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Maternal and Social Determinants of Excessive Weight Gain during Pregnancy: A Cohort Study

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Abstract

Introduction Excessive gestational weight gain might be an emerging health problem in developing countries

Aim To determine the effect of maternal and social factors for excessive gestational weight gain.

Methods A prospective cohort study was carried out at two Medical Officer of Health areas in Sri Lanka. Pregnant women were recruited on or before 16 weeks of gestation and followed up until delivery. The sample size for the first, second and third trimester analysis were 710, 626 and 578 respectively. The variables included socio-demographic characteristics, information on present and past obstetric history and trimester specific data related to physical activity and psychosocial stress which were gathered on average at 12th, 28th, and 36th weeks of gestation. Maternal weight was measured at the first antenatal clinic visit and at delivery. Multiple logistic regression was applied using SPSS and the results were expressed as odds ratios (OR) with the respective 95% confidence intervals (95%CI).

Results: The determinants of excessive weight gain were: being overweight at the booking visit (OR 9.0, 95%CI 4.6, 17.7), maternal complications during pregnancy (OR 3.0, 95%CI 1.1, 8.1), passive cigarette smoking during third trimester (OR 0.1, 95%CI 0.01, 0.9), low educational level (OR 4.2, 95%CI 1.2, 14.4) and high per capita income (OR 2.7, 95%CI 1.1, 6.7), controlling for the effect of gestational age.

Conclusion: Being overweight, maternal complications, passive smoking, low educational level and high income were the determinants of excessive weight gain during pregnancy.

Key words: Pregnancy, weight gain, cohort study, overweight, smoking, stress

Introduction

Excessive weight gain during pregnancy is an emerging health problem in developed countries. Three studies reported that the gestational weight gain exceeded more than the recommended range for over 50% of mothers[1-3] and another study which showed that the proportion gaining excessive weight increased from 15.5% in 1988 to 19.5% in 2003.[4] Excessive gestational weight gain results in adverse pregnancy outcomes for both the mother and the foetus, including delivery complications. Adverse maternal outcomes include gestational hypertension,[5-7] preeclamsia,[6-9] and postpartum weight retention.[10] Delivery complications include augmentation of labour,[5] failed induction,[8] and cesarean delivery.[7-10] Adverse fetal outcomes include stillbirths,[9] shoulder dystocia,[9] meconium aspiration,[9] fetal distress,[9] higher birthweight,[5,10,11] macrosomia,[10,12] large-for-gestational age infants,[7-10] neonatal metabolic abnormality[5] and early neonatal death.[9] With regard to events related to later life, it has been reported that children of mothers who gained more than the recommended weight gain have a greater risk of being overweight at seven years of age[13,14] than for children of mothers who met the weight gain recommendations. In addition, overweight in children had been shown to be associated with higher systolic blood pressure later in life in one of these studies.[13]

Identification of factors that are associated with excessive weight gain is important for the prevention of adverse outcomes described above. Only a few studies have assessed the determinants of excessive weight gain.[2,3,15] and all these studies were from developed countries. Demographic and epidemiological transition in developing countries had led to an increase in the incidence of non-communicable diseases[16] As overweight is a known risk factor for several non communicable diseases, it is important to determine the factors that lead to excessive weight gain during pregnancy which may have contributory role to development of the same in later life of both the mother and the offspring. Therefore, the objective of this study was to determine the effect of maternal and social factors on excessive gestational weight gain.

Methods

A population-based prospective cohort study was carried out in two Medical Officer of Health (MOH) areas of a district in Sri Lanka. The latter areas are the basic health units which provide preventive and promotive health care to the community at the grass root level with a special focus on maternal and child health services. With regard to antenatal services 36 clinics per month were conducted by the field staff of the two areas for which the estimated population was 200,000 at the time of the study. The duration of the study was one year from beginning of May 2001 to mid April 2002. All pregnant mothers eligible to participate in the study were recruited on or before 16 weeks of gestation from filed antenatal clinics and followed up until delivery. The exclusion criteria were pre-existing diabetes mellitus and hypertension and multiple pregnancy. Details of this study have been published elsewhere.[17]

