Predictors and Pathways associated with Potentially High-Risk Preeclampsia among Pregnant Women in Selected Health Facilities in Accra, Ghana

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ABSTRACT

Preeclampsia (PE) is one of the major complications associated with pregnancy. The study sought to determine the predictors associated with potentially high risk for PE and their pathways. This was a prospective study conducted among 403 pregnant women, ≤ 20 weeks of gestational age, who attended antenatal clinic at two hospitals in Accra and were followed till 6 weeks postpartum. The Body Mass Index was calculated based on the World Health Organization criteria. Potentially high risk for preeclampsia was defined as having at least one of the following: systolic blood pressure ≥ 130 mmHg, diastolic blood pressure ≥ 80 mmHg, oedema, and proteinuria. Data analyses were carried out using SPSS Version 22. Binary logistic regression and structural equation modeling were performed to determine the predictors and their pathways respectively. Majority 341 (84.6) of the respondents were aged 20-35 years. Pregnant women with estimated pre-pregnancy BMI ≥ 30 kg/m2 and pre-pregnancy weight ≥71 kg were at significantly increased risk of being at a potentially high risk for PE AOR 3.6; 95%CI (1.09 – 11.75) $p < 0.040$ and AOR3.4; 95% CI (1.250 - 12.703) $p < 0.019$ respectively. Anthropometric indices (estimated pre-pregnancy BMI and pre-pregnancy weight) had a statistically significant positive direct relationship with potentially high risk for PE; $\beta = 0.519$; t-value = 8.545; p-value < 0.001). Estimated pre-pregnancy weight and BMI (obesity ≥ 30 kg/m²) were the predictors and also had a significant direct positive relationship with potentially high risk for PE.

Keywords: Pregnancy, preeclampsia, anthropometric indices, predictors, Ghana

1.0. INTRODUCTION

Preeclampsia (PE) is a pregnancy-induced hypertension characterized by high blood pressure of 140mmHg/90mmHg or higher recorded at 4-6 hours interval and symptoms of damage of an essential organ such as liver and kidney (Mayo Foundation for Medical Education and Research, 1998 - 2019). PE

PE can also be developed within 48hours to six weeks after delivery (Mayo Foundation for Medical Research, 1998 - 2020). PE occurs in two forms: mild and severe. Globally, prevalence of PE has been estimated to be 4.6% (Abalos *et al.,* 2013). Prevalence of PE in developing countries ranges between 1.8 to 16.7% (Lakew *et al.,* 2013) with a prevalence of 10% reported among African women (Nakimuli *et al.,* 2014). In Ghana, Browne et al. (2015) in a prospective cohort study of 1010 women of less than 17 weeks of gestation found prevalence of PE to be 1.7% of the 789 women who completed the study (Browne *et al.,* 2015). The prevalence of PE in a cross sectional study carried out at Komfo Anokye Teaching Hospital among 451 pregnant women was found to be 48.8% (Dassah *et al*, 2019). The consequences of undetermined preeclampsia can be detrimental to the foetus and the pregnant woman. Furthermore, PE increased the risk of developing cardiovascular diseases, metabolic syndrome, and psychological problems in the later years of the women and the foetus.

Most of the studies carried out on PE in Ghana has been linked to parity of one (Otu-Nyarko *et al.,* 2015), high triglycerides and BMI $\geq$ 30 kg/m^2 (Ephraim *et al.,* 2014), and serum nitric oxide upregulation as a evidenced by elevated serum nitric oxide metabolite (Adu-Bonsaffoh *et al.,* 2015). This study determined the predictors of potentially high risk for preeclampsia and its pathways.

2.0. MATERIALS AND METHODS

2.1. Study Design, Setting and Participants

This was a prospective follow-up study conducted at two hospitals in Accra from May, 2018 to February, 2020. These were the Ghana Police Hospital and University of Ghana Hospital, all in the Greater Accra Region of Ghana. The Ghana Police Hospital was established in 1976 nineteen years after Ghana attained her independence. It provides quality health care to the members of the Ghana Police Service and the public. The University of Ghana Hospital has 2,000 beds and 17 clinical and diagnostic Departments/Units. It has an average daily attendance of 150 patients and about 30 patient admissions. Potential pregnant women were contacted at the out-patient departments after they have received care at the two healthcare facilities. Information on their gestational age was taken after an oral consent was sought. Screening interview was carried out and the eligible pregnant women were recruited. The participants who were $\leq$ 20 weeks pregnant were briefed on the study and their written consent taken.

