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Research Article

Incidence and Predictive Factors of Gestational Hypertension in a Pregnant Population of Abidjan, Côte d'Ivoire: A Cohort Study

Incidence et Facteurs Prédictifs de l'Hypertension Gestationnelle dans un Groupe de Femmes Ivoiriennes d'Abidjan, Côte d'Ivoire : Une Étude de Cohorte

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ABSTRACT

Introduction. In sub-Saharan Africa, hypertensive disorders in pregnancy including gestational hypertension are the second leading cause of maternal mortality. The study aimed to determine incidence rate and predictive factors of gestational hypertension in a population of Abidjan pregnant women. **Methodology.** This was a multicenter prospective cohort study over a period of 9 months from February 2022 to May 2023 enrolling pregnant women followed up in 5 health facilities in the Abobo East Health District located in the municipality of Abobo (Côte d'Ivoire, West Africa). **Results.** Three hundred and forty-one pregnant women were followed up with an average age of 27.03 ± 6.09 years. We noted 40 new cases of hypertension, representing a cumulative incidence of 11.7%. Incidence density (ID) was 4.5 cases per 1000 women-months of follow-up. Three factors were positively associated with gestational hypertension: Age (p=, 95% CI, obesity at inclusion and heart rate at inclusion. After multivariate analysis, only obesity appeared to be an independent factor associated with gestational hypertension (p=0.04). **Conclusion.** Incidence rate of gestational hypertension is relatively high in our population, with obesity as the independent factor associated with it.

RESUME

Introduction. En Afrique subsaharienne, les troubles hypertensifs de la grossesse, y compris l'hypertension gestationnelle, sont la deuxième cause de mortalité maternelle. L'étude visait à déterminer le taux d'incidence et les facteurs prédictifs de l'hypertension gestationnelle dans une population de femmes enceintes d'Abidjan. **Méthodologie.** Il s'agissait d'une étude de cohorte prospective multicentrique sur une période de 9 mois allant de février 2022 à mai 2023 enrôlant des femmes enceintes suivies dans 5 formations sanitaires du district sanitaire d'Abobo Est situé dans la commune d'Abobo (Côte d'Ivoire, Afrique de l'Ouest). **Résultats.** Trois cent quarante et une femmes enceintes ont été suivies avec un âge moyen de 27,03 ± 6,09 ans. Nous avons noté 40 nouveaux cas d'hypertension, soit une incidence cumulée de 11,7%. La densité d'incidence (DI) était de 4,5 cas pour 1000 femmes-mois de suivi. Trois facteurs ont été positivement associés à l'hypertension gestationnelle : L'âge (p=, 95% CI, l'obésité à l'inclusion et la fréquence cardiaque à l'inclusion. Après analyse multivariée, seule l'obésité est apparue comme un facteur indépendant associé à l'hypertension gestationnelle (p=0,04). **Conclusion.** Le taux d'incidence de l'hypertension gestationnelle est relativement élevé dans notre population, l'obésité étant le facteur indépendant associé à cette hypertension.

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KEY RESULTS

Aim of the Study
In sub-Saharan Africa, hypertensive disorders in pregnancy including gestational hypertension are the second leading cause of maternal mortality.

Key findings

1. Three hundred and forty-one pregnant women were followed up with an average age of 27.03 ± 6.09 years. We noted 40 new cases of hypertension, representing a cumulative incidence of 11.7%. Incidence density (ID) was 4.5 cases per 1000 women-months of follow-up.

2. Three factors were positively associated with gestational hypertension: Age (p=, 95% CI, obesity at inclusion and heart rate at inclusion.

3. After multivariate analysis, only obesity appeared to be an independent factor associated with gestational hypertension (p=0.04).

Implications for Future policies and practices
Setting up continuing education programs for healthcare professionals on the early detection and management of these disorders as well as awareness-raising programs on the risks of these disorders, targeting women of childbearing age.

