

Maternal Risk Factors and Adverse Birth Outcomes Associated with Preeclampsia: A Prospective Cohort Study in Zanzibar

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Abstract

Background: Preeclampsia (PE) is a significant multi-organ system disorder of pregnancy and is responsible for global maternal morbidity and mortality. In Zanzibar, it affects approximately 26.3% of postnatal women. However, there is limited knowledge regarding the maternal risk factors and birth outcomes associated with PE. This study aimed to examine the maternal risk factors and adverse birth outcomes related to preeclampsia among pregnant women in Zanzibar. **Methods:** A prospective cohort study was conducted in 2021 across public health facilities on Unguja, Zanzibar. A total of 728 pregnant women at ≥ 20 weeks gestation with or without preeclampsia were enrolled and followed through three phases: during antenatal care (ANC), within 24 hours of delivery, and up to 28 days postpartum. Data were analyzed using SPSS version 26.0. Chi-square and regression analyses were conducted, with statistical significance set at $p < 0.05$. **Results:** The incidence of preeclampsia was 7.7%. The median age of women diagnosed with preeclampsia was 28 years (IQR: 24 - 33). Women with a family history of hypertension were significantly more likely to develop preeclampsia (adjusted odds ratio [aOR] = 1.92, 95% CI: 1.05 - 3.51, $p = 0.033$). Women with a history of chronic hypertension (aOR 3.69, 95% CI: 1.01-13.54, $p = 0.049$) and those with a previous history of preeclampsia or eclampsia were likely to develop preeclampsia in

their subsequent pregnancies (aOR = 3.11, 95% CI: 1.11 - 8.71, $p = 0.031$). Additionally, women who delivered low-birth-weight infants according to certain criteria had greater odds of developing preeclampsia compared to women who delivered infants weighing 2.5 - 3.9 kg (aOR = 0.35, 95% CI: 0.15 - 0.82, $p = 0.016$). Conclusion: Preeclampsia affects a significant proportion of pregnant women in Unguja, Zanzibar. A family history of hypertension is significantly associated with an increased risk of developing preeclampsia. Early detection and effective management of preeclampsia, along with targeted health promotion during routine ANC services, through identifying and assessing potential risks to the mother and the baby, such as maternal conditions, family history, and lifestyle factors, may reduce the burden of preeclampsia and the associated maternal and neonatal outcomes in Unguja Zanzibar.

Keywords

Pre-Eclampsia, Risk Factors, Pregnant Women, Maternal Outcome, Perinatal Outcome

1. Introduction

Hypertensive disorders of pregnancy (HDPs) account for approximately 16% of maternal mortality and are responsible for 70,000 maternal deaths globally [1] [2]. The global incidence of hypertensive disorders during pregnancy rose from 31.33 million to 36.10 million, representing a total increase rate of 15.24% between 1990 and 2021 [3]. Preeclampsia and eclampsia (PE/E) are among the most common (HDPs), and are the second most common cause of maternal and perinatal morbidity and mortality worldwide [4]. In sub-Saharan Africa, the overall incidence of preeclampsia was 13%, and the trend analysis found an increase from 2.22% in 2010 to 2.67% in 2018 [5].

Preeclampsia (PE) is a pregnancy-related complication characterized by a syndrome with multisystem involvement and damage based on hypertension (systolic blood pressure of 140 mmHg or diastolic blood pressure of 90 mmHg) that first shows up after 20 weeks of gestation [6]-[8]. PE is represented as a gestational condition with a hypertensive disorder diagnosed after 20 weeks of gestation and coexisting proteinuria or generalized oedema, and certain forms of hematologic disorders such as thrombocytopenia or signs of end-organ damage, including renal impairment, abnormal liver function, pulmonary oedema, and cerebral and visual disturbance [9].

Pregnant women with high blood pressure equal to 140/90 mmHg systolic and diastolic, as well as albumin protein in the urine more than 30 mg/L of albumin, indicate kidney damage, and the presence of these two crucial complications at the same time in pregnancy may point to preeclampsia [10]. The primary mechanism of preeclampsia begins with the inadequate remodeling of the spiral arteries

that supply maternal blood to the intervillous space of the placenta, resulting in suboptimal placentation. This causes hypoxia in the placental tissue, triggering oxidative stress and a reduction in nitric oxide (NO) production, which in turn leads to vasoconstriction, placental ischemia, and endothelial dysfunction [11].

According to the World Health Organization (WHO), preeclampsia is seven times more prevalent in low and middle-income countries (LMICs) [12]. Maternal health remains one of the major public health problems in low- and middle-income countries (LMIC) [13]. In SSA, HDPs are the second leading cause of maternal mortality, 22.1%, in 2020 [14].