2.2. Inclusion Criteria

Pregnant women who have not developed diabetes mellitus, chronic hypertension, have any renal disorders, gestational hypertension, liver disease and PE and were willing to continue all their antenatal and six weeks postpartum clinics at the sele cted hospitals.

2.3. Sampling

Convenient sampling was used in this study. During follow-ups, recruited participants were enrolled at the Out Patients Department of the two health facilities.

2.4. Sample Size Determination

The sample size of 403 was determined using Cochran 1977 sample size formula at a confidence interval of 95%, margin of error of 5%, estimated preeclampsia proportion of 38.0% and attrition rate of 10% (Cochran, 1977).

2.5. Data Collection

Data were collected at baseline (≤ 20 weeks' gestation), midline (28 – 32 weeks' gestation) and endline (6 weeks postpartum). Pre-tested questionnaires were used to collect background characteristics, health and clinical data. Body weight was measured using Camry weighing scale (Zhongshan Camry Electronic, Zhongshan, Guangdong, China) to the nearest 0.1kg whilst height was measured with a stadiometer (model: HM200P Charder USA) to the nearest 0.1cm by participants mounting the foot board of the stadiometer (model: HM200P Charder USA) with the back of their heads, heel and buttocks touching the stadiometer and looking horizontally straight. The weight and height were measured according to the World Health Organization (WHO) guidelines and the body mass index characterized according to the WHO standard (WHO, 1995). Data on oedema and proteinuria were taken at mid-line of gestation along with blood pressure readings. These data were gathered again at six weeks postpartum along with weight and height measurements using the same instruments that were calibrated regularly. The blood pressure readings and proteinuria status were recorded from the pregnant women's hospital folders. Oedema was said to be present if a pregnant woman develops swelling of the feet or fingers or face after 20 weeks gestation.

2.6. Classification of potentially high risk for preeclampsia

Potentially high risk for preeclampsia was defined as having at least a high systolic blood pressure (≥ 130 mmHg) or a high diastolic blood pressure (≥ 80 mmHg) or presence of oedema or proteinuria High systolic blood pressure, high diastolic blood pressure, presence of oedema and proteinuria are risk factors for PE.

2.7. Statistical Analyses

Data input and analysis were carried out in IBM SPSS version 22 (Chicago, USA). Descriptive statistics [mean ± (SD)] was used to characterise continuous data. Background categorical variables were summarized as frequencies and percentages. One or multiple risk factors for potentially high risk for preeclampsia were coded 1 and no risk factor was coded 0 for the regression analysis to determine the predictors. Correlation test was run and variables that

significantly correlated with the dependent variable at $P < 0.05$ were selected to be run in the logistic regression model to determine the association between the independent variables and the dependent variable. The selected variables were analyzed to check for multicollinearity at a variance of inflation factor (VIF) > 5. Structural equation modelling was carried out to determine the pathways through which the predictors operated using SPSS AMOS version 20.

2.8. Ethical Approval

Ethical approval for the study was granted by the Ethics Committee of Basic and Applied Sciences of University of Ghana, Legon, Accra (ECBAS-025/17-18) and the administration of the hospitals. Before recruitment into the study, participants were briefed on the entire study. Participants were informed that they were free to opt out of the study if the need be without any negative consequences. Participants who were potentially at risk of developing PE were referred to the doctors for additional care.

3.0. RESULTS

3.1. Background Characteristics of the Participants

The mean age of the women was 30.6 ± 4.7 years with majority of them 341 (84.6%) being in the age range of 20 - 35 years. Almost one-half of the number of participants, 194 (48.1%), had obtained tertiary education with 22 (5.5%) having had no formal education. A total of 166 (41.0%) were self-employed with 47 (11.7%) being unemployed. A majority of the women were married 347 (86.1%) and 166 (41.2%) were Akans. (Table 1.0).

Table 1: Background Characteristics of the Pregnant Women

Characteristics	**n (%)**
Age (year)	30.6 ± 4.7
≤ 19	1 (0.2)
20 – 35	341 (84.6)
≥ 36	61 (15.2)

