PERINATAL JOURNAL

Original Article

Perinatal Journal 2023;31(3):250-255

The role of gestational weight gain in hypertensive disorders of pregnancy: open prospective cohort study

Bolanle Okunowo[1], Akinsanya Olusegun-Joseph[2], Adeyemi Okunowo[3], Omololu Adegbola[3], Efedaye Ohwovoriole[4]

[1]Lagos State University Teaching Hospital, Diabetes and Metabolism Unit, Department of Medicine, Endocrinology, Lagos, Nigeria

[2]University of Lagos/Lagos University Teaching Hospital, College of Medicine, Department of Internal Medicine, Lagos Nigeria

[3]University of Lagos/Lagos University Teaching Hospital, Department of Obstetrics and Gynaecology, College of Medicine, Lagos, Nigeria

[4]University of Lagos, College of Medicine, Diabetes and Metabolic Unit, Department of Internal Medicine, Endocrinology, Lagos, Nigeria

Abstract

Objective: To determine the impact of Gestational Weight gain and Prepregnancy weight as risk factors for Pregnancy Induced Hypertension.

Methods: The study was a prospective open cohort study at antenatal clinic of Lagos University Teaching Hospital, Nigeria. Ninety pregnant women who were previously not hypertensive prior to conception and booking were recruited for the study. The blood pressure and weight were done at booking and they were followed up till delivery. The pregnant women had no chronic medical condition. The P value of < 0.05 was considered significant.

Results: The frequency of pregnancy induced hypertension was 43 (47.8%). The overall gestational weight gain and prepregnancy weight in pregnant women who developed pregnancy induced hypertension were compared to those without pregnancy induced hypertension. The mean overall weight gain in pregnancy was 11.75 ±4.53kg while mean prepregnancy weight was 65.78±11.52kg. About 37 (41.1%) of the pregnant women had gestational weight gain in the obese and overweight category using the Institute of Medicine classification. The pregnant women who were in the obese and overweight category using the Institute of Medicine classification system were 60.5%. These women had pregnancy induced hypertension while using gestational weight gain greater than 12kg, about 69.8% of woman had pregnancy induced hypertension. Meanwhile 67.4% of pregnant women with prepregnancy, Body Mass Index in the obese and overweight category had pregnancy induced hypertension (Risk ratio (95% confidence interval) 3.66 (1.53-8.75).

Conclusion: Gestational weight gain can be used as a screening tool to predict those at risk for pregnancy induced hypertension especially in pregnant women with prepregnant body mass index in the obese and overweight category in resource poor settings.

Keywords: Delivery, gestational weight gain , institute of medicine, prepregnancy weight, pregnancy induced hypertension

Introduction

Hypertensive disorders are one of the common complications in pregnancy accounting for about 10% of complication globally.[1] Hypertensive disorders in Pregnancy (HDP) includes Pregnancy Induced Hypertension (PIH), Pre-eclampsia and Chronic hypertension.[2,3] The aetiology of HDP remains unknown, however Gestational weight gain(GWG) and Prepregnancy weight have been implicated as one of the risk factors for HDP especially PIH and Preeclampsia.[4] Preeclampsia is the occurrence of hypertension and proteinuria after 20 weeks of gestation while PIH is hypertension without proteinuria.[5] It is associated with increased maternal and fetal morbidity and mortality.[6,7] PIH remains a risk factor for development of chronic hypertension and other cardiovascular diseases.[8-11]

There are physiological changes that occurs in a normal pregnancy such as plasma volume expansion, increase maternal caloric and nutrient intake, reduce physical activity as pregnancy advances with the uterine contents such as growing fetus, amniotic fluid and placenta. [4,12] These changes can cause weight difference of the pregnant woman from pregestational weight. However, excessive GWG and prepregnancy weight are independent and modifiable risk factor for the adverse complications of pregnancy such as PIH and preeclampsia.[13] The Ins-

Correspondence: Bolanle Okunowo, Department of Medicine, Endocrinology, Diabetes and Metabolism Unit, Lagos State University Teaching Hospital, Lagos, Nigeria, **e-mail:** aboutbolanle@yahoo.com, **Received:** October 2, 2023, **Accepted:** December 4, 2023