1. INTRODUCTION

Hypertensive disorders in pregnancy, including gestational hypertension, have become a major public health problem. They are associated with increased risk of maternal, fetal, and neonatal morbidity and mortality [1]. The prevalence of hypertensives disorders in pregnancy varies according to region, with a global prevalence of 116 per 100 000 women of childbearing age and Africa region had the highest prevalence with 335 per 100 000 women of childbearing age [2]. These disorders are responsible for 16% of maternal deaths in high-income countries and approximately 25% in low- and middle-income countries. They are the 2nd leading cause of maternal death overall [3], with a rate of 14% or approximately 42,000 deaths a year. In sub-Saharan Africa, according to a meta-analysis, the pooled prevalence of hypertensive disorders of pregnancy was 8%, with 4.1% attributable to gestational hypertension (4) and these disorders are the second leading cause of maternal mortality [5]. Gestational hypertensive syndrome, is a heterogeneous group of conditions whose common denominator is an increase in blood pressure. Arterial hypertension, being the most frequent medical complication of pregnancy, poses significant potential risks. It is potentially dangerous and can progress to pre-eclampsia [6]. Early management of gestational hypertension is essential for a better prognosis of the chronic complications of this disorder [7,8]. The incidence of this disorder during pregnancy and its predictive factors are poorly documented in our context. This study aimed to determine the incidence rate and predictive factors of gestational hypertension in a population of Abidjan pregnant women.

2. PATIENTS AND METHODES

2.1. Design and setting

This was a multicenter prospective cohort study enrolling pregnant women followed up in 5 health facilities in the Abobo East Health District located in the municipality of Abobo (Côte d'Ivoire, West Africa). The cohort study began with a cross-sectional survey that enabled the recruitment of pregnant women. The pregnant women with chronic hypertension were excluded. The pregnant women who did not have hypertension at inclusion were followed up each month until three months after delivery. The survey ran from February 21, 2022 to May 31, 2023.

2.1.1 Setting: Abobo East Health District

The study was carried out in the Abobo East health district located in the municipality of Abobo. The municipality of Abobo is located in Abidjan, the economic captial of Côte d'Ivoire. Côte d'Ivoire is a country located in West Africa. The municipality of Abobo is Abidjan's second most populous municipality, with numerous neighborhoods, including 19 precarious neighborhoods [9]. Most of these neighborhoods are not serviced, with a growing population and ever-increasing demand for housing. Around 60% of the municipal population lives in these precarious neighborhoods [10]. The Abobo East health district was chosen because more than a half of the population lives in precarious conditions.

2.1.2. Selection criteria for health centers

The selection of facilities was based on two criteria:
- The number of first prenatal consultations recorded during the 1st half of 2021
- The presence of a delivery room.

We identified seven first-contact health facilities, each recording between 379 and 552 first prenatal consultations. Health facilities without a delivery room were excluded from the project. We therefore selected 5 health facilities for the project.

2.2. Study population

The study population consisted of pregnant women seen in consultation at the selected first-contact health facilities.

The study included pregnant women with a gestational age of less than 20 weeks, an administrative age of 18 and over, who had been living in the municipality of Abobo for at least 6 months, and who had signed an informed consent form for the study.

Pregnant women with chronic hypertension were not included.

2.3 Sample and sampling

2.3.1. Sample size calculation

The sample size was calculated to estimate a proportion of hypertensive disorders of pregnancy of 10% with a risk α of 5% and a precision of 4%.

$n = z^2 \times p (1 - p) / i^2$; n = sample size; z = 95% confidence level, z = 1.96

p = estimated proportion of hypertensive disorders in pregnancy. P = 10%

i = tolerated margin of error or precision of 0.04

n = 1.96 X 1.96 X 0.1 X 0.9/ $(0.04)^2$; n = 216.09 or 217
e. a minimum of 44 women to be recruited per health facility.

2.3.2 Sampling method

Recruitment was systematic. The study was offered to all pregnant women attending their first prenatal consultation at the selected facilities, who were less than 20 weeks' amenorrhea and who met the inclusion criteria until the calculated sample size was reached.

2.4. Survey process

Pregnant women were seen every month for follow-up. Research team consisted of investigators, midwives, biologists and medical doctors. All investigators underwent a standardized 2-day training course on measurement techniques, followed by a practical assessment. Research team was responsible for calling pregnant women to remind them of their appointments. During the visits, information was collected on their health status, followed by blood pressure measurements. The frequency of visits was monthly, and the total number of visits was 8 if the women were regular visitors. Visits ended three months after delivery.

2.5. Data collection

2.5.1. Data collection at inclusion of pregnant women

Several data were collected on the pregnant women's inclusion:

- Socio-demographic data (administrative age in years and education)
- Gyneco-obstetrical data (pregnancy and parity)
- Anthropometric and clinical data (weight, height, arterial pressure and heart rate)
- Biological data (blood glucose, creatinine, total cholesterol, HDL cholesterol, LDL cholesterol, triglycerides, uricemia, natraemia, kalemia, chloremia, calcemia , magnesemia)
- Electrocardiographic data (left ventricular hypertrophy)

2.5.2. Data collection during the follow-up of pregnant women

During follow-up, data collected were arterial pressure. The primary outcome was the development of gestational hypertension.