Tanzania's maternal mortality ratio (MMR) significantly dropped to 104 per 100,000 live births in 2022 [15]. Despite some progress in reducing maternal deaths in Tanzania, the maternal mortality rate (MMR) in Zanzibar remains high at 287 per 100,000 live births. The prevalence of pre-eclampsia is 4.2% in mainland Tanzania and 14.3% in Zanzibar [16] [17]. The global maternal mortality ratio is unlikely to meet the Sustainable Development Goal (SDG) target 3.1, which aims for a rate lower than 70 per 100,000 live births by the year 2030 [2]. In Tanzania, several factors contribute to the reduction in maternal mortality, including increased ANC attendance, a decrease in teenage pregnancies, a rise in deliveries at health facilities, decentralizing high-quality comprehensive emergency obstetric and new-born care (EmONC) to lower-level facilities, and more deliveries assisted by skilled healthcare providers [18].

Numerous factors, including chronic hypertension, inappropriate weight gain, unfavorable socioeconomic conditions, presence of chronic diseases, personal and/or family history of PE, nulliparity, multifetal gestation, maternal age, pre-existing diabetes mellitus, having more than one partner and alcohol intake, body mass index > 30 kg/m and Previous history of caesarean section have been associated with preeclampsia [12] [17] [19]-[26].

Severe preeclampsia is linked to severe maternal and perinatal effects, including eclampsia, HELLP syndrome, intracerebral bleeding, cardiovascular diseases, type 2 diabetes, acute renal failure, miscarriage, respiratory distress syndrome, premature delivery, placental abruption, intrauterine growth restriction, obstructed labour and an increased risk of caesarean section, with adverse perinatal outcomes including low birth weight, birth asphyxia, cognitive and psychiatric impairment in offspring, and neonatal death [27]-[31].

Despite its high burden, there remains limited data on maternal risk factors and adverse birth outcomes related to preeclampsia in Tanzania, particularly in Zanzibar. However, in Zanzibar, a facility-based study shows the higher prevalence of severe pre-eclampsia among postpartum women of 26.3%, which is reflected in the number of deaths and complications associated with PE [19]. Given the need to reduce maternal and neonatal mortality and morbidity, early detection and management of preeclampsia are crucial. This study, therefore, aimed to assess maternal risk factors and adverse birth outcomes associated with preeclampsia among pregnant women of Unguja Zanzibar.

2. Methods

2.1. Study Design, Study Area, and Study Period

This prospective cohort study was carried out from April to October 2021 at three public health facilities in three regions of Unguja, Zanzibar. One of these facilities is the Mnazi Mmoja hospital in the Urban region, which has an annual live birth delivery count of 13,291. Kivunge hospital is located in the North “A” region, serving 4000 live births annually, and Makunduchi hospital in the South region, with 1000 live births per year [32]. During the study period, these were the only public health facilities that offered Comprehensive Emergency Obstetric and New-born Care (CEmONC) in Unguja. Moreover, the Urban region recorded the highest proportion of women of childbearing age at 60.9%, with Unguja’s south region coming next at 54.0% [23]. The participants were enrolled at antenatal clinics (ANC) following their antenatal care visits in the selected health facilities in Unguja, Zanzibar.

2.2. Study Population, Sampling Technique, and Sample Size Estimation

Eligible participants were pregnant women at ≥ 20 weeks of gestation attending ANC visits at selected facilities. Inclusion criteria were willingness or intention to deliver within Unguja and their availability for follow-up up to 28 days postpartum/ during the study period. Systematic random sampling was used to select participants from the selected health facilities. Enrolment was undertaken after the women had given consent to participate in the study.

A sample size of 728 pregnant women was estimated to be required, using Kish’s formula (Kish, 1965), based on a 19.5% estimated prevalence of PE/E [33], 95% confidence level, 4% margin of error, design effect of 1.5, 20% anticipated loss to follow-up and a 5% non-response rate. Allocation across sites was based on the average number of women booking at ANC per month. 488 from Mnazi Mmoja, 124 from Kivunge, and 116 from Makunduchi. Pregnant women were followed across three distinct phases. Phase one involved three antenatal follow-up visits at 20, 28, and 36 weeks of gestation. Phase two occurred within 24 hours after childbirth. Phase three included postnatal follow-up conducted at 72 hours, 14 days, and 28 days after childbirth.

3. Data Collection Method and Procedure

Participants were recruited from April and May 2021, then followed up to October 2021, as they registered for booking at the registration desk of the antenatal clinic until the sample size estimated was reached. On every recruitment day, two research assistants sat with the registration nurses to screen women for the gestational age required by the study. Then, women were informed about the study and referred for an ultrasound scan to confirm the gestational age in each health facility. After the ultrasound results, all other inclusion criteria were evaluated. Clients who met all criteria were directed to another room for informed consent and were

assigned an identification number for data collection procedures.

