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Original Article

The effect of maternal weight gain during pregnancy on the child growth until the age of 6 months: A retrospective cohort study

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ABSTRACT

Background & Aim: Recently, early growth patterns have been associated with metabolic and cardiovascular diseases in adulthood. Early child development depends on women's health. Lack of maternal health during pregnancy can lead to death, disease, and disability in the newborn baby. This research was conducted to study the effect of maternal weight gain during pregnancy on the children's growth until 6 months of age.

Methods & Materials: This retrospective cohort study was conducted on a sample of 257 mother/child pairs using the household records of the urbane health center of Amirieh in Shahriar County. Health care records of pregnant women were collected, and their children's weight was measured at birth and 6 months of age. Multiple linear regressions were used to estimate the adjusted association between maternal and infant weight gain from birth to 6 months of life.

Results: According to multiple analysis, there was no statistically significant and clinically important association between the infant weight gain and gestational weight gain [b = 3.8; 95% confidence interval (CI): −20.8, 28.5; P = 0.076]. Gestational weight gain, however, showed a significant association with birth weight (b = 16.34; 95% CI: 3.4, 29.3; P = 0.014).

Conclusion: In this study, there was no association between gestational weight gain and infant weight gain from birth to 6 months. It seems that further studies with larger sample sizes and variables can help us to understand the maternal factors affecting early infant growth.

Introduction

Human growth is a continuous process in which each stage of the life cycle has different characteristics and is influenced by endogenous factors (e.g. biological, genetic, and racial factors); and external factors (e.g. nutrition, cultural, environmental, and social conditions). Several pre- and postnatal factors can affect infant growth (1). Women who gain weight more than normal during pregnancy are at an increased risk of preterm birth, low birth weight, preterm delivery, cesarean delivery, and birth defects (2-4). Li et al. (5) found that weight gain more than 20.43 kg during pregnancy was associated with a risk of early onset of overweight in the offspring. Many studies have found that children who gain more weight in infancy are at a later risk for obesity in childhood and adulthood (6, 7). Evidence suggests that early life growth patterns are associated with an increased risk of metabolic syndrome and chronic diseases such as

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hypertension, high cholesterol, and coronary heart disease (8, 9). In 2009, the Institute of Medicine (IOM) highlighted both pre-pregnancy body mass index (BMI) and excess weight gain during pregnancy as significant contributors to infant evolvement (10-12). According to well-established associations between pre-pregnancy BMI and both high birth weight and later obesity, the IOM has especially focused on the relationship between excess weight gain during pregnancy and childhood obesity as a modifiable risk factor for improving the maternal and child health (10-12). Based on published statistics of the UNICEF, 161 million under-5 years' children were estimated to be stunted in 2013. About half of all stunted children live in Asia and over one-third in Africa (13). In Iran, the prevalence of stunting, wasting, underweighting, and overweighting, among children under 5 years, was 13.1, 4.5, 7.6, and 5.2 percent, respectively, in 2000-2002. The prevalence of stunting and underweighting was so sever in rural areas (14). It represents an urgent need to speed up the integration of nutrition control programs during pregnancy and before the age of two when the speed of physical and emotional growth in children and their evolution is the highest. However, few studies have examined whether maternal weight gain during pregnancy also predicts the weight gain of their children in early infancy (15-17). Therefore, the aim of the present study was to evaluate the effect of maternal weight gain during pregnancy on child growth until 6 months of age.

Methods

This was a retrospective cohort study on mother-infant dyads in Amirieh Health Center. Amirieh is a county with 12,054 residents (according to the 2012 general population and housing census) in central Shahriar City, Tehran. Health-care records for both the pregnant women and their offspring are routinely collected in the Amirieh Health Center. Pregnant women's health are recorded within the first 12 weeks of pregnancy, and other general information including age, education, numbers of pregnancies/infants, family history of diseases, personal history of diseases, and clinical measurements [weight, ultrasonography, blood pressure, gestational diabetes mellitus (GDM) screening tests, and other lab tests]. The health records of the offspring include the information of newborn's postnatal period (< 40 days after birth), infancy (health examinations every 2 months during the first 6 months and at 12 months). The information of the feeding mode (exclusive breastfeeding, mixed breast and formula feeding, and exclusive formula feeding) during the first 6 months and the measurements of weight, height, head circumference are collected and available. We collected 290 records of both mothers and their infants who were born between April 2011 and May 2014. The present study included 257 mother-child pairs with required measurements for analysis. Weight gain during pregnancy was calculated as the difference between weigh measurement taken at the first visit and weight on the last visit. Infant weight gain was calculated as the difference between the weight at birth and at 6 months of age.