The study instrument consisted of an interviewer administered questionnaire, which included socio-demographic characteristics, information on present and past obstetric history and physical activity. . With regard to the latter, the average number of hours spent on standing, walking, sitting and sleeping per day by individual mother in each trimester was inquired. For working mothers, duration of time spent on standing, walking, and sitting per day except sleeping were asked separately for working and non working days and a weighted average was computed. Modified Life Events Inventory (MLEI) and the General Health Questionnaire (GHQ 30) were used to assess the psychosocial status of the mothers. The GHQ 30 is a self-administered questionnaire which had been validated and widely used to detect psychological disorders. It includes 30 questions which is rated on the standard 0-0-1-1 scale and summed up to a total. The cut off for determining case ness is a total score of 6. Sex, age and educational level had been shown to have no significant effect on the validity of the GHQ.[18,19] and it has been recognized to be sensitive to short-tem psychological disorders. MLEI contains a checklist of 28 items of events identified as psychosocial stressors. MLEI has also been used by several authors to assess psychosocial stress during pregnancy.[20,21] All the questionnaires were administered at the time of recruitment, during the second and the third trimesters. The first, second and third trimester assessments were done on average at 12, 28, and 36 weeks of gestation. Four trained data collectors were used for gathering information.

Maternal weights were measured at the first antenatal clinic visit and at delivery. The technique of measurement was standardized and the weighing machines in the clinics were calibrated regularly using a known weight. In addition, maternal height, hemoglobin percentage and blood pressure measurements were carried out according to a standard protocol to minimize inter and intra observer variations. Gestational weight gain was calculated as the difference between maternal weight at delivery and the first antenatal clinic visit. Excessive weight gain was defined according to the recommendations of the Institute Of Medicine [IOM] (2009)[22], in which, categorization of gestational weight gain was based on the pre-pregnancy BMI levels. Recommended total gestational weight gain values are respectively: underweight (<18.5 kg/m2), normal weight (18.5 – 24.9 kg/m2), overweight (25.0 – 29.9 kg/m2), and obese (≥30.0 kg/m2) are 12.5 – 18.0 kg, 11.5 – 16.0 kg, 7.0 – 11.5 kg, and 5.0 – 9.0 kg,.[22] BMI was determined based on the weight and height measurements of the first antenatal clinic visit.

Passive smoking was defined as exposure to someone else's cigarette smoke, whether at home or at work, and alcohol consumption as the consumption of any type of alcohol during pregnancy. Educational status of the mother was defined as the highest received educational level. Per-capita monthly income was determined by the total disclosed family income divided by the number of family members. Maternal complications were defined as bleeding during antenatal period, or the presence of pregnancy induced hypertension or gestational diabetes. Median duration of each posture adopted /day was taken as the cut off level for the final analysis.

The SPSS version 16 was used for data analysis. Bivariate logistic regression was carried out to determine the odds ratio (OR) for excessive weight gain in terms of

each of the socio-demographic and maternal variables and for trimester specific exposures. Unconditional multiple logistic regression was carried out to control for the confounding factors. Eligibility for including the variables into the regression model was based on statistical criteria (p-value <0.25) as well as biological plausibility.[23] The eligible socio-demographic, maternal and trimester specific exposure variables included were coded as zero and one. The initial model contained all the variables and it was modified by concurrent addition and deletion of variables until the most suitable model was accomplished.[23] The number of mothers included in the final regression model was 574. The number of events per variable was 7.4. Interactions between each individual variable in the final model were tested which were not found to be statistically significant. No collinearity between variables was evident.

Informed consent was obtained from individual participants and ethical approval granted by the Ethics Review Committee of the Faculty of Medicine, University of Kelaniya, Sri Lanka.

Results

The total number of women who attended the clinics during the reference period was 942. Twelve refused to participate with a non participation rate of 1.3%. Of the remaining 930, 45 were not eligible (4.7%) and therefore the total recruited was 885. Fifty six mothers were excluded from the analysis due to multiple pregnancy (11) and fetal death (45). Of the remaining 829, 119 (14.4%) were excluded from the analysis due to non-availability of weight measurements at the booking visit or at the final assessment. The final sample included in the first trimester analysis was 710, having completed all the exclusions described above.

The mean age of the mothers was 26.4 (SD 5.5) years of which 757 (91%) were in the age group of 18 to 35 years. Twenty five percent (n=203) had an educational level above grade 10 and 5% (n=40) up to grade five. Three hundred and eighty nine (47%) mothers were primiparous, and six mothers (0.7%) grand multiparous. Two hundred and ten (29.6%) had a BMI of <18.5 kg/m^2 and 114 (16%) a BMI of >25 kg/m^2. Total mean weight gain was 10.6 (SD 3.3) kg. Of the 710, 62 (8.7%) women gained more weight than IOM recommendations. Nineteen (5%) among normal weight mothers (BMI of >18.5 – 24.9 kg/m^2) and 39 (34%) among overweight/ obese mothers (BMI≥25 kg/m^2) had excessive gestational weight gain.