Data were collected using structured and semi-structured questionnaires adapted from validated tools [34]-[36] and then modified to gather the desired information from the sample population. The tool was translated into Kiswahili and back-translated into English to ensure consistency. The questionnaire consisted of a total of 244 questions. In phase 1 (**ANC visits**), a total of 142 questions were asked, assessing socio-demographic, reproductive and obstetric factors, prior and family medical history, and history of maternal complications, current behavioral and obstetric conditions. In Phase 2 (**Delivery**), another 45 questions were asked, assessing the current conditions of the mother and the new-born baby. Phase 3 (**Postnatal**) consisted of 57 questions, assessing the condition of the mother and the new-born baby. The PI and RAs ensured that every woman enrolled in this study had her blood pressure monitored and urine tested for protein in all seven visits of the data collection period. The Clinical reports, documented from the client's ANC card, including the routine laboratory results, ultrasound scan, and partograph, were gathered into the data collection forms by the PI and research assistants. Additionally, the participants' gestational ages were confirmed through ultrasound scans, Blood pressure measurements were taken, and cases of hypertension ($\geq 140/90$ mmHg) accompanied by protein in urine (proteinuria) were recorded. Maternal and neonatal outcomes were documented at each follow-up visit during the data collection period across all three phases.

3.1. Follow-Up of the Study Participants

In this study, a total of seven follow-up visits were carried out: three ANC visits at 20, 28, and 36 weeks of gestation; one visit within 24 hours of delivery; and three visits at 72 hours, 14 days, and 28 days postpartum. All data collected were entered into a prepared database.

To enhance follow-up feasibility, participants were given a follow-up card containing contact information, visit schedules, and the research team's telephone numbers. Participants were reminded of the next ANC visits and were advised to report to the hospital in case of any complications during pregnancy. A reminder call was made to participants one week before and after their expected delivery date (EDD) based on the ultrasound scan, which worked well for most women. The research team, along with obstetricians, increased the timing of ANC and follow-up visits for women suspected of having preeclampsia based on the severity of their condition. The research team made sure that the women were contacted and followed up weekly, and they were advised to go to the hospital if they noticed any warning signs.

3.2. Advanced Birth Measures

Maternal outcome measures were defined as adverse health effects experienced by pregnant women diagnosed with or without preeclampsia in Unguja. These outcomes included chronic hypertension, eclampsia, HELLP syndrome, renal failure, and maternal death. Data were collected from the ANC (during the recruitment)

phase through a 28-day postpartum follow-up. Neonatal outcomes were assessed for new-borns and fetuses born to the same cohort of women (mothers with or without preeclampsia). These included preterm birth, low birth weight, neonatal intensive care unit (NICU) admissions, stillbirth, and neonatal death. These outcomes were monitored from the time of birth up to 28 days postnatal. All outcomes were prospectively recorded as part of the present study data collection process.

3.3. Quality Control

Six bilingual (Swahili and English) female and male nurse officers were trained as research assistants (RAs). The training lasted for 3 days, and they covered the procedure for data collection, ethical conduct, and research tools. The training was facilitated by the principal investigator (PI). A pilot study was conducted at Al-rahma Private Hospital before the commencement of data collection. This health facility (Alrahma Private Hospital), was not selected for the study data collection. After making the needed changes and corrections to the questionnaire, Cronbach's alpha was used to check how reliable the instrument was, and it scored 0.70, which is generally seen as acceptable. PI reviewed the data daily to ensure completeness, consistency, and accuracy. Regular team meetings addressed emerging issues, including blood pressure (B/P) readings, urine protein tests, and laboratory examinations such as creatinine and liver function tests. Standardized protocols were followed for clinical measurements. This included using the correct cuff size for B/P readings and ensuring proper patient positioning. Additionally, the research team discussed any concerns related to the mother and baby.

Later on, the group of pregnant women with preeclampsia was obtained due to the expert categorization where by preeclampsia was defined as a combination of having a high blood pressure (systolic reading of 140 mmHg or higher) and diastolic reading of 90 mmHg or higher, along with albumin levels exceeding 30 mg/L in the urine.

3.4. Statistical Analysis

Data analysis was performed using SPSS software (version 26.0). Descriptive statistics (means, standard deviations, frequencies) were used to summarize the baseline characteristics. Chi-square or Fisher's exact tests were used to determine the statistical association between a set of independent variables and PE/E in a bivariate analysis. Incidence and risk ratios were calculated to compare outcomes between the exposed (PE/E) and non-exposed groups, using a multivariable binomial regression model. A p-value of <0.05 was considered statistically significant, and 95% confidence intervals were reported where applicable.