We used a multiple linear regression model to estimate "b," i.e., the expected change in infant weight gain (g) per 1 kg increase in gestational weight gain, 95% confidence interval after adjusting the variables, maternal age, maternal pre-pregnancy BMI, birth weight and height, maternal level of education, homeowner, mode of delivery, feeding modalities, first pregnancy, personal car ownership, infant sex, and the rank of birth. Categorical variables are presented as frequency (percentage), and continuous variables are summarized as mean standard deviation (SD). We also examined the adjusted associations between gestational weight gain and infant birth weight.

Results

This retrospective cohort study was conducted on a sample of 257 mother/child pairs. About half (129) of the infants were male, 233 (90.7%) of the infants were exclusively breastfed to 6 months of age, 20 (7.8%) were exclusively formula-fed, and 4 (1.6%) received both breast milk and formula. The mean (SD) gestational weight gain was 10.90 (4.14) kg. A total of 129 (50.2%) mothers had a normal pre-pregnancy BMI

(18.5-24.9 kg/m^2) while 91 (35.4%) mothers were overweight, and 19 (7.4%) were obese. It was the first pregnancy for 114 (44.4%) mothers. The mean (SD) infant weight gain from birth to 6 months of age was 4746.6 (808.2) g, ranging from 2550 to 7300 g. Descriptive characteristics of the participants are shown in table 1. In unadjusted regression analyses, only the association between the infant sex and infant weight gain during the first 6 months of life was statistically significant at a 5% level; the mean difference in the infant weight gain between boys and girls was b = 570.7; 95%, confidence interval (CI): 406.8, 734.6 g; P < 0.001. Multiple linear regression of the infant weight gain on gestational weight gain and potential confounding variables are shown in table 2. There was no statistically significant and clinically important association between the infant weight gain and gestational weight gain (b = 3.8; 95% CI: −20.8, 28.5; P = 0.760). According to adjusted regression analysis, birth height (b = 58.6; 95% CI: 3.2, 114.1; P = 0.038) was positively associated with the infant weight gain. Boys gained weight more rapidly from 0 to 6 months than girls (b = 520.1; 95% CI: 327.7, 712.6; P < 0.001). The association between pre-pregnancy BMI and weight gain from birth to 6 months of age tended to be significant (b = 25.6; 95% CI: −1.1, 52.3; P = 0. 060). A significant association was detected between the rate of gestational weight gain and birth weight, for each 1 kg increase in weight gain during pregnancy, the infant weight birth increased by b = 16.34; 95% CI: 3.4, 29.3 g; P = 0.014 (Table 3).

Table 1. Descriptive characteristics of the participants*

Variable	Mean ± SD or n (%)
Maternal age (years)	25.78 ± 5.55
Maternal pre-pregnancy BMI (kg/m^2)	23.94 ± 3.85
Birth weight (g)	3210.21 ± 446.97
Birth height (cm)	50.15 ± 2.21
Head circumference (cm)	34.74 ± 1.43
Family size	3.700 ± 0.759
Infant weight gain from birth to 6 months (g)	4746.60 ± 808.17
Gestational weight gain (kg)	10.90 ± 4.14
Maternal age > 35	11 (4.28)
Maternal age < 18	12 (4.67)
Being nulliparous	114 (44.36)
Type of delivery	
Cesarean	117 (45.53)
Natural	140 (54.47)
Infant sex	
Male	129 (50.19)
Female	128 (49.81)
Mother's education	
Illiterate	13 (5.06)
Elementary	91 (35.41)
High school	67 (26.07)
Diploma	74 (28.79)
Academic	12 (4.67)
Mod of infant feeding	
Exclusive breastfeeding	233 (90.66)
Exclusive formula feeding	20 (7.78)
Mixed breast and formula	4 (1.56)
Homeowner	90 (35.02)
Personal car ownership	91 (35.41)
Pre-pregnancy BMI	
Underweight (<18.5)	18 (7)
Normal (18.5-24.9)	129 (50.19)
Overweight (25-29.9)	91 (35.41)
Obese (≥30)	19 (7.39)

*n (%), except were otherwise indicator, BMI: Body mass index

Table 2. Multiple linear regression models predicting infant weight gain during the first 6 months of life (n = 257)