Ethnicity	
Krobo	4 (1.0)
Akan	166 (41.2)
Ga/Adangbe	71 (17.6)
Ewe	73 (18.1)
Northern ethnicities	83 (20.6)
[1]Other	6 (1.5)
Marital status	
Single	27 (6.7)
Married	347 (86.1)
Co-habiting	25 (6.2)
Divorced/Widowed	4 (1.0)
Highest educational level attained	
None/Primary	22 (5.5)
[1]JHS/MSLC	77 (19.1)
[2]SHS/GCE (OL/AL)/Tech/Voc	110 (27.3)
[3]Tertiary	194 (48.1)
Occupation	
Unemployed	47 (11.7)
[1]Self employed	166 (41.2)
[2]Public servants	124 (30.8)
[3]Other	66 (16.4)

n = 403. JHS/MSLC denotes Junior High School/Middle School Leavers Certificate [2]SHS/GCE (OL/AL)/Tech/Voc denotes Senior High School/ General Certificate Examination (Ordinary level/Advance Level)/ Technical School level/Vocational Education [3]Tertiary denotes Teachers' and Nurses' Training Colleges, Polytechnics, University and higher learning Institutions [1]Other denotes Nzema, Guan etc [2]Public servants denote Government employed professionals (teachers, nurses, medical doctors, pharmacists, lecturers, researches, administrators, police officers etc) [3]Other denotes private hired jobs [1]Self employed denotes traders, beauticians, fashion designers, food vendors etc

3.2. Binary Logistic Regression to show factors associated with Potentially High Risk for Preeclampsia

Estimated pre-pregnancy weight > 71 and pre-pregnancy body mass index ≥ 30 were significantly associated with potentially high risk of developing PE; 3.4 (1.250 - 12.703) p value 0.019 and 3.6 (1.09 – 11.75) p value 0.040 respectively (Table 2.0).

Table 2: Factors Associated with Potentially High Risk for Preeclampsia

Variable	AOR (95% CI)	P value
Maternal age		
≤35	0.9 (0.298 - 2.645)	0.831
≥ 36	1	
Serum vitamin D		
Deficiency	1.1 (0.096 – 12.856)	0.934
Non deficiency	1	
Estimated pre - pregnancy BMI		
≥ 30	3.6 (1.09 – 11.75)	**0.040***
< 30	1	
Estimated pre-pregnancy weight		
> 71	3.4 (1.250 - 12.703)	**0.019***
≤ 71	1	
Primiparity		
Yes	1.2 (0.410 - 3.413)	0.755
No	1	
Serum calcium		
Deficiency	4.8 (0.458 – 49.835)	0.191
Non deficiency	1	
Age at first birth		
≤ 35	0.4 (0.042 - 4.532)	0.488
> 35	1	

Hosmer-Lemeshow Statistic: P = 0.731; Nagelkerke R^2 = 0.419 *denotes associations that were significant at p value of < 0.05

Pathways of predictors on potentially high risk for PE

The socio -demographic characteristics had a negative, direct, non – significant association with potentially high risk for PE, gynaecological factors had a direct positive but non - significant association with potentially high risk for PE and anthropometric indices had a direct, positive significant association with potentially high risk for PE.

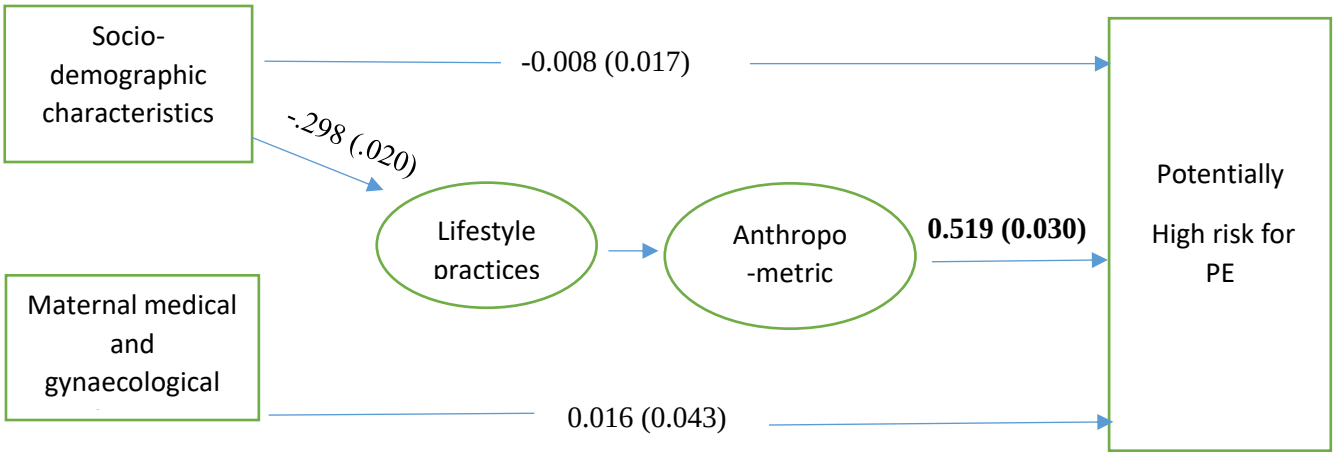

Figure 1: Conceptual framework of the relationship between predictors and potentially high risk for PE

