

Maternal weight gain might predict child's weight at the 12th and 24th months of age in *Damavand* city, North-East Tehran

Fatemeh Ahmadi¹, Alireza Abadi², Saideh Maani³, Saeed Osati¹, Saeid Ghavamzadeh⁴, Arezoo Haghghian Roudsari⁵, Arash Rashidi^{6,*}

¹International Branch, Shahid Beheshti University of Medical Sciences, Tehran, Iran

²Department of Health and Community Medicine, School of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran

³Nutrition Department, The Ministry of Health and Medical Education, Tehran, Iran

⁴Department of Nutrition, Faculty of Medicine, Urmia University of Medical Sciences, Urmia, Iran

⁵Students' Research Committee, National Nutrition and Food Technology Research Institute, Faculty of Nutrition Sciences and Food Technology, Shahid Beheshti University of Medical Sciences, Tehran, Iran,

⁶WHO Collaborating Center in Nutrition Research and Training, National Nutrition and Food Technology Research Institute, Faculty of Nutrition Sciences and Food Technology, Shahid Beheshti University of Medical Sciences, Tehran, Iran,

*Corresponding Author: email address: arashrashidi@yahoo.com (A. Rashidi)

ABSTRACT

The purpose of this study was to investigate the possible association between pregnancy weight gain and child weight at the 12th and 24th months of age in *Damavand* city, North-East Tehran, Iran. Materials and Methods: In a cross-sectional study, using existing data collected by the urban health centers, records of 266 women who attended urban health centers for prenatal care and delivered between March 2004 and March 2008 with singleton term pregnancy were analyzed. Data on pre-pregnancy weight and height, total pregnancy weight gain, mother's age, parity, neonatal birth weight, birth order, mother's education, working status, breastfeeding practice and child weight at the 12th and 24th months of age were extracted. Pregnant Women were categorized based on their pre-pregnancy body mass index (BMI) as underweight, normal, and overweight and obese. Chi-square and ANOVA tests were employed to analyze data using SPSS software. Mean (\pm SD) of gestational weight gain was 11.4 \pm 3.9 kg. On average, 34% of mothers had inadequate weight gain, while 44 and 22% gained appropriate and excessive weight, respectively, based on the US Institute of Medicine (IoM-1990) guidelines. About 11, 56, 20 and 13% of mothers were defined as underweight, normal, overweight, and obese based on their BMI values. Initial BMI and educational level was associated with pregnancy weight gain. There was a significant difference between mean child weight at the 12th and 24th months of ages in all three categories of pregnancy weight gain, i.e. inadequate (<6.8 Kg), normal (6.8–11.3 Kg), and excessive (>11.3 Kg) ($p < 0.01$). Gestational weight gain seemed associated with child weight. Educating and assisting pregnant women to meet the weight gain within recommendations range might therefore be an important strategy to prevent child malnutrition, both under- and overweight, in early life.

Keywords: Pregnancy weight gain; child weight; pre-pregnancy Weight

INTRODUCTION

Pregnancy is a crucial stage of a woman's life. It influences the growth and development of fetus, its health status later in life, and the mother herself [1]. Maternal gestational weight gain is an important predictor of short- and longer-term outcomes of pregnancy. Higher maternal weight gains are associated with decreased risk of small-

for-gestational age (SGA) birth, but with increased risk for large-for-gestational age (LGA) birth and maternal postpartum weight retention. Very low and very high gestational weight gains increase risk of preterm delivery. Studies on gestational weight gain and child obesity have found that children born to mothers who gained more weight are also at elevated risk of becoming

