy on long term weight gain. Maternal weight was corrected for the effect of aging, which was based on the average weight gained per month between pregnancies. After the aging correction results showed only 3.4 lb. Retention, however the average follow up time was only 3 years. This is more comparable to a short term follow up by Olson et al. (2003) where retention was 3.32 lb. at 12 months. Although aging may play a role in long term weight gain, this follow up tends toward short term and the corrections were original and may have underestimated the relationship.

Gestational Weight Gain and Child Implications

Due to the implications of gestational weight gain as a risk factor for obesity in the mother, research has examined its relationship to obesity risk in the offspring (Table 4).

The relationship between gestational weight gain and offspring obesity has first been related to offspring birthweight. The World Health Organization (WHO) has published weight ranges for low, normal, and high birthweight or macrosomia where both low and high birthweight have various health risks. Schack-Nielsen et al. (2010) determined that for every 4.4 lb. increase in gestational weight gain, the average birthweight increased significantly as well.

One study also determined that women exceeding the IOM guidelines were 765 more likely to have macrosomic babies. (Frederick et al., 2008). This relationship was also confirmed when a study determined that women grouped as high gestational weight gains had significantly larger babies (Gümüs et al., 2010).

With such a high and increasing prevalence of childhood and adult obesity, research has examined prenatal characteristics such as maternal gestational weight gain, birthweight, and weight status as potential risk factors (Ogden et al., 2006) (Table 5). A study on a Greek cohort of preschool children determined that high birthweight was significantly related to overweight status at 6 and 12 months old and between 3 and 5 years of age (Mochonis et al., 2008). Of mothers who gained excessively during pregnancy, 48% of their offspring were obese at 3 years compared to only 23.7% of the offspring from mothers who gained appropriately with a stronger trend with increasing maternal BMI (Olson et al., 2008).

Table 4. Gestational Weight Gain and Birthweight

Study	N	Findings
Gümüs et al., 2010	**537**	**BW and macrosomia were more common in the higher GWG group**
Frederick et al., 2008	**2670**	**Above GWG range resulted in an increased risk of a macrosomic infant**
Schack-Nielsen et al., 2010	**4234**	**BW was significantly associated with GWG**

BW= birthweight, GWG= gestational weight gain

Table 5. Gestational Weight Gain and Offspring Obesity

Study	N	Length of Follow- Up	Findings
Olson et al., 2008	**208**	**6 mo., 3 years**	**Excessive GWG is related to Ob, BW was related to Ob**
Schack-Nielsen et al., 2010	**4234**	**1-14, 42 years**	**High GWG contributed to half of Ob, modulated by BW and childhood Ob**
Stuebe et al., 2009	**26,506**	**36-56 years**	**Strong relationship of GWG to Ob in obese mothers, Moderate GWG effects on Ob in normal mothers**
Gunnarsdottir et al., 2004	**3708**	**50 ± 8 years**	**BW was associated with Ob, though higher BW did not mean a higher risk of Ob**
Mochonis et al., 2008	**2374**	**1-5 years**	**BW was related to Ob at 6 and 12 months, 3-5 years**
Araújo et al., 2009	**5160**	**11 years**	**Highest BW group had highest Ob, BW more effective than length or ponderal index at predicting Ob**

Ob= offspring obesity, GWG= gestational weight gain

The relationship between birthweight and late childhood and adult BMI has also been examined, where birthweight was the best predictor of obesity at 11 years of age when compared to length at birth

and ponderal index in a cohort of Brazilian infants (Araújo et al., 2009). Gestational weight gain was attributed to half of the cause of adult obesity, mediated through birthweight and childhood BMI in a study that followed offspring at 14 years and into adulthood (Schack-Nielsen et al., 2010). Gunnarsdottir et al. (2004) found a positive association between birthweight and adult BMI, though did not find an increased risk for obesity however this may be due to the general trend of the Icelandic population to have high birthweight but less prevalence of obesity than in the United States (Ogden et al., 2006). Adult BMI was found to be related to both extremes of gestational weight gain in a cohort of female nurses (Stuebe et al., 2009).