2.6. variables measurement

The size was taken from ID document
The weight was measured on a SECA 750 scale capable of weighing up to 150 kilograms. Weight was measured on a scantily clad woman. Obesity was assessed with body mass index in the first trimester of pregnancy [11,12]. The blood pressure was measured in a seated subject after 15 minutes' rest using an OMRON M[6] automatic digital sphygmomanometer fitted with a cuff (belonging to the list of sphygmomanometers validated by the French Society of Hypertension) [13]. It was taken on the bare arm, placed on a table with the palm facing upwards. Three measurements were taken at 5-minute intervals; the mean of the last two measurements was considered for each participant. The highest blood pressure was taken as the arterial pressure.

Gestational hypertension was defined as a systolic blood pressure (SBP) ≥ 140 mmHg and/or diastolic blood pressure (DBP) ≥ 90 mmHg during follow-up after 20 weeks of amenorrhea in a woman who previously had not hypertension

The heart rate was measured with the OMRON M[6] automatic digital sphygmomanometer.

The electrocardiogram was performed after blood pressure was taken in a supine patient on the examination table. The twelve-lead electrocardiogram was performed on a BIOCARE model iE3 electrocardiograph. Electrocardiographic leads were placed in accordance with standard practice. Recordings were made at 25 mm/second, calibrated at 10 mm/mV and printed on graph paper with time represented on the x-axis and voltage represented on the y-axis. Left ventricular hypertrophy was objectified by the Sokolow-Lyon index [14] or the Cornell index [15].

2.7. Statistical analyses

Data were entered using KoboCollect software and analyzed using R version 4.1.1 and SPSS version 29.0.

2.7.1. Analysis of inclusion data

Analysis of inclusion data covered sociodemographic, gyneco-obstetric, anthropometric and clinical, biological and electrocardiographic characteristics,

2.7.2. Analysis of follow-up survey data

Follow-up data analysis focused on blood pressure measurements. The incidence of blood pressure was expressed in numbers and percentages.
Predictive factors were compared using the KHI square test at 5% alpha risk. We constructed logistic regression models that enabled us to estimate the probability of occurrence of gestational hypertension by relative risk and its confidence interval.

2.8. Ethics

This study has been approved by the national ethics committee. Pregnant women were only included in the study when they gave their consent. Study participants were free to withdraw from the study at any time without prejudice. All the information on the participants remained confidential and was known only to the research team. An individual identification number was used for the medical record, data entry and biological collection.

3. RESULTS

Among the women recruited, 341 were seen at least once after the start of the survey. The average age of the 341 women was 27.03 ± 6.09 years, and the median age was 26 years, with extremes ranging from 18 to 46 years. Almost two-thirds of the women were aged between 18 and 29. Around 28% of the women had no formal education. More than a third were nulliparous. Almost a fifth of the women were obese at inclusion. Forty women (12.4%) had tachycardia (heart rate > 100 beats/min) at inclusion.

3.1 Incidence rate of gestational hypertension

We observed 40 incident cases of arterial hypertension, representing a cumulative incidence rate of 11.7%. These

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new cases of hypertension included 24 (60%) cases of grade I hypertension, 7 (17.5%) cases of grade II hypertension and 9 (22.5%) cases of grade III hypertension.

Table I. Characteristics of followed-up pregnant women and the association with gestational hypertension

Characteristics	N(%)	Gestational hypertension N (%)		P
		No	Yes	
Age (years)				
18-29	223(65.4)	200(89.3)	23(10.3)	
30-34	65(19.1)	60(92.3)	5(7.7)	**0.023**
35 - 46	53(15.5)	41(77.4)	12(22.6)	
Total	**341**	**301**	**40**	
Education				
No schooling	90(27.5)	80(88.9)	10(11.1)	
Schooled	237(72.5)	208(87.8)	29(12.2)	**0.47**
Total	**327***	**288**	**39**	
Parity				
Nulliparous	121(38.1)	109(90.1)	12(9.9)	
Primiparous	90(28.3)	82(91.1)	8(8.9)	**0.34**
Multiparous	107(33.6)	91(85.0)	16(15.0)	
Total	**318***	**282**	**36**	
Obesity at inclusion				
No	191(82.3)	175(91,6)	16(8,4)	
Yes	41(17.7)	31(75,6)	10(24,4)	**0.007**
Total	**232***	**206**	**26**	
Heart rate (beats/min) at inclusion				
HR ≤ 100	282(87.6)	255(90.4)	27(6.9)	
HR > 100	40(12.4)	29(72.5)	11(27.5)	**0.003**
Total	**322***	**284**	**38**	
*** : missing data**				

