ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 8, Issue, 10, pp.39975-39978, October, 2016

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

THE RELATIONSHIP BETWEEN FETAL GENDER AND NEONATAL BIRTH WEIGHT WITH MATERNAL WEIGHT GAIN DURING PREGNANCY IN A SAMPLE OF IRAQI WOMEN

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ARTICLE INFO

Article History:
Received 08th July, 2016
Received in revised form
20th August, 2016
Accepted 14th September, 2016
Published online 30th October, 2016

Key words:

Maternal weight gain,
Fetal sex , Male,
Female,
BMI and neonatal birth weight.

ABSTRACT

Objective: The aim of this study was to determine whether there is a significant relationship between maternal weight gain during pregnancy and the newborn sex ratio and neonatal birth weight.
Study Design: A cross sectional study was done on 560 patients , data were collected from private clinics in different areas of Baghdad including Hay Aljameaa and Alharthya from the beginning of 2013 to the end of 2014, all 560 case had single pregnancy ,term births (>=37 weeks and >=2500 grams).Number of male fetuses = 292 and female fetuses = 268. Sex ratios were calculated by dividing the number of male newborns by those of female newborns,sex ratio (for total) =male / female ratio= 292/268 = 1.0895 and calculated for each maternal weight gain group during pregnancy.
Results: The percentage of male/total increased with increasing maternal weight gain during pregnancy as with low weight gain < 5 kg the of male/total ratio is (40%) while in those with higher weight gain the ratio reaches (63.15%)in mothers gaining >18.1kg , so male/female ratio increase from (0.67) in those gaining < 5kg to (1.71) in the largest weight gaining group. most of women gaining <5 kg during pregnancy (53.3%)delivered neonates weighting 2.5-3 kg, while the largest % of women gaining =>18.1kg during pregnancy (31.6) (26.3%) delivered neonates weighting 4000 – 4499 and > 4.5 kg respectively.
Conclusion: There is significant relationship between maternal weight gain during pregnancy and the newborn sex ratio and neonatal birth weight.pregnant women should advised to gain weight within the recommendation of IOM.

Citation: DalyaThamer Ahmad, D. 2016. "The relationship between fetal gender and neonatal birth weight with maternal weight gain during pregnancy in a sample of Iraqi women.", *International Journal of Current Research*, 8, (10), 39975-39978.

INTRODUCTION

Maternal nutrition and health are considered as the most important regulators of human fetal growth and wellbeing. A healthy mother can produce a healthy child (Anisa M. Durrani and Anjali Rani, 2011; Sahoo and Panda, 2006). A woman's normal nutritional requirement increases during pregnancy in order to meet the needs of the growing fetus and of the maternal tissues associated with pregnancy. Proper dietary balance is necessary to ensure sufficient energy intake for adequate growth of the fetus without drawing on the mother's own tissues to maintain her pregnancy (Anisa M. Durrani and Anjali Rani, 2011; Mridula *et al*., 2003). In 2009, the Institute ofMedicine IOM recommended a weight gain of 25 to 35 lb (11.5 to 16 kg) for women with a normal pre-pregnancy body mass index (BMI). (Elizabeth M. Ward, 2009; Liu *et al*., 2012) Women who are underweight (BMI of less than 18.5), should gain between 12.7–18 kg (28–40 lbs), while those who are overweight (BMI of 25–29.9) are advised to gain between 6.8–11.3 kg (15–25 lbs) and those who are obese (BMI>30) should gain between 5–9 kg (11–20 lbs) (American College of Obstetricians and Gynecologists, 2013). Women should start the pregnancy with a BMI in the normal weight category and limit their gestational weight gain (GWG) to the range specified for their pre-pregnancy body mass index BMI to improve pregnancy outcome. (Li *et al*., 2013) The correlation of a mother's gestational weight gain and the sex of her child are unclear (Sarah Bruyn Jones, 2014). Sex differences in fetal growth have been reported, but how this happen remains to be described. It is unknown if fetal growth rates, a reflection of genetic and environmental factors, express sexually dimorphic sensitivity to the mother herself. Sex modified the effects of maternal height and weight on fetal growth rates and birth weight (Michelle Lampl *et al*., 2010). Male embryos start life with higher rates of cell division and higher metabolic rates compared to females (Michelle Lampl *et al*., 2010; Burgoyne, 1983). These differences appear to extend through the second trimester, as male fetuses exhibit faster growth rates prior to the third trimester, after which the sex differences in growth rates appear to even out (de Zegher *et al*., 1999).