How to cite this article: Okunowo B, Olusegun-Joseph A, Okunowo A, Adegbola O, Ohwovoriole E. The role of gestational weight gain in hypertensive disorders of pregnancy: open prospective cohort study. Perinatal Journal 2023;31(3):250-255 DOI: 10.59215/prn.23.0313013

ORCID ID: B Okunowo 0000-0001-5471-6256; A Olusegun-Joseph 0000-0001-7039-7320; A Okunowo 0000-0002-8375-4443; O Adegbola 0000-0001-5026-2330; E Ohwovoriole 0000-0002-4976-8622

CETUS Publishing

titute of Medicine (IOM) has guidelines for appropriateness of weight gain in pregnancy. The recommended weight gains for underweight (BMI < 18.5 kg/m2) 12.5–18kg, normal weight (BMI = 18.5–24.9 kg/m2) 11.5–16kg, overweight (BMI = 25.0–29.9 kg/m2) 7.0–11.5kg and obese women (BMI > 30.0 kg/m2) 5-9kg.[14]

This is an area that have not been well researched, only few studies have examined the association between IOM guidelines and risk of PIH in Nigeria and Africa generally. Most studies reported in the literatures were mainly on the impact of HDP on pregnancy outcomes rather than the risk factors for HDP. This study aims to determine the impact of GWG and Pre-pregnancy weight as risk factors for PIH. Hence the results of this study will be very useful to the clinicians in the management of HDP.

Methods

The study was an open prospective cohort, carried out at the Lagos University Teaching Hospital (LUTH), Lagos state, South Western Nigeria. The study population from which the participants were sampled consisted of pregnant women at first and second trimester who attended the antenatal clinics in LUTH during the period of recruitment and newborns of the index pregnancies.

The main outcome of this study is PIH. The inclusion criteria were pregnant Nigerian women without hypertension, those women at gestational age of within 13 to 24 weeks at the time of recruitment and those who accepted to participate and gave informed consent. Studies have showed that the gestational age at booking is generally late in Nigerians.[15-16] The exclusion criteria were pregnant women with multiple gestations from result of booking ultrasound scan or as stated in their case notes, those women with pre-gestational diabetes mellitus from history documented in booking notes, women who cannot recall their pre-pregnancy weight, those been managed for chronic medical conditions, women on medications that could affect glucose tolerance in pregnancy for example beta adrenergic agonists, steroids e.t.c as documented in booking notes.[7] and women who did not accept to participate in the study nor gave informed consent.

The sample size for the study objective was determined using a correlational formula and assuming a significance level of 0.05 in a two-tailed analysis, a moderate effect size (rho=3 according to Cohen)[8] and allowing for 20% attrition rate in view of the prospective nature of the study, a total of 90 mother to newborn pairs were recruited for the study. This sample size has a power of 80%.

The research null hypothesis states there is no relationship between GWG, Pre-pregnancy weight and PIH.

The participants were recruited through simple random sampling method between 1st March 2017 and 30th June 2017 from the antenatal clinics between gestational age within 13 to 24 weeks. The sampling frame consisted of all the pregnant women that attended and received care in the antenatal clinic. Eligible pregnant women, who met the inclusion criteria at each clinic day, were randomly selected using the table of random numbers and were invited to participate in the study. Women who gave consent to be part of the study were enrolled into the study until the desired sample size was attained. The study participants were categorized into underweight, normal weight, overweight and obesity at the time of recruitment.

A structured study data form was used to collect information on participant's sociodemographic, medical, obstetrics and reproductive characteristics. Maternal blood pressure, pulse rate and anthropometric characteristics were also obtained at the time of recruitment. Their prepregnancy weight was noted as well as weight at recruitment which were also recorded and followed up till 37 weeks gestation. The pregnant women blood pressure was measured using mercury sphygmomanometer in a sitting position after resting for 15 minutes. Diagnosis of HDP was made based on ACOG guidelines. Women diagnosed with HDP were managed according to standard treatment protocol and all the study participants were followed up till 37 weeks gestation.