Table II. Bivariate analysis, predictive factors of gestational hypertension and relative risk (RR)

Characteristics	Gestational hypertension N (%)		Total	RR	95% CI	p-value
	No	Yes				
Age (years)						
18 – 29	200(89.3))	23(10.3)	223	-	-	
30 - 34	60(92.3)	5(7.7)	65	0.7	[0.3 – 1.9]	**0.023**
35 - 46	41(77.4)	12(22.6)	53	2.2	[1.2 – 4.1]	
Total	301	40	341			
Obesity						
No	175(91.6)	16(8,4)	191	-	-	
Yes	31(75.6)	10(24,4)	41	2.9	[1.4 – 5.9]	**0.007**
Total	206	26	232			
Heart rate (beats/min)						
HR ≤ 100	255(90.4)	27(6.9)	282	-	-	
HR > 100	29(72.5)	11(27.5)	40	2.9	[1.5 – 5.3]	**0,003**
Total	284	38	322			

The mean duration of follow-up was 111.36 ± 57.39 days, with extremes of 10 and 319 days. The sum of exposure durations was 37974 person-days or 8739.212 person-months. The incidence density (ID) was 4.5 cases per 1000 women-months of follow-up.

Table I shows the characteristics of the women followed and the association with gestational hypertension.

Three factors were positively associated with gestational hypertension: Age, obesity at inclusion, and heart rate at inclusion. In fact, 22.6% of women aged 35 to 46 developed gestational hypertensions (p=0.027). Similarly, 24.4% of women with obesity at baseline (p=0.007) and 45% of women with tachycardia at baseline (p=0.03) developed gestational hypertension.

Furthermore, we did not find any significant association between biological characteristics and gestational hypertension on the one hand nor between left ventricular hypertrophy and gestational hypertension on the other.

3.2. Associative factors of gestational hypertension and their relative risk (RR)

Table II summarizes the bivariate analysis of predictive factors of hypertension.

Table III. Multivariate analysis

Characteristics	RR	95% CI	p-value
Age (years)			
18 - 29	-	-	**0.1**
30 – 34	0.8	[0.3 – 2.4]	
35 - 46	2.1	[0.8 – 5.4]	
Obesity			
No	-	-	**0.04**
Yes	2.4	[1.1 – 5.8]	
Heart rate (beats/min)			
HR ≤ 100	-	-	**0.08**
HR > 100	2.3	[1.0 – 5.6]	

In a bivariate analysis, pregnant women aged 35 to 46 had a 2.4-times greater risk of contracting gestational hypertension, with a statistically significant association. The survey found a significant association between obesity at inclusion and gestational hypertension. About a quarter of obese women at baseline had gestational hypertension. These women were about three times more likely to have gestational hypertension than non-obese women. Similarly, a heart rate above 100 bpm at baseline is associated with a 2.87-times greater risk of developing gestational hypertension, with a statistically significant association.

3.3. Multivariate analysis

In multivariate analysis, obesity appears to be an independent risk factor associated with gestational hypertension, with a statistically significant link. Obesity is the predictive factor of gestational hypertension in our study.

4. DISCUSSION

4.1. Bias and limitations of the study

As with all questionnaire-based surveys, data may be subject to over- or underestimation due to the inherent subjectivity of respondents' answers, such as their assessment of personal history of hypertension. This also has the effect of underestimating the values collected, given that hypertension may be unrecognized by patients, given the clinical latency of this pathology.

There may be a bias in the measurement of physical parameters (anthropometric parameters, blood pressure), as these measurements were taken by several people.

We recruited only women living in the municipality of Abobo. This could also constitute a selection bias, as the women residing there are not representative of all women. Of the seven health centers identified, two were excluded because they did not have a delivery room. This exclusion may have limited the representativeness of the sample, as health facilities without a delivery room generally serve more vulnerable populations. In addition, the relatively small size of our sample could affect our ability to detect some significant associations.

4.2 Incidence rate of gestational hypertension

Our survey revealed an overall incidence rate of 11.7% of gestational hypertension, with an incidence density of 4.5 cases of hypertension per 1000 women-months of follow-up. The incidence rate of gestational hypertension

in our survey is lower than that reported by authors in Africa [16–18] and outside Africa [19]. Indeed, Davies et al. in South Africa reported that 176 women or an incidence rate of 17.6% developed gestational hypertension [16]. Hinkosa et al. in their survey conducted from 2015 to 2017, found an incidence rate of gestational hypertension of 14.1% [17] while Muti et al. reported an incidence of 19.4% in Zimbabwe [18]. In India, Mathew et al. observed that 119 primiparous women out of 807 who were not hypertensive at inclusion had gestational hypertension, an incidence rate of 14.7% [19].

