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ASSOCIATION OF GESTATIONAL WEIGHT GAIN, HAEMODYNAMIC FACTORS AND INFANT BIRTH WEIGHT IN AN ASIAN INDIAN OBSTETRIC POPULATION LIVING IN AND AROUND KOLKATA, WEST BENGAL, INDIA: A LONGITUDINAL STUDY

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ABSTRACT

Objective: The present longitudinal study aims to find out the association of gestational weight gain (GWG) with haemodynamic changes and birth weight (BW). **Materials and Methods:** The study was conducted among 218 Asian Indian women with singleton pregnancy and of ≥20 years age, before or on 4th week of pregnancy at two multi-specialty nursing homes at Kolkata, India. The studied population was divided into three groups based on the total GWG- low (GWG <25th percentile), high (GWG >75th percentile and average (GWG 25th-75th percentiles). **Result:** 3rd trimester weight, early and late pregnancy weight change, 1st and 3rd trimester body mass index (BMI), total gestational and, early and late pregnancy BMI change, and BW significantly varied among the three GWG based groups (P<0.05). But no statistically significant difference in systolic and diastolic blood pressure (SBP and DBP), mean arterial pressure (MAP) and their total and inter-trimester changes across the trimesters could be revealed. Overall, the SBP, DBP and MAP across the trimesters slightly differed between low and high GWG group. Scheffe's posthoc test revealed remarkably strong variation in BW between high GWG group and average GWG group than that of low GWG group. **Discussion:** GWG is not significantly associated with the gestational haemodynamic alternations in the studied population and it is presumed to exist probable underlying mechanism of genetic, clinical and lifestyle factors. However, GWG is found as prerequisite for obtaining an optimum infant BW.

Keywords: Asian Indian women, Birth weight, Blood pressure, Gestational weight gain, Percentile distribution.

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INTRODUCTION

The increased prevalence of obesity and obesity-associated morbidities seeks crucial attention for the earliest prevention strategies and treatment. Despite of persisting nutritional deficiencies, the neoteric transition in socio-economic and demographic attributes are contributing to increased adiposity and several adverse cardiovascular consequences, more alarmingly in the developing countries viz. India. From 1990 to 2020, there is a 120% escalation of ischemic heart disease and 107% escalation in cerebrovascular disease among the women of developing countries.[1] The principle risk factor for most of the lethal cardiovascular consequences is atherosclerosis which induces the development of hypertension (HT), hyperglycemia, dyslipidaemia and many other cardiovascular disease risk factors. The obese individuals are highly susceptible to all of these cardiovascular abnormalities and around 70% of HT is caused by adiposity.[1]

The Framingham Study reported 20-30% increase in blood pressure (BP) with each 5% weight gain[2] but there are several genetic and environmental determinants for the onset and severity of obesity-induced hypertension. Since decades myriads of studies have concentrated on the association of gestational weight gain (GWG) with the development of gestational HT but studies are notably meagre from the Indian obstetric population.

During early pregnancy increased insulin secretion inflates the glycogen accumulation in tissues and fats by abstaining lyposis. Increased fat deposition observed during the early pregnancy rapidly breaks down during late pregnancy for enhancing the fetal development.[3] GWG is more rapid during the late pregnancy than the early months. Maternal early pregnancy weight gain is due to increased fat accumulation while late pregnancy body weight includes the weight of growing baby and of the increased amount of fluid in the body. This weight gain ensures the circulation of the baby as well as of the placenta and amniotic fluid.[4] An appropriate GWG corroborates the increased metabolic requirement for the progression of pregnancy.[5] But excessive GWG is associated with several adverse birth outcomes including pregnancy induced hypertension, preeclampsia, gestational diabetes mellitus, caesarean delivery, preterm birth, small and large for gestational age babies, macrosomia, high birth weight (BW) etc[6-8] while inadequate GWG is responsible for low BW.[9] Such information are remarkably meagre from the Asian Indian origin.

In 2009, the Institute of Medicine (IOM) published a revised guideline of GWG based on the pre-pregnancy Body Mass Index (BMI) specifically for the American population which potentially fits other populations as mentioned in several studies.[3] But it is pragmatically not always possible to measure pre-pregnancy BMI as the rate of pre-planned pregnancy is low in India. Therefore, in such circumstance, it is presumed that trimester-specific population-based percentile values of GWG can be reliably and effectively used to predict the associated birth outcomes than calculating pre-pregnancy BMI based on self-reported pre-pregnancy weight. Moreover, it is not only the GWG but also the celerity of weight gain alters the obesity-associated pregnancy outcomes. Therefore, trimester-specific weight gain measures are also crucial factors for consideration.