4. Results

4.1. Socio-Demographic Characteristics

Most women were aged 20 - 34 (77.6%), married (97.4%), and had secondary ed-

education (76.2%). More than half (59.3%) were housewives with a median monthly income of 16,000 Tsh (approximately \$6), (IQR 7,000 - 56,500). Two-thirds (66.9%) resided in urban areas (**Table 1**).

Table 1. Socio-demographic characteristics of study participants (N = 728).

Variable	n (%)
Age (Years)	
<20	21 (2.9)
20 - 34	565 (77.6)
≥35	142 (19.5)
Median age	28 (24,33)
Marital Status	
Never married/widowed/divorced	19 (2.6)
Married	709 (97.4)
Education Level	
No formal education	15 (2.1)
Primary education	107 (14.7)
Secondary education	555 (76.2)
College/ University	51 (7.0)
Current Occupation	
Government employee	56 (7.7)
Self-employed	217 (29.8)
Housewife	432 (59.3)
Private employee	23 (3.2)
Monthly Income (Tsh)	
<150,000	616 (84.6)
150,000 - 300,000	84 (11.5)
>300,000	28 (3.9)
Median (IQR)	16,000 (7000 - 56,500)
Area of residence	
Urban	487 (66.9)
Rural	241 (33.1)
Type of family	
Nuclear family	649 (89.2)
Joint/Extended family	79 (10.8)

4.2. New-Born Characteristics

Of the new-borns, 51.5% were male. The mean birth weight was 3.1 kg (SD ±0.5), and 82.8% weighed between 2.5 - 3.9 kg. Their mean gestational age was 36.9 weeks (SD ±2.4), with a mean Apgar score at 1 minute of 8.3 (SD ±2.2) (**Table 2**).

Table 2. New-born characteristics of the study population (N = 714*).

New-born characteristics	n (%)
Sex	
Male	371 (51.5)
Female	350 (48.5)
Birthweight (Kg)	
<2.5	91 (13.2)
2.5 - 3.9	573 (82.8)
≥4	28 (4.0)
Apgar score at 1 minute	
<3	37 (5.4)
4 - 6	16 (2.3)
≥7	632 (92.3)
Mean(±SD)	8.3 (±2.2)
Gestation age (weeks)	
<28	9 (1.2)
28 - 34	45 (6.2)
35 - 36	302 (41.8)
≥37	367 (50.8)
Mean (±SD)	36.9 (±2.4)

* = Missing due to 9 Abortion, 5 Loss of follow up.

4.3. Factors Associated with Preeclampsia

4.3.1. Reproductive Factors

Of the enrolled women, 728 were followed up through 28 days post-delivery (**Figure 1**). Among these, 5 pregnant mothers were lost during the first phase. About 723 (99%) of pregnant women were followed until delivery, of whom 55 developed preeclampsia, and nine women had an abortion and could not be followed up, resulting in a cohort of 714 women followed up until 28 days post-delivery. None of the studied reproductive factors showed a statistically significant association with preeclampsia in either crude or adjusted models ($p > 0.05$ for all comparisons) (**Table 3**).

4.3.2. Medical and Family History Factors

Women with a history of chronic hypertension had 3.6 times higher odds of developing preeclampsia (aOR= 3.69, 95%CI: 1.01-13.54, $p = 0.049$). Similarly, a previous history of preeclampsia (aOR 3.19, 95% CI: 1.04 - 9.72, $p = 0.041$) and a family history of hypertension (aOR = 1.92, 95% CI: 1.05 - 3.51, $p = 0.033$) were independently associated with a higher risk of preeclampsia (**Table 4**).

4.3.3. Previous Maternal/Obstetric Complications

Women with a previous history of preeclampsia or eclampsia were significantly more likely to develop preeclampsia in their subsequent pregnancy than their counterparts (aOR = 3.11, 95% CI: 1.11 - 8.71, $p = 0.031$) (**Table 5**).

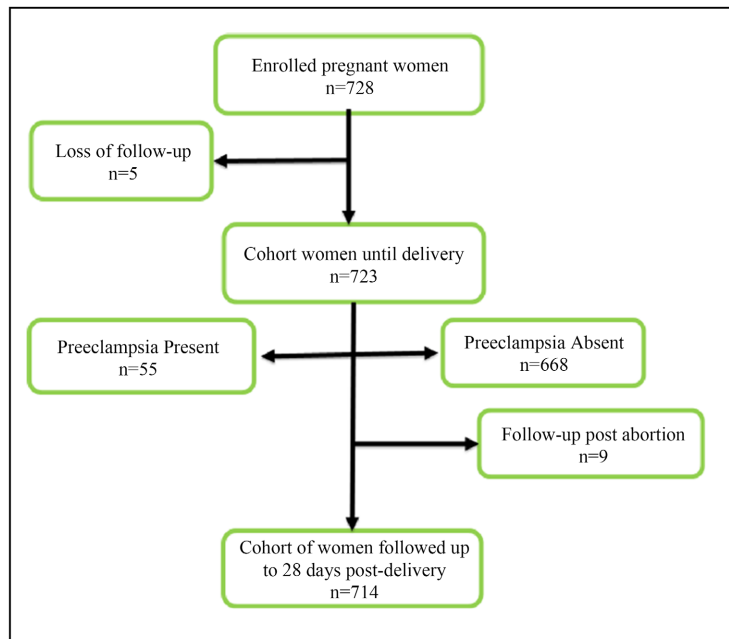


Figure 1. Flow chart of the participants recruited for the study.