Variable	Infant weight gain (g) from birth to age 6 months			
	b*	P value	95% confidence interval	
Pre-pregnancy BMI (kg/m^2)	25.6	0.060	-1.1	52.3
Sex (0 = female, 1 = male)	520.1	< 0.001	327.7	712.6
Birth weight (g)	-0.315	0.029	-0.03	-0.6
Birth height (cm)	58.6	0.038	3.2	114.1
Mod of infant feeding (formula feeding)	62.6	0.490	-114.4	239.6
Homeowner	206.2	0.054	-3.9	416.3
Personal car ownership	-151.8	0.150	-359.8	56.1
Gestational weight gain (kg)	3.83	0.760	-20.8	28.5
Mother's education	22.45	0.670	-82.01	126.9
Type of delivery (natural)	97.4	0.330	-98.9	293.7
Maternal age (years)	-7.97	0.480	-30.4	14.4
Rank of birth	-102.8	0.410	-346.9	141.4
First pregnancy	-159.23	0.320	-476.4	157.9

*Mean difference in infant weight gain (g) for categorical binary variables and expected change in infant weight gain (g) per one unit increase for continuous variables

Table 3. Multiple linear regression models predicting birth weight (n = 294)

Variable	Birth weight (g)			
	b*	P value	95% confidence interval	
Pre-pregnancy BMI (kg/m^2)	19.7	0.005	6.01	33.4
Sex (0 = female, 1 = male)	-17.9	0.720	-117.3	81.6
Ownership	-31.9	0.570	-142.4	78.5
Personal car ownership	83.4	0.120	-23.4	190.3
Gestational weight gain (kg)	16.3	0.014	3.4	29.3
Mother's education	36.18	0.180	-17.1	89.5
Maternal age (years)	-7.91	0.180	-19.6	3.7
The rank of birth	108.8	0.090	-17.4	235
First pregnancy	0.95	0.990	-161.5	163.4

*Mean difference in birth weight (g) for categorical binary variables and expected change in birth weight (g) per one unit increase for continuous variables

Discussion

Few studies have examined the effect of maternal pre-pregnancy BMI and gestational weight gain on infant anthropometric outcomes. The majority of previous studies in literature have focused on the association between weight gain during pregnancy and outcomes at birth (18-23).

This study was conducted to investigate the effect of maternal weight gain during pregnancy on the child growth until 6 months of age.

The result showed that both maternal pre-pregnancy overweight and excessive weight gain during pregnancy were associated with a higher birth weight. These results support previous studies (17, 24).

Although most previous studies have showed an association between gestational weight gain and children's weight gain after birth. (15-17, 25-28) We did not find any significant association between gestational weight gain and pre-pregnancy BMI with infant weight gain from birth to 6 months of age. However, some studies have reported no association (29-31). Nonetheless, in our study, the relationship between pre-pregnancy BMI and weight gain from birth to 6 months of age was borderline significant (P = 0.060).

The results of this study support the earlier findings of Baker et al. (32) on a negative association between birth weight and infant weight gain. However, some researchers such as the study of Olson et al. (29) and Whitaker (31) have reported a positive association between birth weight and subsequent growth.

In our study, we found a significant association between height at birth and infant weight gain, which is consistent with the results of the study by Whitaker (31). Consistent with other studies, boys gained weight more rapidly than girls (31, 32). There was no association between infant weight gain and other variables such as the mother's educational level, maternal age, and first pregnancy in this study. In the study by Whitaker, first pregnancy and preschooler obesity were related, but there was no association between maternal education level, maternal age, and risk of obesity in children of preschool age (31).

The strength of this study was the use of the data of health records as an opportunity for research. It can encourage researchers to use such information which unused in health centers.

This study had several limitations. The anthropometric measurements were taken as part of routine care and were not specifically taken for the purposes of this study. Likewise, all other variables of interest were extracted from the health records. The second limitation was that we only followed infant growth to 6 months of age. Thus, we cannot assess the effect of maternal weight gain during pregnancy on the offspring's growth and development after 6 months. More studies are recommended to evaluate the impact of maternal weight gain during pregnancy on other age groups of children. Another limitation of this study was that the information in health records was collected by different health-care workers which could affect their accuracy.

Conclusion

It seems that further studies with larger

sample sizes and more variables can help us to understand the maternal factors affecting the early infant growth

Conflict of Interests

Authors have no conflict of interests.

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