Eighty four mothers (12%) during the second and 132 (18.6%) during the third trimesters had not attended the routine antenatal clinics. Therefore only 626 mothers for the second and 578 for the third trimester were left for the analyses. Of the 626 mothers who participated during the second trimester and 578 mothers in the third trimester, 57 and 52 had excess gestational weight gain respectively.

Compared to the mothers who did not exceed recommended weight gain mothers with excess gestational weight gain were younger (16% vs 28%) which had a statistically

significant difference. The mothers with excess weight gain had higher per-capita monthly income (85.5% vs 73%), weight >52 kg (79% vs 30%), BMI >23 kg/m^2 (63% vs 11.6%), and more maternal complications (16% vs 3.4%) than the control group and all these differences were statistically significant. Although the mothers with excess weight gain had lower educational levels than the control group (10% vs 4.5%) the difference was not statistically significant. All the mothers with excess gestational weight gain were not anaemic compared to the control group.

Mothers who experienced more than two life events during the first trimester were 27% (n=17) compared to the control group (19%; n=123) but this difference was not statistically significant (Table 2). Proportion of mothers who sleep ≤ 8 hours/day was more than in the control group (37% vs 33.6%) during the first as well as in the third (19% vs 16.6%) trimester (Tables 2 and 4). A lower percentage of mothers with excess weight gain than that of the control group were exposed to passive cigarette smoke during the second (7% vs 11.6%) and third (02% vs 10%) trimesters (Table 3 and 4). However, none of these differences were statistically significant.

Multivariate analysis revealed a 4.2 fold increased risk for school educational level of grade ≤5, a 2.7 fold increased risk for per-capita monthly income ≥1500 Rupees, a 9.0 fold increased risk for BMI ≥23 kg/m^2 in relation to excess weight gain compared to the control group after controlling for the period of gestation (Table 5). Further, the mothers who had complications during pregnancy had a 3 fold increased risk of excess weight gain in comparison those without complications. Mothers who were exposed to passive cigarette smoke during the third trimester had a 88% decreased risk of excess weight gain after controlling for the potential confounding factors (Table 5).

Discussion

Our study revealed that overweight, maternal complications during pregnancy, passive smoking during third trimester and low educational level were determinants of excessive weight gain after having controlled for the gestational duration.

We could not find any other studies that assessed the effect of passive cigarette smoking for excessive weight gain. All the participants in our study were non-smokers. Several studies[24,25,26] assessed the effect of active cigarette smoking for excessive weight gain and found that it had a negative association with gestational weight gain. In contrast to the findings of the above studies, two US based cohort studies reported by Brawarsky[2] and Chasan-Taber[3] found that cigarette smoking had no significant association with excessive weight gain.

Carbon monoxide in the cigarette smoke binds to hemoglobin and forms carboxyhemoglobin. This reduces the quantity of hemoglobin in the blood, thereby causing anaemia.[27] A developing fetus, thus deprived of adequate oxygen, is exposed to an increased risk of perinatal mortality.[27,28]

As Asian populations were observed to have higher cardiovascular risk status than the Western populations at any given BMI level[30], the BMI cut-off points for overweight and obesity of Asian populations were revised by the World Health Organization (WHO).[29] The study supported the use of BMI ≥25.0 kg/m^2 as a new cut-off point for obesity and a BMI of 23.0-24.9 kg/m^2 for overweight[30] which is lower than that recommended for Western populations. According to our findings, overweight and obese women (≥23 kg/m^2) defined using the above cut-off values were more likely to gain excess weight during pregnancy. Our results were consistent with the findings reported by both Brawarsky[2] and Chasan-Taber.[3]

Several studies had found that excessive weight gain was associated with gestational hypertension[5-7] or preeclamsia.[6-9]. According to our study too, maternal complications during pregnancy were observed to be associated with excessive gestational weight gain. However, for the purpose of this study, bleeding during antenatal period, preeclampsia, and gestational diabetes mellitus were categorized together as maternal complications due to the inadequate sample size for separate analysis.

Low education of the women had a higher risk for excessive weight gain. Our results were consistent with the findings of a US based larger study, including secondary data, reported by Howie.[31] In contrast, several studies[2,3,25] had failed to report any association between educational level and excessive weight gain. This may be attributed to the use of different cut-off values for categorizing educational achievements in the studies. Possibly, a low level of education deprives people of access to necessary information on healthy life styles as well as making them less attentive to heeding the advice of experts. Indeed, in Sri Lankan culture, pregnant women are encouraged to consume more food in order to meet with demands of the developing fetus.