Table 3. Reproductive Factors associated with Preeclampsia (N = 728).

Variables	Total	PREECLAMPSIA		COR	p-Value	AOR	p-Value
		Yes (%)	No (%)				
Reproductive History							
Age at menarche							
<12	205	20 (9.8)	185 (90.2)	1			
13 - 15	432	32 (7.4)	400 (92.6)	0.74 (0.41 - 1.33)	0.313	1.47 (0.68 - 3.17)	0.323
≥16	91	4 (4.4)	87 (95.6)	0.43 (0.14 - 1.28)	0.129	0.47 (0.09 - 2.25)	0.343
Ever been pregnant before							
No	136	10 (7.4)	126 (92.7)	1			
Yes	592	46 (7.8)	546 (92.2)	1.06 (0.52 - 2.16)	0.869	1.68 (0.47 - 5.93)	0.423
Age at first pregnancy in (years)							
≤18 years	265	23 (8.7)	242 (91.3)	1			
19 - 25 years	375	24 (6.4)	351 (93.6)	0.72 (0.39 - 1.30)	0.278	0.61 (0.26 - 1.44)	0.257
26 - 35 years	88	9 (10.2)	79 (89.8)	1.19 (0.53 - 2.69)	0.662	0.84 (0.28 - 2.45)	0.743
Parity							
0	182	15 (8.2)	167 (91.8)	1			
1 - 4	487	31 (6.4)	456 (93.6)	0.76 (0.39 - 1.44)	0.395	0.62 (0.17 - 2.26)	0.469
≥5	59	10 (16.9)	49 (83.1)	2.27 (0.96 - 5.38)	0.062	1.72 (0.39 - 7.52)	0.474
Age of the last child							
≤2 years	171	22 (12.9)	149 (87.1)	1			
3 - 4 years	110	15 (13.6)	95 (86.4)	1.07 (0.53 - 2.16)	0.852	1.31 (0.53 - 3.21)	0.560
>5 years	82	10 (12.2)	72 (87.8)	0.94 (0.42 - 2.09)	0.881	1.25 (0.47 - 3.32)	0.661
Paternal change							
No	114	8 (7.0)	106 (93.0)	1			
Yes	514	38 (7.4)	476 (92.6)	1.06 (0.48 - 2.33)	0.889	1.18 (0.49 - 2.83)	0.706

Table 4. Previous Medical and Family History Factors associated with Preeclampsia (N = 728).

Variable	Total	PREECLAMPSIA		cOR	p-Value	aOR	p-Value
		Yes	No				
History of Chronic Hypertension							
No	712	52 (7.3)	660 (92.7)	1			
Yes	15	4 (26.7)	11 (73.3)	4.62 (1.42 - 15.00)	0.011	3.69 (1.01 - 13.54)	0.049
History of preeclampsia							
No	634	39 (6.2)	595 (93.9)	1			
Yes	37	9 (24.3)	28 (75.7)	4.90 (2.161 - 11.11)	<0.001	3.19 (1.04 - 9.72)	0.041
Previous history of Eclampsia							
No	647	56 (8.0)	645 (92.0)	1			
Yes	21	0 (0.0)	26 (100.0)	4.39 (1.53 - 12.55)	0.006	1.75 (0.43 - 7.23)	0.434
Family history of hypertension							
No	468	28 (6.0)	440 (94.0)	1			
Yes	260	28 (10.8)	232 (89.2)	1.89 (1.09 - 3.28)	0.022	1.92 (1.05 - 3.51)	0.033
Family history of Pre/Eclampsia							
No	705	653 (92.6)	52 (7.4)	1			
Yes	23	19 (82.6)	4 (17.4)	2.64 (0.87 - 8.06)	0.0870	0.76 (0.34 - 1.69)	0.495
Family history of Diabetes Mellitus							
No	587	46 (7.8)	514 (92.2)	1			
Yes	141	10 (7.1)	131 (92.9)	0.89 (0.44 - 1.83)	0.766		
Chronic disease in a previous pregnancy							
No	658	47 (7.1)	611 (92.9)	1			
Yes	23	2 (8.7)	21 (91.3)	1.24 (0.28 - 5.44)	0.772		

Table 5. Previous maternal/obstetric complications associated with Preeclampsia (N = 728).