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AIM OF THE STUDY

Keeping the view in mind, our present investigation was aimed to find out the association of GWG, haemodynamic factors and BW. The null hypothesis is that the haemodynamic factors across the trimesters and BW do vary with the GWG.

MATERIALS AND METHODS

The present investigation is a part of a longitudinal study conducted among 218 Asian Indian women with singleton pregnancy and of ≥20 years who started their antenatal medical consultation on or before 4th week of pregnancy at two multi-specialty nursing homes at Kolkata, a metropolitan city in India. 166 participants (76.1%) were nulliparous. Gestational age (GA) was estimated based on the last menstrual period confirmed by the first ultrasound report. Written informed consent was obtained from each participant included in the study. The study was approved by the Human Research Ethics Committee of Visva-Bharati University, India.

Exclusion criteria

Participants with self-reported pre-pregnancy HT, diabetes mellitus, hypo- or hyperthyroidism, dyslipidaemia and any heart disease were excluded from the study. Pregnancies with assisted reproductive technology and twin pregnancies were also excluded.

Anthropometric parameters

Weight was measured nearest to the 0.1 kilogram at each trimester using a digital weighing scale. The weight measured at the first visit to the clinic at 4th week of gestation was considered as the weight of 1st trimester. The weight measured at the 16th week of gestation was considered as the weight of 2nd trimester and the weight measured on the day of delivery was considered as the weight of 3rd trimester.

Haemodynamic parameters: The systolic (SBP) and diastolic blood pressure (DBP) of the participants was measured on the left arm using an aneroid sphygmomanometer after 5 minutes of rest in sitting position. The BP was measured at each trimester at the time of anthropometric measurements.

STATISTICAL ANALYSIS

The total GWG was calculated as 3rd trimester weight minus 1st trimester weight. The studied population was divided into three groups based on the total GWG- weight gained below 25th percentile (Group 1: low), weight gained above 75th percentile (Group 3: high) and weight gained between 25th and 75th percentiles (Group 2: average).[10] Mean arterial pressure (MAP) was calculated subsequently:

$$MAP = DBP + \frac{1}{3}(SBP - DBP)$$

Early pregnancy weight change= (2nd trimester weight - 1st trimester weight).

Late pregnancy weight change= (3rd trimester weight - 2nd trimester weight).

Total gestational gain in BMI, SBP, SBP, and MAP, early and late pregnancy changes in BMI, SBP, SBP, and MAP were calculated likewise. Trimester-specific percentiles distribution of the anthropometric and haemodynamic variables was calculated. One-way ANOVA with Scheffe's post-hoc test was performed to observe whether significant differences existed for the variables across the three groups. All

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statistical analyses were performed using Statistical Package for Social Sciences (SPSS). A *p* value <0.05 was considered as significant.

RESULTS

The socio-demographic characteristics of the studied women are shown in table 1. The age of the participants is 28.97±4.719 years and monthly family income is 69144.495±130406.537 INR. 75.22% participants have completed their college education and 26.60% have salaried job. The socio-economic status was calculated according to the Kuppuswamy socioeconomic scale[11] updated for the year 2020; 39% participants belong to upper-middle class, 26.1% and 31.2% participants belong to lower-middle and upper-lower class, respectively.

The descriptive statistics of anthropometric and haemodynamic variables and their total and inter-trimester changes have been shown in the table 2. One-way ANOVA showed significant difference in 3rd trimester weight, early and late pregnancy weight change, 1st and 3rd trimester BMI, total gestational BMI change, early and late pregnancy BMI change, and BW among the three groups (P>0.05). But no significant group difference could be found in SBP, DBP and MAP and their total and inter-trimester changes.

Furthermore, Scheffe's post-hoc test revealed that the mean values of early and late pregnancy weight change, total gestational BMI change, early and late pregnancy BMI change of average GWG group was higher than those of the low GWG group and lower than the high GWG group. Mean BW was significantly higher among the high GWG group than the low GWG group and no significant variation in respect of average GWG group was revealed. Trimester-specific percentile distribution (5th, 25th, 50th, 75th, 85th, and 95th) of weight, BMI, SBP, DBP and MAP is shown in the Figure 1.