4.0. DISCUSSION

4.1. Predictors of Potentially high Risk for Preeclampsia

The pre-pregnancy body weight and pre-pregnancy body mass index were the predictors of potentially high risk preeeclampsia. Pregnant women with estimated pre-pregnancy bodyweight of > 71 kg were at a potentially high risk for PE compared with those with a weight ≤ 71kg likewise pregnant women with estimated pre- pregnancy body mass index of < 30 were less likely to be at potentially high risk for preeclampsia compared with those who were obese. This high body weight and body mass index recorded may be due to the Ghanaian women preference for high body weight/body mass index (Appiah *et al.*, 2016). Excessive weight gain can lead to atherosclerosis and hence build-up of high blood pressure (World Heart Federation, 2017).

Similarly, the findings of Mrema among pregnant women in Tanzania indicated that obese women were at a higher risk of developing preeclampsia compared to those with normal BMI (Mrema *et al.*, 2018). Canto-Cetina and colleagues in a study in Mexico found preeclamptics to have a higher pre-pregnancy body mass index compared with non – preeclamptics (Canto-Cetina *et al.*, 2018). A meta-analysis by Poorolajal and Jenabi indicated that obesity was associated with a high risk of developing PE

(Poorolajal and Jenabi, 2016). Furthermore, Bej and colleagues in a study in India, found increased BMI to be associated with high risk of developing PE (Bej *et al.,* 2013). In Columbia, USA, increased BMI was also found to be associated with high risk for PE (Ayala-Ramírez *et al.,* 2020). Furthermore, an inverse relation is created between serum vitamin D level and obesity as a result of volumetric dilution (Walsh *et al.,* 2017) and vitamin D plays critical role in regulating the Renin-Angiotensin System (RAS) and thus influencing the regulation of blood pressure (Li *et al.,* 2002; Li *et al.,* 2004). The pathways showed that as the anthropometric indices increase one's risk of being at a potentially high risk for PE also increase. This can be attributed to the fact that high body weight as well as high body mass index have been known to lead to build–up of blood pressure through downward regulation of nitric oxide secondary to upward regulation of asymmetric dimethylarginine (ADMA) and oxidative stress or through increased expression of sympathetic tone and angiotensinogen by adipose tissue (Dandona *et al.,* 2005).

4.2. Strengths and weaknesses of the study

This study has added onto the knowledge previously known about PE; prevalence of potentially high risk for PE, its predictors and the pathways through which these predictors operate. However, there are limitations to this study. First and foremost, percentage body fat should have been measured instead of BMI to really know that the excess weight is due to fat and not muscles. Secondly, biochemical analysis for 25 hydroxyvitamin D, calcium and magnesium were only carried out with samples at the baseline hence the influence on PE should their concentration change in the cause of the study would be missed out because of financial challenge. Thirdly, serum vitamin D, calcium, haemoglobin and magnesium were the only biochemical data determined even though there are other biochemical data which may be of importance due to financial constraint. Fourthly, the study was limited to public hospitals hence the findings cannot be generalized since public and private hospitals may have different practices which may/not influence the development of PE or place one at any potentially risk of developing PE. Finally, out of the 403 participant recruited, only 203 gave us their blood samples and this can go a long way to affect the analysis and their reasons for refusing to give their blood samples were anaemic and also they were afraid their blood will be used for ritual. The findings from this research will serve as a basis for future research on PE and work as a reference for policy planners in their quest towards curbing this menace.

5.0. CONCLUSIONS

Predictors of PE were pre-pregnancy weight and pre-pregnancy body mass index. These anthropometric indices had a direct positive significant association with potentially high risk for PE. Women should be

encouraged during antenatal attendance not to gain weight more that recommended by the Institute of Medicine guidelines. Additional education should be provided to them regarding energy intake and the consequences of preeclampsia on their health and that of the foetus.

Authors contribution

Heckel Amoabeng Abban; was involved with study design, data collection and input, analysis and writing of manuscript.

Seth Adu-Afarwuah; was involved in data collection, analysis and the writing of the manuscript.

Timothy Senuyeme; was involved with the data collection and diagnosis.

Obed Akwaa Harrison; was involved in writing of manuscript.

Samuel Otu – Nyarko; was involved with data collection, writing and reading of the manuscript.

Frederick Vuvor; was involved with data collection and writing of manuscript.

Jacob Setorglo; was involved with study design, data interpretation, and writing of manuscript.

Matilda Steiner- Asiedu; was involved with data collection, analysis and manuscript writing.

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Conflict of Interest

The Authors declare no conflict of interest.

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