The anthropometric measurements were taken using standard techniques.[1] Two measurements were taken and average value used. If the measurements differ by 1kg, a third measurement was taken. The average of the two was used, otherwise the average of three. This was to minimize intra and inter observational errors.

Ethical approval for the study was obtained from LUTH ethical committee (ethical approval number AM/DCST/HREC/APP/862). Informed consent was obtained from all the participants before the commencement of the study.

Data generated from clinical and biophysical parameters were analyzed using statistical package for social science (SPSS) version 26 along with Microsoft excel P value <0.05 was considered to be statistically significant. Descriptive statistics were presented as mean and 95% confidence interval for data that were normally distributed. The proportion of pregnant women who were obese, overweight, normal weight and underweight were determined. The mean systolic and diastolic blood pressure was determined for each group of pregnant women. The average blood pressure and weight gain per week was noted for each pregnant woman. Tables was used to present

the data obtained. Chi square statistics was used to compare proportions between the groups of pregnant women based on pre-pregnancy weight and weight gain in pregnancy. Risk ratio and 95% confidence interval were used to determine clinical significance. The strength of predictive value of a variable was determined using risk ratio.

Results

Table 1 showed the baseline characteristics of the pregnant women. The overall average age was 32.61 ± 4.89 years while the average prepregnancy weight was 65.78 ± 11.52kg.

Table 1. Baseline Characteristics of Pregnant women

Parameters of mothers	Mean ± SD	95% Confidence Interval
Age (years)	32.61 ±4.89	31.59-33.63
EGA(weeks+days)	12.90 ± 3.30	12.25-13.61
Prepregnancy weight (kg)	65.78 ±11.52	63.37-68.20
Booking weight (kg)	67.55 ± 11.88	65.06-70.04
Weight at delivery (kg) **GWG (kg)**	77.88 ± 13.85 11.75± 4.53	74.98-80.78 10.80-12.70

EGA: estimated gestation age, GWG: gestational weight gain

Those women with PIH, the mean age was 32.40±5.27 years and those without PIH, the mean age was 32.81±4.56 years. The frequency of PIH was 43 (47.8%).

Table 2. Relationship between weight, pregnancy and PIH

Parameters (Kg)	PIH (Mean ± SD)	Normal (Mean ± SD)	p value
PrePregnancy weight	67.77 ±10.9	62.13 ±10.91	0.001
Weight at booking	71.79 ±11.13	63.67 ±11.2	0.001
Weight at 37 weeks gestation	83.81 ±12.66	72.46±13.23	0.001
GWG	13.95 ±4.00	9.74 ± 4.05	0.001
Mean change in weight per week	0.380 ±0.11	0.264 ±0.11	0.001

GWG: gestational weight gain, PIH: pregnancy induced hypertension

The women who developed PIH had a higher blood pressure at booking and also higher blood pressure at delivery. The mean rise in blood pressure per gestational age was statistically significant (p value 0.001).

Table 3. Relationship between blood pressure, pregnancy and PIH

Parameters	PIH (Mean ±SD)	Normal (Mean±SD)	p value
PR at booking (bpm)	83.30 ±4.86	81.85±5.81	0.205
PR at 37 weeks gestation (bpm)	91.72±6.25	90.74 ±8.08	0.610
Pulse difference (bpm)	8.33 ±6.35	9.09 ±6.24	0.569
SBP at booking(mmHg)	117.86±12.10	108.04±10.02	0.001
SBP at 37 weeks gestation (mmHg)	148.19±12.05	126.64±9.19	<0.001
DBP at booking(mmHg)	70.30 ±10.60	64.81±8.54	<0.001
DBP at 37 weeks gestation (mmHg)	89.56±7.95	76.28±9.98	<0.001
Mean change in SBP(mmHg)	1.31±0.48	0.72 ±0.45	<0.001
Mean change in DBP(mmHg)	0.94 ±0.49	0.48 ±0.33	0.001

SBP;systolic blood pressure,DBP;diastolic blood pressure,PR pulse rate, PIH: pregnancy induced hypertension.