DISCUSSION

Around 14% women across the world and 50% women in United States gain excessive gestational weight. The African-Americans are reported with the highest risk of excess GWG and weight-allied risk among them is threefold compared to the Whites.[12,13] Recent studies from South India revealed nearly 4fold risk of gestational hypertensive disorders and 3-9fold risk of preeclampsia among the obese pregnant women.[6,14] Several other studies beyond India[15,16] have reported excessive GWG as associated with pregnancy-induced hypertensive disorders but the present study showed a contrasting outcome.

An appropriate placental and vascular adaptation for optimal BP regulation[17] occurs during pregnancy and involves several hormonal activities. Relaxin, a polypeptide hormone produced from placenta abruptly increases during gestation and obtains its peak concentration at early mid-pregnancy. Relaxin is reported have significant role in vasodilation reducing the BP. Furthermore, progesterone and estrogen are two principal pregnancy hormones profoundly produced during gestational period for a healthy pregnancy survival. These two reproductive hormones ameliorate vascularisation in uterus and placenta and estrogen has potential structural and functional haemodynamic effect through ephemeral vasodilation and proliferating aortic compliance.[18] Therewithal, certain trace elements also have remarkable contribution in it. Antioxidant selenoprotein along with the glutathione peroxidase eliminates hydroperoxides and oxidized lipoproteins to avert detrimental endothelial dysfunction thereby reducing risk of

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gestational hypertension.[19] Studies also reveal an optimum level of Zinc to reduce the magnitude of gestational HT.[20] Therefore, it can be culminated that all pregnancies with high GWG may not represent significant haemodynamic alternations compared to the average GWG. In addition to it, several other conventional factors like age, genetic predisposition, socio-economic status, diet, antihypertensive drug use etc. may have crucial role behind it.

Around 80% of obese children are reported to become obese in their adult life.[1] The obesogenic utero exposure induces the risk of neonatal obesity and maternal gestational obesity is apparently a responsible facet of foetal adiposity. Elevated concentration of serum lipids and glucose among the obese mothers affects the nutrient supply to the foetus and disrupts the normal growth and development of the foetus.[21] The present study revealed significant association of BW with low and high GWG. Similar findings have been documented in several other studies across the world.[22,23]

CONCLUSION

- GWG is not significantly associated with the gestational haemodynamic alternations in the studied population presumably due to probable underlying mechanism of genetic, clinical and lifestyle factors.
- Infant BW significantly varied between high and low GWG groups of mothers.

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DISCLOSURE

Author Contribution

MM, RG, NB and IL are responsible for data collection. MM is responsible for study design, statistical analysis and draft manuscript. AG is responsible for study design and final draft of the manuscript.

Conflict Of Interest

There is no conflict of interest so far as the authorship is concerned.

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REFERENCES

1. Kotchen TA. Obesity-Related Hypertension: Epidemiology, Pathophysiology, and Clinical Management. Am J Hypertens. 2010; 23(11): 1170-78.

2. Vasan RS, Larson MG, Leip EP, Kennel WB, Levy D. Assessment of frequency of progression to hypertension in non-hypertensive participants in the Framingham Heart Study. Lancet 2001; 358; 245-57.

3. Mitra M & Ghosh A. Cardiometabolic Risk Factors and Pregnancy Outcomes: A Systematic Review. J Cardiovasc Dis Res. 2019; 10(3):87–93.

4. Pregnancy and birth: Weight gain in pregnancy. (2018). Institute for Quality and Efficiency in Health Care (IQWiG).

5. Asefa F, Cummins A, Dessie Y, Hayen A, Foureur M. (2020) Gestational weight gain and its effect on birth outcomes in sub-Saharan Africa: Systematic review and meta-analysis. PLoS ONE 2020; 15(4):e0231889.

6. Kutchi I, Chellammal P, Akila A. Maternal Obesity and Pregnancy Outcome: in Perspective of New Asian Indian Guidelines. J Obstet Gynecol India 2020; 70(2):138–44.

7. Kiel DW, Dodson EA, Artal R, Boehmer TK, Leet TL. (2007). Gestational Weight Gain and Pregnancy Outcomes in Obese Women: How Much Is Enough? Obstet Gynecol. 2007; 110(4):752–8.

8. Laitinen J, Jääskeläinen A, Hartikainen A-L, Sovio U, Vääräsmäki M, Pouta A, et al. (2012). Maternal weight gain during the first half of pregnancy and offspring obesity at 16 years: a prospective cohort study: Early pregnancy weight gain and offspring obesity at 16. BJOG 2012; 119(6):716–23.