The incidence rate of gestational hypertension in our investigation is higher than that reported by other researchers. In fact, Van Der Linden et al. observed an incidence of 7.8% in Ghana [20] ; while Ayogu et al. in Nigeria noted 14 cases of gestational hypertension out of 221 women monitored, i.e. an incidence of 8.6% [21]. In Portugal, Alves et al. found an incidence of gestational hypertension of 1.9% in primiparous women and 1.9% in multiparous women [22].

This observed difference could be explained by the disparity of health system strategies concerning mother and child between countries, the accessibility of different health structures and the degree of awareness of patients of the real risks of the disease [23].

4.3. Predictive factors for gestational hypertension

In our study, bivariate analysis showed that age between 35 and 46, obesity and heart rate above 100 bpm were statistically significantly associated with gestational hypertension.

In multivariate analysis, only obesity appeared to be an independent factor associated with gestational hypertension.

With regard to age, our results are consistent with those of certain studies in Africa [24] and outside Africa in Asian [25–27], Latin American and Caribbean [28] populations. In these studies, age greater than or equal to 35 years was associated with gestational hypertension. High maternal age, 35 or over, is associated with an increased risk of maternal morbidity [29]. Our results are contrary to those of a study which found that low maternal age was positively associated with the occurrence of preeclampsia in white, non-white and black populations. In this survey, published in 1990,

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women aged 18 to 19 were almost 2 times more likely to develop preeclampsia than women aged 30 to 34 [30].

In relation to heart rate, the study noted a significant association between heart rate at inclusion and gestational hypertension. Women were approximately 3 times more likely to have gestational hypertension than those who did not. Our findings are consistent with studies carried out in various populations, whether in the young adult population, the general population or black students, which have demonstrated a significant association between high heart rate and the subsequent development of hypertension [31–34]. Further studies are therefore needed to offer pregnant women the opportunity to participate in surveys. Reducing the heart rate of pregnant women could be one way of reducing the incidence of gestational hypertension.

Obesity was the predictive factor significantly associated with gestational hypertension, after multivariate analysis. Women who were obese were about three times more likely to develop gestational hypertension than those who were not obese. These results corroborate those of some authors in Africa [24,35,36] and outside Africa [11,37]. In Africa, according to Owiredu et al. in Ghana, obese women were 4 times more likely to suffer from gestational hypertension than normal-weight women [24]. Iyoke et al. in Nigeria found that obese women were 2.31 times more likely to acquire gestational hypertension than non-obese women [35]; while Antwi et al. in Ghana reported that obese women were almost twice more likely to have gestational hypertension than normal-weight women [36]. Outside Africa, a study reported that, compared with normal-weight women, the risk of gestational hypertension increased by 2.4 to 3 times for obese women [11]. Similarly, Salihu et al, in their systematic review, noted that obese women were 4.5 to 8.7 times more likely to have gestational hypertension than normal-weight women [37].

As obesity is a risk factor for non-communicable diseases, including cardiovascular disease, its increasing prevalence among women of childbearing age will have an impact on maternal health and obstetrical outcomes [20,35]. Indeed, the incidence rate of maternal obesity is rising worldwide, and is associated with short- and long-term complications for mothers and children during pregnancy, childbirth and the post-partum period [12]. Research is needed to better understand the impact of obesity on maternal health in our developing countries, and to better guide awareness programs. Our results suggest that obesity is a major risk factor for gestational hypertension in pregnant women in Abobo. It is therefore crucial to set up obesity prevention and management program before and during pregnancy. More intensive screening for gestational hypertension could be beneficial in obese women. A pilot program of close follow-up could be implemented in Abobo health facilities to assess the feasibility and impact of such an intervention.

5. CONCLUSION

At the end of our study, the incidence of gestational hypertension in Abobo East health district is relatively high, with obesity as the independent factor associated with it. This study highlights the necessity of targeting gestational hypertension prevention on obese women in the Abobo Est health district. We recommend implementing a pre-conception weight management program and the intensification of prenatal follow-up for these at-risk women. A subsequent study with a larger sample including all Abidjan health districts or on a larger scale at national level could give us results with greater statistical strength.

DECLARATIONS

Conflicts of interest: The authors declare no conflicts of interest.
Authors' contributions: MKS designed the study, conducted the survey and drafted the method and results; KKF and BBC wrote the introduction and discussion, YTA wrote results, MGD, AKA, S-KJ and OAS revised manuscript
Ethical considerations: The approval of the national ethics committee was obtained

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