Variables	Total	PREECLAMPSIA		cOR	p-Value	aOR	p-Value
		Yes (%)	No (%)				
Abortion							
No	659	52 (7.9)	607 (92.1)	1			
Yes	69	4 (5.8)	65 (94.2)	0.72 (0.25 - 2.05)	0.536		
Preeclampsia/eclampsia							
No	634	39 (6.2)	595 (93.9)	1			
Yes	37	9 (24.3)	28 (75.7)	4.90 (2.16 - 11.11)	<0.001	3.11 (1.11 - 8.71)	0.031
Premature labour							
No	310	33 (10.7)	277 (89.4)	1			
Yes	51	13 (25.5)	38 (74.5)	2.87 (1.39 - 5.93)	0.004	2.11 (0.91 - 4.92)	0.082

4.3.4. Maternal and Foetal Adverse Birth Outcomes

In adjusted analysis, high blood pressure (SBP \geq 140 mmHg) at first ANC visit was strongly associated with developing PE/E, (aOR = 12.23, 95% CI: 1.02 - 146.77, p = 0.048) compared to low blood pressure of SBP < 140 mmHg. Proteinuria at any level was also a significant predictor: for preeclampsia (aOR = 81.65

(95% CI: 18.89 - 353.02) (1+); 50.62 (95% CI: 3.16 - 809.57) (2+), and 273.79 (95%CI: 20.40 - 3674.21) (3+), all $p < 0.001$). On the other hand, women who gave birth to an infant weighing 2.5 - 3.9 kg had significantly lower odds of developing preeclampsia (aOR = 0.35, 95% CI: 0.15 - 0.82, $p = 0.016$) as compared to their counterparts who gave birth to low-birth-weight infants (**Table 6**).

Table 6. Maternal and fetal adverse birth outcomes associated with Preeclampsia (N = 728).

Variables	Total	PREECLAMPSIA		χ^2 P Value	cOR	p-Value	aOR	P-Value
		Yes (%)	No (%)					
Number of ANC visit								
1	20	2 (10.0)	18 (90.0)	0.927	1			
2 - 3	119	10 (8.4)	109 (91.6)		0.83 (0.17 - 4.08)	0.814		
4+	409	32 (7.8)	377 (92.2)		0.76 (0.17 - 3.44)	0.726		
1st_ANCSBP_mmHg								
<100	67	2 (3.0)	65 (97.0)	<0.001	1			
100 - 139	556	32 (5.8)	524 (94.2)		1.98 (0.46 - 8.47)	0.355	1.03 (0.11 - 9.32)	0.981
≥140	50	21 (42.0)	29 (58.0)		23.53 (5.17 - 107.07)	<0.001	12.23 (1.02 - 146.77)	0.048
1st_ANC DPB_mmHg								
<60	55	2 (3.6)	53 (96.4)	<0.001	1			
60 - 89	558	35 (6.3)	523 (93.7)		1.77 (0.41-7.58)	0.440	7.61 (0.40-142.84)	0.175
≥90	60	18(30.0)	42 (70.0)		11.36 (2.49-1.72)	0.002	11.80 (0.51-270.78)	0.123
Trimester registered ANC								
≤13 weeks	137	7 (5.1)	130 (94.9)	0.452	1			
14 - 27 weeks	566	47 (8.3)	519 (91.7)		1.68 (0.74-3.81)	0.212		
≥28 weeks	25	2 (8.0)	23 (92.0)		1.61 (0.32-8.27)	0.565		
GA_ at 1st_ANC_clinic								
<16 weeks	150	10 (6.7)	140 (93.3)	0.555	1			
17 - 20 weeks	33	2 (6.1)	31 (93.9)		0.90 (0.19 - 4.33)	0.899		
21 - 28 weeks	100	5 (5.0)	95 (95.0)		0.74 (0.24 - 2.22)	0.588		
≥29 weeks	445	39 (8.8)	406 (91.2)		1.34 (0.65 - 2.77)	0.420		
Proteinuria(20_27wks)								
Nil	330	21 (6.4)	309 (93.6)		1			
≤+1	18	14(77.8)	4 (22.2)	<0.001	51.5 (15.58 - 170.28)	<0.001	81.65 (18.89 - 353.02)	<0.001
+2	5	4 (80.0)	1 (20.0)		58.86 (6.29 - 550.35)	<0.001	50.62 (3.16 - 809.57)	0.006
≥±3	10	8 (80.0)	2 (20.0)		58.86 (11.75 - 294.83)	<0.001	273.79 (20.40 - 3674.21)	<0.001
Haemoglobin level g/dl								
<8.5	56	1 (1.8)	55 (98.2)	0.040	1			
8.5 - 10.9	422	21 (5.0)	401 (95.0)		2.88 (0.38 - 21.84)	0.306		
≥11	192	18 (9.4)	174 (90.6)		5.69 (0.74 - 43.59)	0.094		