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The result is a nearly 100 g weight difference between male and female newborns (Tamimi *et al*., 2003). This disparity in growth rates between males and females indicates that nutritional requirements should also be sex-specific. Indeed, women carrying boys had 10% higher energy intake compared to those carrying girls (Tamimi *et al*., 2003; Kristen J. Navara, 2014). Women with diseases that lower food intake or nutritional absorption such as anorexia, bulimia, and celiac disease, produce lower percentages of male offspring (Bulik *et al*., 2008; Khashan *et al*., 2010). Further, during times of famine, the sex ratio at birth declines, becoming female biased (Herna´ndez-Julia´n *et al*., 2013; Song, 2012), Ethiopian women that were in a better nutritional state according to body mass and muscle indices had a higher percentage of male births, and Italian women who were thinner produced a lower percentage of boys (Cagnacci *et al*., 2004). On the other hand, women with binge-eating disorders produced significantly higher percentages of males (Bulik *et al*., 2008) and rich individuals who likely have access to larger amounts of nutritious food also produce more male babies (Cameron and Dalerum, 2009; van Bodegom *et al*., 2013). The calorie intake per capita is also related to sex ratios at birth; countries with lower caloric intakes produce lower percentages of males at birth, likely due to higher rates of male fetal death (Williams and Gloster, 1992). These studies suggest that extreme decreases in energy intake are detrimental to the survival of male fetuses (Kristen J. Navara, 2014; Barbara Abrams *et al*., 2000).

MATERIALS AND METHODS

A population-based study aiming to determine whether there is a significant relationship between maternal weight gain during pregnancy and the newborn sex ratio and neonatal birth weight. Deliveries occurred during the years 2013 to the end of 2014. The data was collected from women who attend the outpatient clinics in different areas of Baghdad including Hay Aljameaa and Alharthya from the beginning of 2013 to the end of 2014, information include the pre-pregnancy BMI, maternal at time of delivery and neonatal weight at time of delivery, also information about gestational age at delivery and any complication during pregnancy whether medical or surgical were recorded. All 560 case had term births (>=37 weeks) and neonatal weight (>=2500 grams), Sex ratios were calculated by dividing the number of male newborns by those of female newborns, and calculated for each maternal weight gain group during pregnancy.

Statistical methods

All 560 cases were divided into 5 groups according to their weight gain (< 5 kg , 5.1 – 9 kg , 9.1 – 13.6 kg , 13.7 -18 kg , >18.1 kg) (<11 Ib, 11-20 Ib , 21-30 Ib , 31-40 Ib and >40 Ib). The association between sex ratio and maternal weight gain during pregnancy was estimated by Odds ratios with 95% confidence intervals which were calculated by unconditional logistic regression analysis with adjustments for maternal and infant characteristics. The association between neonatal weight and maternal weight gain during pregnancy was estimated for each weight gain group by using P -value and the relationship between pre-pregnancy BMI and maternal weight gain was described also.

Strengths and limitations

The major strength of our study was the population-based design, suggesting that the results from this study are generalizable to other settings. Although one of the potential limitation is small study population, but we were able to stratify the exposure by dividing the sample into 5 groups according to their weight gain and also to study other variables for each group and comparing the result to find a significant association.