Gestational weight gain influences birthweight, where a higher than recommended gestational weight gain leads to a higher birthweight (Gümüs et al., 2010; Frederick et al., 2008; Schack-Nielsen et al., 2010). Further research has shown a link between a child's birthweight, childhood obesity risk, and even adult obesity risk (Stuebe et al., 2009; Schack-Nielsen et al., 2010; Gunnarsdottir et al., 2004; Araújo et al., 2009; Mochonis et al., 2008). Not only is gestational weight gain related to maternal weight status, but is related to childhood weight status and risk for offspring obesity as well.

Discussion

The research that examines gestational weight gain with reference to maternal and child future weight outcomes has identified a consistent relationship. Although the relationship is dynamic, compliance with the IOM gestational weight gain guidelines is important to the future health of the mother and child.

Although many long term studies had dropouts, this is expected. Regardless of the dropouts, the fact that these studies were performed in longitudinal international circumstances only supports the evidence further. Dropouts are most often associated with low income and education, and minority status (Linné et al., 2003) which would only increase the power of the results because of the increased obesity prevalence and trend towards greater gestational weight gain in these populations (Gore et al., 2003; Ogden et al., 2006).

The results are supportive of the implications of gestational weight gain, and dropouts only increase the significance, however there are limitations associated with reliance on self-reported weight, other factors relating to long term weight gain, a lack of information between short term and long term follow up, and different categorizing strategies for gestational weight gain and birthweight.

Self-report is used in almost every study discussed in this analysis, and is not an ideal data collection method, although in some cases is the only realistic option. In order to have valid unbiased conclusions, research should not rely on self-report. This is not to say that the results of these studies should be discounted, because the reliability of self-report has been examined in depth. The NHANES study examined the efficacy of self report in a sample of 17,176 participants and determined that with corrections for socioeconomic and racial characteristics all self report BMI was comparable to a measured BMI (Stommel & Schoenborn, 2009). Due to the use in most studies the resulting error should be the same in every study, and the results relatively comparable between studies. Most data was corrected for the identified variables, which further improves reliability.

The long term studies that examined gestational weight gain with reference to maternal long term weight gain were not successful in separating the effects of pregnancy from the life changes associated with becoming a new mother, from aging in general, or from lifestyle. Harris et al. (1997) attempted to correct for weight gain associated with aging, however their analysis resulted in a very conservative estimate of the effects of gestational weight gain. A control group for pregnant women is unrealistic because a non-child bearing group would have many other confounding variables. Distinctions between effects of pregnancy, motherhood, and aging could be made by using women who gave their infants up for adoption after birth. These women would still go through pregnancy and birth, but would not become new mothers. This would allow researchers to determine if this long-term weight gain phenomenon is due to the physical act of being pregnant, from motherhood, or a combination of both.

Long-term studies also do not take into account the events that could have occurred during the time

period that may affect weight gain. Parity was only medical event taken into account in these studies, however its influence on long-term weight gain has not been shown (Williamson et al., 1994; Linné & Rössner, 2003). Other events could have occurred leading to long-term weight gain, which consist of detrimental emotional events, major life changes, or a change in health, all of which were not accounted for. Consistent annual data collection could account for these other variables and would allow researchers to identify pregnancy as the main cause for long-term weight gain, or to determine an alternative cause.

Many studies used different methods of categorizing and comparing both birthweight and gestational weight gain which makes comparison between studies problematic. The WHO and IOM have provide research based categorizations for birthweight and gestational weight gain that have documented relevance, so comparison to these designations is the most legitimate categorization method. Birthweight was only categorized according to the WHO designations for birthweight by two studies (Frederick et al., 2008, Olson et al., 2008). Similar categorization issues were present with gestational weight gain where only 7 of the 16 studies compared directly to the IOM guidelines (Keppel & Taffel, 1993; Walker et al., 1996; Lederman et al., 2002; Olson et al., 2003; Rooney & Schauberger, 2002; Frederick et al., 2008; Olson et al., 2008). Future research should group birthweight and gestational weight gain only with reference to the WHO designations and IOM guidelines respectively to improve consistency and due to their confirmed relevance.