9. Sun Y, Shen Z, Zhan Y, Wang Y, Ma S, Zhang S, et al. (2020). Effects of pre-pregnancy body mass index and gestational weight gain on maternal and infant complications. BMC Pregnancy Childbirth 2020; 20(1):390.

10. Wu Y, Wan S, Gu S, Mou Z, Dong L, Luo Z, et al. (2020) Gestational weight gain and adverse pregnancy outcomes: a prospective cohort study. BMJ Open 2020; 10(9):e038187.

11. Saleem SM. Modified Kuppuswamy socioeconomic scale updated for the year 2020. Indian J Forensic Community Med. 2020;7(1)

12. Walker LO, Fowles ER, Sterling BS. (2011). The Distribution of Weight-Related Risks Among Low-Income Women During the First Postpartum Year. J Obstet Gynecol Neonatal Nurs 2011; 40(2):198–205.

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13. Meng Y, Groth SW, Stewart P, Smith JA. An Exploration of the Determinants of Gestational Weight Gain in African American Women: Genetic Factors and Energy Expenditure. Biol Res Nurs. 2018; 20(2):118–25.

14. Bhavadharini B, Anjana RM, Deepa M, Jayashree G, Nrutya S, Shobana M, et al. Gestational weight gain and pregnancy outcomes in relation to body mass index in Asian Indian women. Indian J Endocr Meta. 2017; 21(4): 588-593.

15. Chen C-N, Chen H-S, Hsu H-C. Maternal Prepregnancy Body Mass Index, Gestational Weight Gain, and Risk of Adverse Perinatal Outcomes in Taiwan: A Population-Based Birth Cohort Study. Int J Environ Res Public Health 2020; 17(4):1221.

16. Spradley FT. Metabolic abnormalities and obesity's impact on the risk for developing preeclampsia. Am J Physiol-Reg I 2017; 312(1):R5–12.

17. Jensen DM, Ovesen P, Beck-Nielsen H, Molsted-Pedersen L, Sorensen B, Vinter C, et al. Gestational Weight Gain and Pregnancy Outcomes in 481 Obese Glucose-Tolerant Women. Diabetes Care 2005; 28(9):2118–22.

18. Kristiansson P, Wang JX. Reproductive hormones and blood pressure during pregnancy. Hum Reprod 2001; 16(1):13–7.

19. Mistry HD, Wilson V, Ramsay MM, Symonds ME, Pipkin FB. Reduced Selenium Concentrations and Glutathione Peroxidase Activity in Preeclamptic Pregnancies. Hypertens 2008; 52(5):881–8.

20. Cherry FF, Bennett EA, Bazzano GS, Johnson LK, Fosmire GJ, Batson HK. (1981). Plasma zinc in hypertension/toxemia and other reproductive variables in adolescent pregnancy. Am J Clin Nutr 1981; 34(11):2367-75.

21. Poston L, Harthoorn LF, van der Beek EM. Obesity in Pregnancy: Implications for the Mother and Lifelong Health of the Child. A Consensus Statement. Pediatr Res 2011; 69(2):175–80.

22. Patel K, Chaudhary M, Shah M. Effect of gestational weight gain on pregnancy outcome of Indian mothers. *Int* J Reprod Contracept Obstet Gynecol 2020; 9(4):1681.

23. Arora R, Arora D, Patumanoud J. Risk of high gestational weight gain on adverse pregnancy outcomes. OJOG 2013; 3: 142-147.

Table 1: Socio-demographic characteristics of the women under study

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Variables	Mean±SD	Range
Age (in years)	28.97±4.719	4.719
Monthly family income (INR)	69144.495±130406.537	1190000.000
	N	%
Education, college and above	164	75.229
Occupation, salaried job	58	26.600
Socio-economic class		
Upper	04	1.80
Upper middle	85	39.0
Lower middle	57	26.10
Upper lower	68	31.20
Lower	04	1.80

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Table 2: Anthropometric and haemodynamic characteristics of the pregnant women.