Continued

Maternal adverse outcomes

The facility in which the women have labour

Others	45	4 (8.7)	41 (91.3)	0.002	1			
Mnazi Mmoja	461	47 (10.2)	414 (89.8)		1.19 (0.41 - 3.47)	0.747	0.83 (0.16 - 4.17)	0.817
Kivunge	102	3 (2.9)	99 (97.1)		0.32 (0.07 - 1.48)	0.145	0.33 (0.04 - 2.45)	0.279
Makunduchi	115	1 (0.9)	114 (99.1)		0.09 (0.01 - 0.85)	0.035	0.23 (0.02 - 3.52)	0.294

The gestational age (weeks)

<28	9	2 (22.2)	7 (77.8)	<0.001	1			
28 - 34	45	11 (24.4)	34 (75.6)		1.13 (0.20 - 6.27)	0.887	0.45 (0.06 - 3.15)	0.421
35 - 36	302	25 (8.3)	277 (91.7)		0.32 (0.06 - 1.61)	0.167	0.38 (0.05 - 2.57)	0.317
≥37	367	17 (4.6)	350 (95.4)		0.17 (0.03 - 0.88)	0.035	0.26 (0.04 - 1.92)	0.188

Birth complications

Placenta Previa

No	721	55 (7.6)	666 (92.4)	0.511	1			
Yes	7	1 (14.3)	6 (85.7)		2.02 (0.24 - 17.06)	0.519		

Foetal outcomes

Low birth weight (kg)

<2.5	91	21 (23.1)	70 (76.9)	<0.001	1			
2.5 - 3.9	573	29 (5.1)	544 (94.9)		0.18 (0.09 - 0.33)	<0.001	0.35 (0.15 - 0.82)	0.016
4 - 5	28	3 (10.7)	25 (89.3)		0.4 (0.11 - 1.46)	0.165	0.68 (0.15 - 3.17)	0.628

Severe birth asphyxia

No	715	54 (7.6)	661 (92.5)	0.294	1			
Yes	13	2 (15.4)	11 (84.6)		2.23 (0.48 - 10.29)	0.306		

Low Apgar score

≤3	40	6 (15.0)	34 (85.0)	0.110	1			
4 - 6	15	2 (13.3)	13 (86.7)		0.87 (0.16 - 4.88)	0.876		
≥7	630	43 (6.8)	587(93.2)		0.42 (0.17 - 1.04)	0.061		

Premature birth

No	367	55 (7.6)	670 (92.4)	0.095	1			
Yes	347	1 (33.3)	2 (66.7)		6.09 (0.54 - 68.23)	0.143		

Stillbirth fresh

No	350	45 (12.9)	305 (87.1)	0.876	1			
Yes	14	2 (14.3)	12 (85.7)		1.13 (0.24 - 5.21)	0.876		

Stillbirth macerated

No	352	44 (12.5)	308 (87.5)	0.204	1			
Yes	12	3 (25.0)	9 (75.0)		2.33 (0.61 - 8.95)	0.217		

Neonatal death

No	669	50 (7.3)	619 (92.7)	0.143	1			
Yes	45	6 (13.3)	39 (86.7)		1.95 (0.79 - 4.82)	0.149		

Of the enrolled women, 714 were followed up until 28 days post-delivery. Among them, 345 (48.3%) experienced premature labour; of these, 45 (6.3%) had premature labour between 28 and 34 weeks of gestation, while 302 (42.3%) had premature labour during 35 to 36 weeks of pregnancy. Among the 714 babies born, 45 (6.3%) died within 28 days post-delivery. None of these maternal and neonatal adverse birth outcomes studied showed a statistically significant association with preeclampsia in either crude or adjusted models ($p > 0.05$ for all comparisons) (**Table 6**).

In summary, individual and family history of hypertensive disorders, high BP at first ANC visit, and proteinuria were the important predictors for preeclampsia. None of the sociodemographic and reproductive variables showed a statistically significant association with preeclampsia.

5. Discussion

In a recent finding, the occurrence of preeclampsia was 7.7%. The median age of women diagnosed with preeclampsia was 28 years. A family history of hypertension, history of chronic hypertension, and history of preeclampsia were predictors of preeclampsia development.

In the present study, the incidence of preeclampsia was found to be 7.7%. This finding is consistent with findings from various regions, including the Eastern, Western, and developing other nations, where the incidence ranges from 2% to 8% of pregnancies [37]. However, our findings differ from those reported in certain sub-Saharan African countries and Canada, where the incidence was reported at 13%, 8.8% [5] [38]. These variations may be attributed to differences in socio-demographic characteristics, methodological approaches, genetic predispositions, and geographic factors, as supported by previous studies.