RESULTS

Total number of 560 cases ,number of male fetuses = 292 and female fetuses = 268. Sex ratio (for total) =male / female ratio= 292/268 = 1.0895 and calculated for each maternal weight gain group during pregnancy. In this table we find that the percentage of male/total increased with increasing maternal weight gain during pregnancy as with low weight gain < 5 kg the of male/total ratio is (40%) while in those with higher weight gain the ratio reaches (63.15%)in mothers gaining >18.1kg , so male/female ratio increase from (0.67) in those gaining < 5kg to (1.71) in the largest weight gaining group. In this table we see that most of women gaining <5 kg during pregnancy (53.3%)delivered neonates weighting 2.5-3 kg, while the largest % of women gaining = > 18.1kg during pregnancy (31.6) (26.3%) delivered neonates weighting 4000 – 4499 and > 4.5 kg respectively , most of women gaining 9-13.6 kg during pregnancy (45.1%) delivered neonates weighting 3.5-4 kg , women gaining 5.1-9 kg during pregnancy (44.6%) delivered neonates weighting 3-3.5 kg and finally women gaining 13.7- 18.1 kg during pregnancy (36.8%) delivered neonates weighting 3.5-4 kg.

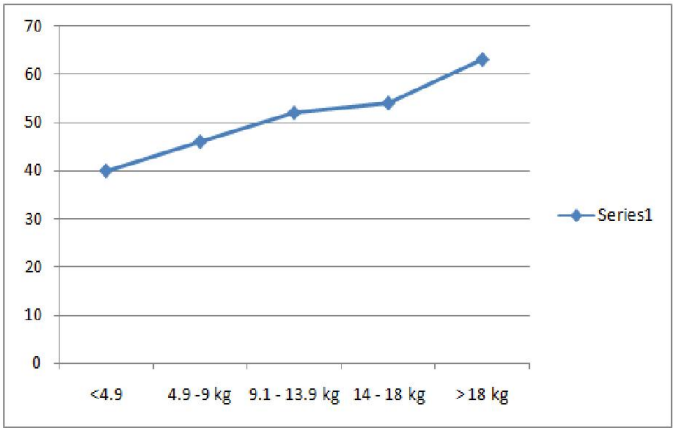

Figure 1. Show the line of percentage of male/total increasing with increase weight gain

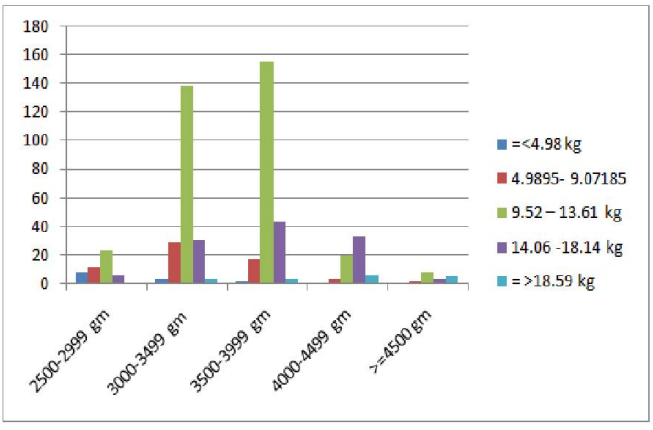

Figure 2. Show the number of neonates in each group of neonatal weight distributed according to each maternal weight gain group

Table 1. Effect of fetal sex on maternal weight gain

Weight gain during pregnancy			Male/total = (%)	Male/female sex ratio	Total OR (95% CI)
Weight gain	No.	%			
<11 Ib= <5 kg	15	2.68	6/15= (40)	0.67	0.7644 0.2916 to 2.0041
11-20 Ib = 5.1 – 9 kg	65	11.61	30/65= (46.15|)	0.86	0.8821 0.5520 to 1.4094
21-30 Ib= 9.1 – 13.6 kg	344	61.42	180/344= (52.32)	1.1	1 (references)
31-40 Ib = 13.7 -18kg	117	20.89	64/117= (54.7)	1.21	1.0454 0.7337 to 1.4895
>40 Ib= >18.1 kg	19	3.39	12/19= (63.15)	1.71	1.2070 0.5731 to 2.5422

Table 2. The relationship between Newborn weights and maternal Weight gain during pregnancy

Weight gain during pregnancy		Newborn weights									
Weight gain	NO.	2500-2999 gm		3000-3499 gm		3500-3999 gm		4000-4499 gm		>=4500 gm	
		No.	%	No.	%	No.	%	No.	%	No.	%
<11 Ib= < 5 kg	15	8	53.3	4	26.7	2	13.3	1	6.7	0	0
11-20 Ib=5.1 - 9 kg	65	12	18.5	29	44.6	17	26.2	4	6.2	2	3.1
21-30 Ib= 9.1–13.6 kg	344	23	6.7	138	40.1	155	45.1	20	5.8	8	2.3
31-40 Ib= 13.7-18kg	117	6	5.1	31	26.5	43	36.8	33	28.2	4	3.4
>40 Ib= >18.1 kg	19	0	0	4	21.1	4	21.1	6	31.6	5	26.3