obese [2]. In 1990, the Institute of Medicine (IoM) of the US National Academy of Sciences developed recommendations for weight gain during pregnancy based on pre-pregnancy Body Mass Index [BMI=weight(Kg)/height(m²)]. According to the guidelines, women with a normal pre-pregnancy BMI, i.e. 19.8-26.0kg/m² should gain 11.5-16 kg, underweight women with a BMI<19.8 kg/m² should gain 12.5 -18 kg, overweight women with a BMI between 26.0-29.0 kg/m² should gain 7.0-11.5 kg and obese women with a BMI > 29.0 kg/m² should gain at least 6.0 kg during pregnancy [3]. A minority of women in the US (33-40%) gain the recommended amounts of weight gain in pregnancy. Meanwhile, excessive gestational weight gain is more prevalent than inadequate weight gain [3]. A recent study in rural areas of Northern Iran showed that 45, 38 and 17% of women gained less than, within and higher than the IOM recommendations, respectively [4]. It has been suggested that pregnancy weight gain within IOM recommendation range decreases the risk low birth weight delivery (<2500g), macrosomia (>4000g), SGA, LGA, pre-eclampsia, cesarean delivery, and preterm delivery [3, 5-6]. There is a significant relationship between gestational weight gain within IOM recommendation range and birth size of 3000-4000g [3]. It has also been shown that gestational weight gain is directly associated with neonatal outcomes such as birth weight, delivery method, and breastfeeding duration. Moreover, it affects programming of child weight and health later in life [3, 7]. Few recent studies have shown a relation between pregnancy weight gain and overweight and obesity in children in early childhood.

Oken et al. showed that women with adequate or excessive gestational weight gain had an approximately 4-fold increased odds of having a child who had a BMI ≥95 percentile at the 3rd year of life (versus BMI<50 percentile) compared to women with inadequate weight gain [7]. However, to our knowledge, previous studies to examine relationship between maternal weight gain and child weight at different ages in Iran were lacking. The present study, therefore, aimed at investigating possible relationship between maternal weight gain and child weight at the 12th and 24th months of age in *Damavand* city, North-East Tehran.

MATERIALS AND METHODS

Population and study design

In this cross-sectional study, existing data collected by the urban health centers in *Damavand* city were used. Records of women who had attended the urban health centers for prenatal care and delivery during a 4 year period (March 2004 to March 2008) were reviewed. We included 266 mothers who were 18-35 years of age, first antenatal visit before the 12th week of gestation and last antenatal visit within 10 days before delivery, with alive full term (≥37 weeks) singleton neonate with birth weight of >2500 grams (LBW cases were excluded). Data on pre-pregnancy weight and height, total pregnancy weight gain, mother's age, parity, neonatal birth weight, birth order, mother's education, mother's working status, breastfeeding practice and child weight at the 12th and 24th months were extracted.

Criteria to interpret BMI and gestational weight gain values

We calculated total gestational weight gain by subtracting a woman's weight at her first antenatal visit in the first trimester (before the 12th week of pregnancy) from weight recorded in last antenatal visit. We also categorized women for their pregnancy weight gain as inadequate, adequate or excessive according to the IoM-1990 guidelines.

We defined underweight as having BMI of 19.8 or less, normal weight as BMI of 19.8-26.0 kg/m², overweight as BMI of 26.1-29.0 kg/m², and obesity as BMI of at least 29.0 kg/m². Age-and-sex-specific BMI percentiles were calculated based on CDC-2000 reference values. We defined child severe underweight as BMI less than the 5th percentiles, at risk of underweight as BMI between the 5th and the 15th percentiles, normal weight as BMI between the 15th and the 84th percentiles, overweight as BMI between the 85th and the 94th percentiles, and obesity as BMI equal or greater than the 95th percentile.

Statistical analysis

One-way analysis of variance (ANOVA), Chi-square and Fisher's Exact tests using SPSS (Ver. 16) were employed to analyze the data. Post-hoc multiple comparisons between groups were undertaken by least significant difference.

A p-value of less than 0.05 was considered as statistically significant.