Characteristics (mean±SD)		Total Gestational Weight Gain			
	Total (N=218)	<25th Percentile Low (N=54)	25th-75th Percentile Average (N=110)	>75th Percentile High (N=54)	F value
1st trimester weight(Kg)	61.122±12.787	64.629±14.385	60.322±10.872	59.246±14.210	0.059
2nd trimester weight(Kg)	64.452±13.053	65.324±14.969	63.922±11.031	64.661±14.897	0.216
3rd trimester weight(Kg)	71.827±12.772	69.368±13.566	70.849±10.851	76.277±14.607	4.761*
Early pregnancy weight change(Kg)§,§§	3.329±3.574	0.694±3.304	3.60±2.814	5.414±3.665	30.829*
Late pregnancy weight change (Kg)§,§§	7.374±4.316	4.044±3.484	6.926±3.165	11.616±3.674	69.850*
1st trimester BMI (Kg/m^2)	24.317±4.719	25.955±5.236	24.045±4.147	23.231±4.932	5.046*
2nd trimester BMI (Kg/m^2)	25.653±4.806	26.240±5.528	25.479±4.216	25.420±5.195	0.537
3rd trimester BMI (Kg/m^2)	28.581±4.667	27.851±4.957	28.243±4.195	29.998±5.061	3.514*
Total gestational BMI change (Kg/m^2)§,§§	4.262±2.039	1.896±1.304	4.198±0.736	6.766±1.452	263.925*
Early pregnancy BMI change (Kg/m^2)§,§§	1.336±1.427	0.285±1.320	1.433±1.110	2.188±1.473	31.420*
Late pregnancy BMI change (Kg/m^2)§,§§	2.928±1.727	1.611±1.412	2.764±1.259	4.577±1.536	68.848*
1st trimester SBP(mmHg)	119.56±11.810	120.65±14.395	119.27±9.226	119.04±13.681	0.313
2nd trimester SBP(mmHg)	119.26±14.253	119.20±16.476	119.04±12.621	119.78±15.242	0.049
3rd trimester SBP(mmHg)	123.65±15.188	125.46±18.4	122.16±13.087	124.85±15.628	1.081

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Total gestational SBP change(mmHg)	4.091±16.315	4.814±17.344	2.890±14.452	5.814±18.787	0.650
Early pregnancy SBP change(mmHg)	-0.293±13.327	-1.444±13.011	-0.236±13.217	0.740±14.008	0.363
Late pregnancy SBP change(mmHg)	4.385±15.159	6.259±15.797	3.127±15.179	5.074±14.495	0.846
1st trimester DBP(mmHg)	77.75±7.874	77.37±8.614	78.11±7.363	77.41±8.222	0.227
2nd trimester DBP(mmHg)	76.80±9.175	77.72±10.097	76.13±8.505	77.24±9.592	0.629
3rd trimester DBP(mmHg)	78.34±10.189	78.87±10.172	77.95±7.963	78.61±13.801	0.173
Total gestational DBP change(mmHg)	0.587±11.311	1.500±10.898	-0.163±9.331	1.203±14.953	0.496
Early pregnancy DBP change(mmHg)	-0.954±8.439	0.351±8.984	-1.981±8.116	-0.166±8.417	1.708
Late pregnancy DBP change(mmHg)	1.541±11.404	1.148±11.134	1.818±10.051	1.370±14.155	0.070
1st trimester MAP(mmHg)	91.77±8.676	91.83±9.424	92.18±7.782	90.87±9.678	0.413
2nd trimester MAP(mmHg)	90.79±10.304	91.31±11.548	90.46±9.468	90.93±10.793	0.129
3rd trimester MAP(mmHg)	93.06±9.955	93.63±11.884	91.97±8.064	94.72±11.190	1.504
Total gestational MAP change(mmHg)	1.293±11.609	1.796±11.975	-0.209±10.419	3.851±13.172	2.311
Early pregnancy MAP change(mmHg)	-0.981±9.315	-0.518±9.004	-1.718±9.485	0.055±9.311	0.744
Late pregnancy MAP change(mmHg)	2.275±10.847	2.314±11.572	1.509±10.634	3.796±10.567	0.804
Birth weight (Gram)§§§	2770.90±423.486	2642.13±385.497	2795.56±437.435	2849.44±409.510	3.702*

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*significant difference at 0.05 level. One-way ANOVA with Scheffe's post-hoc test revealed that
§ Group 2 has significantly higher mean than Group 1.
§§ Group 2 has significantly lower mean than Group 3.
§§§ Group 3 has significantly higher mean than Group 1.

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Figure 1: Trimester-specific percentile distribution of anthropometric and haemodynamic characteristics of pregnant women.