According to our study, higher income levels were associated with excessive weight gain. Our results were consistent with the findings of the study reported by Hickey[24] and Rodrigues[25] who found that higher income levels were positively associated with weight gain. The former study[24] was a review and the latter a cohort study[25] conducted in another developing country. In contrast, Chasan-Taber[3] had reported that income was not associated with excessive gestational weigh gain.

We were not able to observe any association between physical activity in terms of duration of walking and standing per day during pregnancy and excessive weight gain. Our findings are consistent with that of three other studies [2,3,25] which reported similar findings. In contrast to the above, Löf [15] had reported a significant association between excessive gestational weight gain with low pre-pregnancy physical activity level.

We were neither able to demonstrate an association between psychosocial stress and excessive gestational weight gain. Psychosocial stress was assessed by administering GHQ 30 and MLEI. Our findings were consistent with the findings of Brawarsky[2] and Chasan-Taber[3]. These authors too have used the same instruments as ours to assess psychosocial stress.

We defined excess gestational weight gain based on IOM 2009 recommendations, which is based on the WHO cut-off points for BMI categories.[17] The other studies described above[2,3] were based on the IOM 1990 recommendations which defined underweight as a BMI of <19.8 kg/m^2 and overweight as >26 kg/m^2. Therefore direct comparisons of results are not possible.

Being a cohort study, loss to follow up was a major limitation of this study. However the attrition rate was in the acceptable range and would not considerably affect either the internal or the external validity. Although this was a follow up study, the exposure statuses were determined on a trimester specific basis by asking participants to recall exposures within the most recent past three months. Therefore, there was still a minimal chance for recall bias to occur. Ideally, the participants would have been required to maintain a diary. However, this step was purposely omitted in order to avoid undue taxing of the participants. Despite above such inevitable limitations, assessment of the exposure status on trimester specific basis could be considered as a strength of our study.

In conclusion, being overweight or obese, earning a higher income, passive smoking and low educational level were determinants of excessive weight gain during pregnancy. Therefore, we would recommend better health education and closer follow up of mothers with high BMI, especially for high income families with a low educational background.

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Table 1: Unadjusted Odds ratios for excessive gestational weight gain by selected socio-demographic and maternal variables

Exposure variable	Excess weight gain Yes (n=62) n (%)	No (n=648) n (%)	OR	[95% CI]	p value
Maternal age < 25 years	10(16)	181(28)	0.49	[0.24, 0.98]	0.04
Education ≤ 5 grade	6(10)	29(4.5)	2.28	[0.91, 5.74]	0.07
Paid employment	16(26)	148(23)	1.17	[0.65, 2.12]	0.60
Per-capita monthly income > Rs 1500	53(85.5)	473(73)	2.15	[1.04, 4.46]	0.03
Maternal height ≤ 153 cm	28(45)	337(52)	0.76	[0.45, 1.28]	0.30
Maternal weight >52 kg	49(79)	197(30)	8.63	[4.57, 16.3]	<0.001
BMI >23 kg/m^2	39(63)	75(11.6)	13.0	[7.34, 22.8]	<0.001
Primi parity	32(51.6)	293(45)	1.29	[0.76, 2.17]	0.34
Inter pregnancy interval ≤ 24 months	3(5)	45(7)	0.68	[0.20, 2.26]	0.53
Haemoglobin < 11 g/dl	0(0)	41(6.7)	0.90	[0.88, 0.93]	0.04
Sex of newborn - male	30(49)	352(54)	1.23	[0.73, 2.09]	0.43
Maternal complications	10(16)	22(3.4)	5.47	[2.46, 12.2]	<0.001

OR - Odds Ratio; 95% CI - 95% Confidence Interval

Table 2: Unadjusted Odds ratios for excessive gestational weight gain by first trimester exposure variables

Exposure variable	Excess weight gain Yes (n=62) n (%)	No (n=648) n (%)	OR [95% CI]	p value
Physical activity				
Standing > 2.5 hours/day	15 (24)	186 (29)	0.79 [0.43, 1.45]	0.44
Walking > 2.5 hours/day	19 (30.6)	209 (32)	0.92 [0.52, 1.62]	0.79
Sitting < 3.5 hours/day	20 (32)	241 (37)	0.80 [0.46, 1.40]	0.44
Sleeping ≤ 8 hours/day	23 (37)	218 (33.6)	0.86 [0.50, 1.48]	0.58
Psychosocial status				
GHQ Score > 5	23 (37)	229 (35.4)	1.07 [0.62, 1.84]	0.79
MLEI Score ≥ 2	17 (27.4)	123 (19)	1.60 [0.88, 2.90]	0.11
Passive smoking – Yes	15 (24)	133 (20.5)	1.23 [0.67, 2.27]	0.49
Alcohol consumption – Yes	2 (3)	19 (3)	1.10 [0.25, 4.84]	0.89