RESULTS

Characteristics of the pregnant women and their children are shown in table 1. About 11, 56, 20, and 13% of the studied women had pre-pregnancy BMI values <19.8, 19.8-26.0, 26.0-29.0 and >29.0 Kg/m², respectively. Mean (\pm SD) of gestational weight gain was 11.4 \pm 3.9 kg. Based on IoM-1990 recommendations, 34, 44 and 22% of women gained inadequate, adequate and excessive weight, respectively. We found an association between maternal weight gain and pre-pregnancy BMI values and educational status ($p < 0.001$ and $p < 0.04$, respectively). As presented in Table 2, there were significant differences between mean child weights at the 12th and 24th months of age in all three categories of pregnancy weight gain ($p < 0.01$). Children whose mothers gained adequate/excessive weight during their pregnancies were significantly more likely to have higher BMI values both at the 12th and 24th months of age than children of mothers with inadequate weight gain, as shown in Fig 1. No significant difference was found between children of mothers with adequate and excessive weight gain during pregnancy.

Table1. Characteristics of 266 mothers-children attending urban health centers in Damavand city, Iran (March 2004-March 2008)

Characteristics	no. (%)
Maternal	
Age(years)	
18-23	103(39)
24-29	102(38)
30-35	61(23)
Working status	
Not employed	259(97)
Employed	7(3)
Education	
Uneducated	101(38)
Elementary	90(34)
Above	75(28)
Delivery method	
Caesarean	114(43)
Vaginal	152(57)
Birth Order	
First	130(49)
Second	100(38)
Third	36(13)
Child	
BMI at the 12 th month	
<5 th	39(15)
5 th -15 th	60(22)
15 th -84 th	161(60)
85 th -94 th	6(3)
$\geq 95^{\text{th}}$	0
Child weight status at age 2 y	
BMI<5 th	43(16)
BMI=5-15 th	38(14)
BMI=15-84 th	168(64)
BMI=85-94 th	17(6)
BMI $\geq 95^{\text{th}}$	0

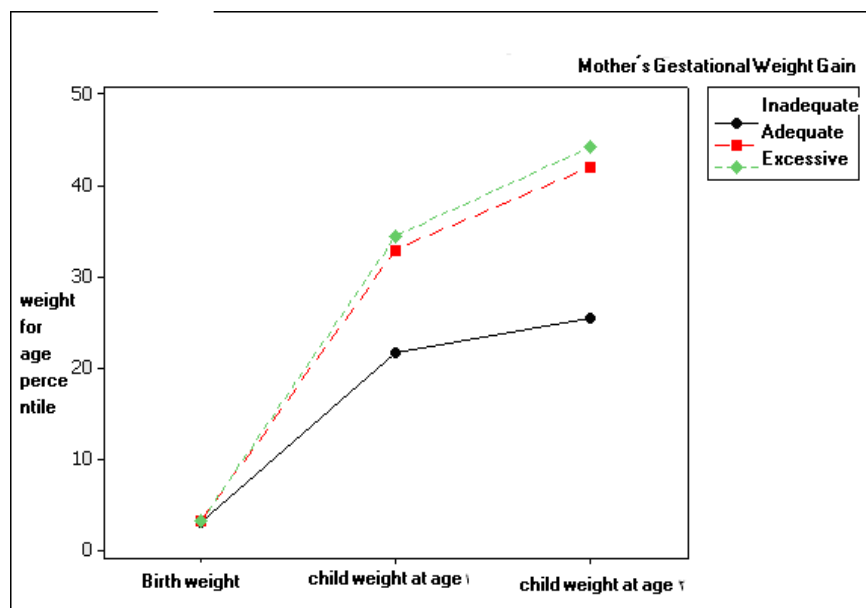


Figure1. Association between maternal weight gain and children's weight at the 12th and 24th months of age

Table2. Children's weight-for-age (W/A) at the 12th and 24th months of age in different imaternal gestational weight gain (GWG) categories

Children's W/A (Mean ±SD)	Gestational Weight gain			ANOVA Test
	inadequate	adequate	excessive	
At the 12 th mo	34.50 ± 4.51	32.99 ± 24.53	21.71 ± 23.11	P=0.007
At the 24 th mo	44.24 ±26.46	42.06 ± 28.73	25.46 ± 24.33	P=0.007