Table 4 compared the initial prepregnancy weight, absolute weight gain in pregnancy and excessive weight gain (based on IOM classification) in the women who developed PIH and those without PIH. The average overall weight gain in pregnancy was 11.75 ±4.53kg while average prepregnancy weight was 65.78±11.52kg. Using the initial prepregnancy weight category, 67.4% of pregnant women who were categorized into the obese and overweight category had PIH (risk ratio (95% confidence interval) 3.66 (1.53-8.75). Meanwhile, 37 (41.1%) of the pregnant women using the IOM classification had excessive weight gain in the obese and overweight category. Out of these pregnant women in the obese and overweight category using IOM classification, 60.5% had PIH (risk ratio (95%confidence interval) 5.01 (2.01-12.45). While using the absolute weight gain in pregnancy greater than 12kg, 69.8% of woman had PIH.

Table 4. Factors influencing PIH

Parameters	PIH (Number (%))	Normal (Number (%))	Total (Number (%))	Chi square value	p value	Risk ratio (95% Confidence interval)
Initial weight category (prepregnancy weight category)						
Obese/overweight	29 (67.4)	17 (36.2)	46 (51.1)	8.788	0.003	**3.66 (1.53-8.75)**
Normal/Underweight	14 (32.6)	30 (63.8)	44 (48.9			
Absolute weight gain in pregnancy						
>12kg	30 (69.8)	12 (25.6)	42(46.7)	25.88	<0.001	
10-12kg	10 (23.2)	9 (19.10)	19 (21.1)			
<10kg	3 (7.0)	26 (55.3)	29 (32.2)			
Excessive weight gain (IOM recommendation)						
Overweight/obese	26 (60.5)	11 (23.4)	37 (41.1)	12.74	<0.001	**5.01 (2.01-12.45)**
Normal/underweight	17 (39.5)	36 (76.6)	53 (58.9)			
Parity						
Nullipara	9(19.6)	4 (9.0)	13 (14.4)	2.480	0.234	
Primipara	6 (13.0)	9 (20.5)	15 (16.7)			
Multipara	31(67.4)	31 (70.5)	62 (68.9)			
Family history of Hypertension						
No	29 (63.0)	33 (75.0)	62(68.9)	1.500	0.259	
Yes	17(37.0)	11 (25,0)	28 (31.1)			

IOM; Institute Of Medicine, PIH; Pregnancy Induced Hypertension

Discussion

Higher prepregnancy weight has been linked to development of pregnancy induced hypertension. Women with PIH had a higher prepregnancy weight and gestational weight gain, this is similar to the findings by IOM.The IOM in 2009 similarly showed the risk of development of PIH with overweight and obese weight gain in pregnancy.[14] Several studies have shown the association and risk of hypertensive disorder in pregnancy in those with higher prepregnancy weight and excessive weight gain in pregnancy.[17-19] The risk of development of PIH increases by 5-fold with increase weight in the overweight and obese range of IOM classification (RR; 5.01) in this study. Also, this study demonstrated approximately four-fold increase risk of PIH (RR; 3.66) with prepregnancy weight in the obese and overweight women. Those with PIH also had a higher weight gain and blood pressure rise per gestational week from booking to 37 weeks of gestation. This may be linked to the relationship between overweight and obesity to insulin resistance and endothelial dysfunction.

Mori T et al [20] demonstrated that women with pre-eclampsia had significantly lower plasma concentrations of adiponectin but higher concentrations of leptin, plasminogen activator inhibitor-1, interleukin-6, vascular cell adhesion molecule-1, E-selectin and C-reactive protein. He also showed that their plasma triglyceride levels were significantly higher in preeclamptic women with reduced flow-mediated vasodilation. Their plasma adiponectin concentrations correlated negatively with their body mass index. The decrease in plasma adiponectin concentrations is linked with the development of endothelial dysfunction in preeclamptic women.

This is a prospective cohort which gives a higher level of evidence-based study. Also, gestational weight gain as a risk factor for PIH has not been well researched. Only few studies have examined the association between Institute of Medicine (IOM) guidelines on gestational weight gain and risk associated with development of Pregnancy Induced Hypertension (PIH). To the best of our knowledge, there is no literature on the subject in Nigeria and Afri-

ca. Most studies reported in the literatures were mainly on the impact of Hypertensive Disorder of Pregnancy (HDP) on pregnancy outcomes rather than the impact of GWG as a risk factor for the development of PIH.