Clinical Implications

Due to the long term health relevance of gestational weight gain, and up to 42% of normal weight women exceeded the guidelines along with 70% of obese women, health professionals need to encourage methods of regulating gestational weight gain (Olson et al., 2003; Vesco et al., 2009). According to one study, 12% of pregnant women reported not having received any information on gestational weight gain while 23% received information that was incorrect and suggested higher weight gains than IOM recommends (Althuizen et al., 2009). Polley et al. (2002) examined the effectiveness of an intervention that educated women on the importance of appropriate weight gain, exercise, and healthy eating and determined that the normal weight intervention group was more likely to stay within their guidelines. The effectiveness alone of providing education and encouragement may have dramatic effects on gestational weight gain.

In addition to emphasis on gestational weight gain guidelines, methods of controlling weight gain are necessary as well. Exercise frequency has been related to gestational weight gain, and weight loss by 6 months postpartum has also been related to participation in aerobic exercise (Olson et al., 2003; Rooney & Schauberger, 2002). Although the American College of Obstetricians and Gynecologists suggest at least 5 days a week of exercise, only 16% of pregnant women reported compliant exercise compared to 27% of non-pregnant women (ACOG Committee, 2002; Petersen et al., 2005).

Although pregnant women should not be concerned with caloric restriction, they need to be aware of caloric requirements for each trimester of pregnancy and other dietary considerations. Special attention to vitamins and minerals is important for the ideal development and health of the infant and women should be educated on eating a healthy diet consisting of vegetables, fruit, milk and dairy, grains, proteins, fats and oils (ACOG Ed. Pamphlet AP001, 2008).

Due to the relevance of gestational weight gain, emphasis on proper gestational weight gain and perinatal exercise and nutrition will begin to address this public health issue. With this emphasis on education, more women will stay within their weight gain ranges and have less risk of themselves and their offspring becoming obese and may help with controlling the obesity epidemic.

Conclusion

There are many reasons for the increasing prevalence of obesity, and even more methods of trying to control and diminish the epidemic. The purpose of this paper was to determine the

relationship between gestational weight gain and obesity in the mother and child, and to propose education in a clinical setting to address this public health crisis. Gestational weight gain has been significantly correlated to maternal postpartum weight retention in the short and long term, where exceeding the IOM recommendations leads to higher long term BMI (Keppel & Taffel, 1993; Walker, 1996; Lederman et al., 2002; Huang & Dai, 2007; Olson et al., 2003; Linné et al., 2003; Rooney & Schauberger, 2002; Harris et al., 1997). Gestational weight gain has also been associated with offspring birthweight and future obesity (Olson et al., 2008; Gümüs et al., 2010; Frederick et al., 2008; Schack-Nielsen et al., 2010; Stuebe et al., 2009; Gunnarsdottir et al., 2004; Mochonis et al., 2008; Araújo et al., 2009).

Exceeding the IOM guidelines of gestational weight gain may lead to excessive weight gain and retention in both the mother and offspring. Gestational weight gain is clearly a modifiable risk factor for obesity, and emphasis on the importance of the IOM weight ranges is necessary. Up to 70% of pregnant women excessively gain weight during pregnancy, and pregnancy is identified as the onset of significant weight gain for obese women (Vesco et al., 2009; Bradley, 1985; Rössner, 1992). There are guidelines for gestational weight gain, prenatal exercise, and dietary considerations available for pregnant women, and this information needs to be communicated more effectively. Implementation of these guidelines may increase compliance, decrease postpartum weight retention, and minimize long term obesity development. Gestational weight gain is a modifiable risk factor for obesity in the mother and child and should become a larger concern for health practitioners and patients alike.

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