DISCUSSION

The results of this study indicate that gestational weight gain is associated with weight status in the offspring at the 12th and thee 24th months of age. Our findings are consistent with very few research results which supporting a positive association between gestational weight gain and weight early in next generation. For instance Olson et al showed that excessive gestational weight gain is associated with increased risk of child overweight at the 3rd year of life [8]. There are a number of possible mechanisms responsible for the association between the above parameters. From a life course perspective, intrauterine development is a critical time period during which maternal weight gain would contribute to the programming of future risk of childhood overweight; insulin metabolism might be a link. Excessive gestational weight gain and hyperglycemia may overstimulate fetal pancreatic cells and consequently results in fetal hyper-insulinism. Insulin itself is a growth hormone for the fetus, resulting in higher birth weight and in impaired glucose tolerance and obesity later in adolescence. In animal studies, fetal hyperinsulinism can elevate the expression of neuropeptide Y neurons in the arcuate hypothalamic nucleus, which results in hyperphagia and weight gain in postnatal life.

REFERENCES

Maddah, M. Pregnancy weight gain in Iranian women attending a cross-sectional study of public health centers in Rasht. *Midwifery*. 2005; 21: 365-370.

1.Oken, E, Kleinman, KP, Belfort, MB, Hammitt, JK & Gillman, MW. Associations of gestational weight gain with short- and longer-term maternal and child health outcomes. *Am J Epidemiol*. 2009; 170: 173-80.

2.Olson, CM. Achieving a healthy weight gain during pregnancy. *Annu Rev Nutr*. 2008; 28: 411-23.

An alternative explanation for the association between gestational weight gain and offspring overweight is that mothers with greater gestational weight gain may have children who gain more weight through shared mechanisms including genetics, dietary preferences, and physical activity patterns [9]. It is not however possible to distinguish between those possibilities based on this study. Meanwhile, present study has a number of limitations. We did not have any information about the starting time of complementary feeding, or maternal diet and physical activity during pregnancy. Starting time of complementary feeding was demonstrated to be related to an infant's weight. One study showed that this variable has been negatively associated with infants weight gain at age 1 year [10]. We couldn't however adjust our result based on these important variables.

CONCLUSION

This study suggests that maternal weight gain might be a strong determinant for child's weight and BMI at the 12th and 24th months of age, through its possible metabolic programming during fetal growth. More studies are needed to explore this complex relationship and its consequences.

3.Panahandeh, Z. Gestational Weight Gain and Fetal Birth Weight in Rural Regions of Rasht/Iran. Joint Conference of the 21st International Congress of Pediatrics/7th National Pediatric Nursing Congress. Tehran, Iran, Tehran Univ Medical Sciences. 2009.

4.Myles, T, Langford, A, Joshu, C & Leet, T. Does gestational weight gain affect the risk of adverse maternal and infant outcomes in overweight women? 27th Annual Meeting of the Society-of-Maternal-Fetal-Medicine. San Francisco, CA, Mosby-Elsevier. 2007.

5.Oken, E, Rifas-Shiman, SL, Feild, AE, Frazier, AL & Gillmanm W. Maternal Gestational Weight Gain and Offspring Weight In Adolescence. *Obestetrcs and Gynecology*. 2008; 112: 999-1006.

6.Oken, E, Taveras, EM, Kleinman, KP, Rich-Edwards, JW & Gillman, MW. Gestational weight gain and child adiposity at age 3 years. *American Journal of Obstetrics and Gynecology*. 2007; 196: 322.e1.

7.Olson, CM, Strawderman, MS & Dennison, BA. Maternal Weight Gain During Pregnancy and Child Weight at Age 3 Years. *Matern Child Health J*. 2008.

8.Wrotniak, BH, Shults, J, Butts, S & Stettler, N. Gestational weight gain and risk of overweight in the offspring at age 7 y in a multicenter, multiethnic cohort study. *Am J Clin Nutr*. 2008; 87: 1818-24.

9.Messman, L, Roseboom, TJ, Bonsel, GJ, Gemke, RJ, Van der Wal, MF & Vrijkotte, TG. Maternal pre-pregnancy body mass index explains infant's weight and BMI at 14 months results from a :multi-ethnic birth cohort study. *BMJ*. 2009: 1-20.