In our study, pre-pregnancy weight was self-reported which was seen in other similar studies.[21,22] Self-reported pre-pregnancy weight may be subject to recall bias. However, a study by Shin et al showed the validity of self-reported prepregnancy weight and measured weight.[23] Similar study also done by Oken et al showed a correlation of 0.99 between self-reported and measured prepregnancy weight.[24]

The IOM recommendations are mainly from population information from North America, which limits its use in other ethnicities. Most African women generally have a lower BMI prior to pregnancy than those in Westernized societies countries, hence gestational weight gain in pregnancy greater than 12kg was also compared in this study. This is because the IOM classification has not been extensively studied in other ethnicities. However, there are no clear recommendations for BMI and GWG cut-off points among Africans.

Excessive gestational weight gain is associated with development of pregnancy induced hypertension; hence this should be monitored in pregnancy and the women counselled appropriately.

Conclusion

Excessive prepregnancy weight and GWG according to the IOM recommendations are associated with the risk of HDP especially PIH and should therefore be avoided. Assessment risk model using GWG can be used to predict those at risk for PIH in resource poor settings. Women should be counselled against excessive weight prior to conception and need to avoid excessive weight gain in pregnancy. The need to eat healthy with plenty of fruits, exercise and reduction of sugary and excessive calory food should be stressed to our pregnant women.

Studies on larger pregnant population needs to be done to further demonstrate these findings.

References

1. World Health Organization, 2011 WHO Recommendations for prevention and treatment of pre-eclampsia and eclampsia.
2. Von Dadelszen P, Magee LA. Preventing deaths due to the hypertensive disorders of Pregnancy. Best Pract Res Clinic Obstet Gynecol 2016;36:83-102. [PubMed][CrossRef]
3. Mol BWJ, Roberts CT, Thangaratinam S, Magee LA, de Groot CJM, Hofmeyr GJ.Preeclampsia, Lancet 2016;387:999-1011. [PubMed][CrossRef]
4. Heude B, Thiebaugeorges O, Goua V, Forhan A, Kaminski M, Foliquet B et al. EDEN mother-child Cohort Study Group. Prepregnancy body mass index and weight gain during Pregnancy: relations with gestational diabetes and hypertension and birth outcome. Matern Child Health J 2012;16: 355-363. [PubMed][CrossRef]
5. Hutcheon JA, Lisonkova S, Joseph KS. Epidemiology of pre-eclampsia and the other hypertensive disorders of pregnancy. Best Pract Res Clin Obstet Gynaecol. 2011;25:391-403. [PubMed][CrossRef]
6. Lenfant C; National Education Program Working Group on High Blood Pressure in Pregnancy. Working group report on high blood pressure in pregnancy. J Clin Hypertens (Greenwich). 2001 ;3:75-88. [PubMed] [CrossRef]
7. Roberts JM, Cooper DW. Pathogenesis and genetics of pre-eclampsia. Lancet. 2001 6;357:53-56. [PubMed] [CrossRef]
8. Brown MC, Best KE, Pearce MS, Waugh J, Robson SC, Bell R. Cardiovascular disease risk in women with pre-eclampsia: systematic review and meta-analysis. European journal of epidemiology. 2013; 28:1-9. [PubMed][CrossRef]
9. Bellamy L, Casas JP, Hingorani AD, Williams DJ. Pre-eclampsia and risk of cardiovascular disease and cancer in later life: systematic review and meta-analysis. BMJ. 2007; 335:974-983. [PubMed][CrossRef]
10. Garovic VD, Hayman SR. Hypertension in pregnancy: an emerging risk factor for cardiovascular disease. Nature clinical practice Nephrology. 2007; 3:613-622. [PubMed] [CrossRef]
11. McDonald SD, Malinowski A, Zhou Q, Yusuf S, Devereaux PJ. Cardiovascular sequelae of preeclampsia/eclampsia: a systematic review and meta-analyses. American heart journal. 2008; 156:918-930. [PubMed][CrossRef]
12. Waring ME, Moore Simas TA, Liao X. Gestational weight gain within recommended ranges in consecutive pregnancies: a retrospective cohort study. Midwifery. 2013;29:550-556. [PubMed][CrossRef]
13. Lei Q, Zhou X, Duan DM, Lv LJ, Lin XH, Ji WJ, Cai W, Zhang Z, Li YM, Niu JM. Trimester-Specific Weight Gain and Midpregnancy Diastolic Blood Pressure Rebound During Normotensive Pregnancy. Hypertension. 2017; 70:804-812. [PubMed][CrossRef]
14. Institute of Medicine (US) and National Research Council (US) Committee to Reexamine IOM Pregnancy Weight Guidelines. Weight Gain During Pregnancy: Reexamining the Guidelines. Rasmussen KM, Yaktine AL, editors. Washington (DC): National Academies Press (US); 2009. . [PubMed]
15. Adegbola O. Gestational age at Antenatal booking in Lagos University Teaching Hospital (LUTH), Nig.Qt. Hosp. Med,2008;12:79-82. [PubMed][CrossRef]
16. Olufemi Olayinka T, Sebutu Bello I, Oluwafemi Olajubu T, Oloyede Oyegbade O, Omobolanle Olajubu A, Tamunotonye Ezeoma I. Factors Influencing the Booking Gestational Age Among Antenatal Clinic Attendees