OR - Odds Ratio; 95% CI - 95% Confidence Interval

Table 3: Unadjusted Odds ratios for excessive gestational weight gain by second trimester exposure variables

Exposure variable	Excess weight gain Yes (n=57) n (%)	No (n=569) n (%)	OR	[95% CI]	p value
Physical activity					
Standing > 2.5 hours/day	14 (25)	142 (25)	1.01	[0.53, 1.89]	0.98
Walking > 2.5 hours/day	21 (37.5)	182 (32)	1.28	[0.72, 2.6]	0.39
Sitting < 3.5 hours/day	17 (30.4)	241 (42)	0.59	[0.33, 1.07]	0.08
Sleeping ≤ 8 hours/day	19 (33.3)	180 (31.5)	0.92	[0.52, 1.64]	0.78
Psychosocial status					
GHQ Score > 5	10 (17.5)	105 (19)	0.92	[0.45, 1.88]	0.82
MLEI Score ≥ 2	6 (10.5)	84 (15)	0.67	[0.28, 1.62]	0.37
Passive smoking – Yes	4 (7)	66 (11.6)	0.57	[0.20, 1.64]	0.29
Alcohol consumption – Yes	2 (3.5)	13 (2.3)	1.56	[0.34, 7.10]	0.56

OR - Odds Ratio; 95% CI - 95% Confidence Interval

Table 4: Unadjusted Odds ratios for excessive gestational weight gain by third trimester exposure variables

Exposure variable	Excess weight gain Yes (n=52) n (%)	No (n=529) n (%)	OR	[95% CI]	p value
Physical activity					
Standing > 2.5 hours/day	11 (21.6)	112 (21)	1.02	[0.50, 2.05]	0.95
Walking > 2.5 hours/day	14 (27.5)	189 (36)	0.67	[0.36, 1.28]	0.23
Sitting < 3.5 hours/day	19 (37)	219 (41.6)	0.83	[0.46, 1.51]	0.55
Sleeping ≤ 8 hours/day	14 (27)	186 (35)	1.47	[0.78, 2.79]	0.23
Psychosocial status					
GHQ Score > 5	15 (29)	115 (23)	1.37	[0.72, 2.59]	0.33
MLEI Score ≥ 2	10 (19)	88 (16.6)	1.20	[0.58, 2.47]	0.63
Passive smoking – Yes	1 (2)	54 (10)	0.17	[0.02, 1.27]	0.06
Alcohol consumption – Yes	1 (2)	11 (2.1)	0.92	[0.16, 7.28]	0.94

OR - Odds Ratio; 95% CI - 95% Confidence Interval

Table 5: Adjusted Odds ratios for excessive gestational weight gain by exposure variables in the final model

Exposure variable	**β**	**SE**	**OR**	**95% CI**	**p value**
Maternal complications	1.11	0.50	3.03	[1.13, 8.12]	0.03
Passive smoking during 3rd trimester	-2.13	1.05	0.12	[0.01, 0.94]	0.04
Overweight (BMI ≥23)	2.19	0.35	8.98	[4.55, 17.7]	<0.001
Low educational level	1.43	0.63	4.20	[1.22, 14.4]	0.02
High per-capita monthly income	1.00	0.45	2.72	[1.11, 6.65]	0.03
Period of gestation (weeks)	0.22	0.09	1.25	[1.04, 1.49]	0.01
Period of gestation at recruitment (weeks)	-0.13	0.07	0.88	[0.76, 1.01]	0.08

SE - Standard Error; OR - Odds Ratio; 95% CI - 95% Confidence Interval

Hosmer and Lemeshow test: Chi-square = 5.08 P-value = 0.75

Table (supplementary) – New recommendations for total weight gain during pregnancy, by pre pregnancy BMI

Pre pregnancy BMI	**BMI (kg/m2)**	**Total weight gain**
Underweight	<18.5	28 – 40 (Ibs) (12.5 – 18.0 kg)
Normal weight	18.5 – 24.9	25 – 35(Ibs) (11.5 – 16.0 kg)
Overweight	25.0 – 29.9	15 – 25(Ibs) (7.0 – 11.5 kg)
Obese (includes all classes)	≥30.0	11 – 20 (Ibs) (5.0 – 9.0 kg)

Source: Adopted from the Institute of Medicine of the National Academies