Table 3. Relationship betweenpre-pregnancy body mass index and maternal Weight gain

Maternal weight gain	Pre-pregnancy BMI								
	<18		18-24		25-29		30 & more		Total
	No.	%	No.	%	No.	%	No.	%	
=< 5 kg	1	7	2	13	3	20	9	60	15
5.1- 9 kg	15	23.2	9	13.8	22	33.8	19	29.2	65
9.1– 13.6 kg	60	17.4	161	46.8	103	29.9	20	5.8	344
13.7 -18 kg	23	19.6	64	54.7	28	23.9	2	1.7	117
= >18.1 kg	5	26.3	5	26.3	6	31.6	3	15.8	19
	104		241		162		53		560

Finally in this descriptive table we see the distribution of weight gain during pregnancy with pre-pregnancy BMI , as we see the largest group of mothers gaining < 5 kg were have 30 or more BMI (60%) , while most of mothers who were gained >18.1 kg and those who were gained 5-9 kg were have BMI of 25 -30 about (31.6%) , (33.8) respectively , while mothers who gained 9.1 – 13.6 kg and mothers who gained 13.7 – 18 kg were have BMI of 18-24 about (46.8) and (54.7) respectively.

DISCUSSION

As predicted, women who gained high amounts of weight during gestation produced a significantly higher proportion of male offspring compared with those who gained low amounts of weight. It is possible that this relationship results from the fact that male embryos and fetuses have higher metabolic rates, and likely need more caloric energy to develop successfully (Ray *et al*., 1995; Tamimi *et al*., 2003). In Table-1- Effect of fetal sex on maternal weight gain we see that male/female ratio increase with the increase of amount of maternal weight gained during pregnancy, The results in this study are in accordance with the hypothesis of most of previous studies for example a studydone byendocrinologist Kristen J. Navarra of the University of Georgia studied 68 million births over 23 years, published in October 2014 for 4 racing group (American Indian, Asian, Black, and White descent) (Kristen J. Navara, 2014) they found that Gestational weight gain and the proportion of male births were positively correlated; a lower proportion of males was produced by women who gained less weight and this strong pattern was exhibited in four human races. (Kristen J. Navara, 2014)

Caulfield *et al*. (1996) showed that women carrying male fetuses were more likely to over-gain. The same result was found in china by Lei Hou *et al*. 2014. Also by Dr. Richard L. Naeye (1987) and Michela Torricelli *et al*. (2013)

In this study, we found that fetal weight increase with increase of maternal weight gain during pregnancy as we see in Table-2- most of women gaining <5 kg during pregnancy (53.3%) delivered neonates weighting 2.5-3 kg while the largest % of women gaining = > 18.1kg during pregnancy (31.6) (26.3%) delivered neonates weighting 4000 – 4499 and > 4.5 kg respectively, this result are in agreement with most other studies that done for the same objective, for example a large study done in 2011 by McDonald *et al*. (2011) they found that high gestational weight gain GWG was associated with lower risk of low birth weight LBW, Langley-Evans (2003) found that one of the factors that affect birth weight is positively correlate with good maternal nutrient intakes and weight gain during pregnancy, also in India by Shahnawaz *et al*. (2014), also a study published at 1989 in Tanzania (Bo möller *et al*., 1989), in Saudia Arabia (Ahmed A. Al-Shoshan, 2007) and Iran (Zahra Panahandeh, 1999). This study showed that pregnancy weight gain within the IOM's recommended ranges for some groups in the study, for example; the largest group of mothers gaining <5 kg were have 30 or more BMI (60%), while most of mothers who were gained >18.1 kg (31.6%) weight gain during pregnancy is not within the IOM's recommended ranges as they were have BMI of 25 -30, this may relate to variation in nutritional state during pregnancy.

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