at Primary Health Centers in South West, Nigeria: A Cross-Sectional Study. SAGE Open Nurs. 2022 Nov 22;8:23779608221139078. [PubMed][CrossRef]

17. la Torre L, Flick AA, Istwan N, Rhea D, Cordova Y, Dieguez C, Desch C, González-Quintero VH. The effect of new antepartum weight gain guidelines and prepregnancy body mass index on the development of pregnancy-related hypertension. Am J Perinatol. 2011;28:285-92. [PubMed] [CrossRef]
18. Macdonald-Wallis C, Tilling K, Fraser A, Nelson SM, Lawlor DA. Gestational weight gain as a risk factor for hypertensive disorders of pregnancy. Am J Obstet Gynecol. 2013;209:327.e1-17. [PubMed][CrossRef]
19. Li H, Miao C, Xu L, Gao H, Bai M, Liu W, Li W, Wu Z, Zhu Y. Maternal pre-pregnancy body mass index, gestational weight gain trajectory, and risk of adverse perinatal outcomes. Int J Gynaecol Obstet. 2022;157:723-732. [PubMed][CrossRef]
20. Mori, T., Shinohara, K., Wakatsuki, A.. Adipocytokines and endothelial function in preeclamptic women. Hypertens Res2010;33: 250–254. [PubMed][CrossRef]
21. Hung TH, Hsieh TT. Pregestational body mass index, gestational weight gain, and risks for adverse pregnancy outcomes among Taiwanese women: A retrospective cohort study. Taiwan J Obstet Gynecol. 2016;55:575-81. [PubMed][CrossRef]
22. Shao, Y., Qiu, J., Huang, H., Mao, B., Dai, W., He, X., Cui, H., Lin, X., Lv, L., Wang, D., Tang, Z., Xu, S., Zhao, N., Zhou, M., Xu, X., Qiu, W., Liu, Q., & Zhang, Y. Pre-pregnancy BMI, gestational weight gain and risk of preeclampsia: a birth cohort study in Lanzhou, China. BMC pregnancy and childbirth 2017; 17: 400-406. [PubMed][CrossRef]
23. Shin D, Chung H, Weatherspoon L, Song WO. Validity of prepregnancy weight status estimated from self-reported height and weight. Matern Child Health J. 2014 Sep; 18:1667-1674. [PubMed][CrossRef]
24. Oken E, Taveras EM, Kleinman KP, Rich-Edwards JW, Gillman MW. Gestational weight gain and child adiposity at age 3 years. Am J Obstet Gynecol. 2007; 196:322. e1-8. [PubMed][CrossRef]