5.1. Factors Associated with Preeclampsia

5.1.1. Reproductive Factors

Additionally, in the current study, changes in paternity were not statistically associated with the development of preeclampsia. This finding contrasts with a previous study conducted in Ethiopia, which reported a significant association between paternity change and the risk of preeclampsia [39]. The contrasts could have been caused by the inherited family pattern, which may play a role in the development of pre-eclampsia, as the placenta plays a significant role in the disease's pathogenesis [40]. Moreover, the current findings contrast with those of another study carried out in Zanzibar, which suggested that women who changed partners had a 7.7 times greater risk of developing preeclampsia [19].

This variation could be attributed to the fact that the present study was limited to three public hospitals in Unguja, whereas the other study encompassed both Unguja and Pemba islands. Moreover, the variance may arise from the different study designs and populations: our research involved the enrollment and follow-up of pregnant women from antenatal care (ANC) through to the postnatal pe-

riod, whereas the other study concentrated on postnatal mothers only. On the other hand, our research indicated that the risk of developing preeclampsia was 1.2 times greater for women with previous pregnancies than for those without any prior pregnancies. This could be attributed to the disease's aetiology, as multigravida women have an increased risk of developing preeclampsia, considering they may have experienced this condition before.

Similar findings were reported in other sub-Saharan African studies, where the multigravida women had 1.89 times higher risks for preeclampsia compared to the nullipara women [5]. However, this contrasts with a study from Ghana, where primigravida status was not associated with preeclampsia [25]. This variation may be attributed to the sociodemographic characteristics of study participants.

5.1.2. Medical and Family History Factors

The present research demonstrated that the likelihood of developing preeclampsia was 3.7 times higher for women with a history of chronic hypertension and 3.9 times higher for those with a family history of hypertension. Similar to the studies conducted in China, Malaysia, Colombia, Pakistan, Ethiopia, Brazil, Sierra Leone, and Zanzibar, which reported that a history of chronic hypertension and a family history of hypertension were predictors of preeclampsia [6] [10] [19] [26] [41]-[45]. On the other hand, the current findings were inconsistent with the studies done in Bangladesh, Uganda, and Ghana, which revealed that a previous history of hypertension was not associated with preeclampsia [4] [25] [46]. This could be due to the geographical area of the study participants.

5.1.3. Previous Maternal/Obstetric Complications

Furthermore, women who had a prior history of preeclampsia or eclampsia were 3.2 times more likely to develop preeclampsia in their following pregnancy compared to their counterparts. The findings were in line with the findings reported in Colombia and Bangladesh women with a previous history of preeclampsia had a 4 to 5 times higher risk of developing preeclampsia [47] [48]. This could be due to the genetic factors that might contribute to the physiological predisposition of preeclampsia.

5.2. Adverse Birth Outcomes Associated with Preeclampsia

In a recent study, the present findings demonstrate that women with preeclampsia had higher odds of having low-birth-weight infants compared to their counterparts. The finding were in line with other studies done in Malaysia, Cameroon, Nigeria, Uganda, Zimbabwe, Southern and Northeast Ethiopia, China and Thailand, reported that babies born to preeclamptic women were at a higher risk of perinatal death, low birth weight, birth asphyxia, neonatal intensive care unit (NICU) admission and preterm birth than babies born to normotensive women [1] [30] [42] [49]-[53]. On the other hand, premature labour and neonatal deaths were not significantly associated with preeclampsia in the present study, as reported in the previous studies. The divergences may result from methodological

factors of the study utilized, such as the study setting, sample size, and study design. The current finding suggests a statistical correlation for women with high blood pressure (SBP \geq 140 mmHg) during their first ANC visit, and had 12 times higher risk of preeclampsia than those with SBP $<$ 140 mmHg. However, the results contradict those of a prospective study conducted in Uganda, which identified diastolic hypertension \geq 90 mmHg as significant to preeclampsia [46].

6. Limitations of the Study

This longitudinal population-based cohort study reflects a follow-up of pregnant women who attended antenatal clinics from 20 weeks of gestation until 28 days after delivery. The information was recorded in the medical charts of all women during ANC visits up to 28 days post-delivery. Limitations of this study are the absence of a control group consisting of pregnant women with or without preeclampsia, impeding a direct comparison of disease outcomes, as well as the loss of information regarding blood sample investigations. Furthermore, referring to the study design, study site, and being conducted in the health facilities, the generalizability may be limited to those attending public health facilities in Unguja. This approach, which is based in hospitals, only includes women who go to the three chosen hospitals. This is because many women die without having visited a health facility, and also because perinatal deaths were considered only for those at an institution. We also included family history of hypertension and preeclampsia as variables in our study; these may have been affected by potential recall bias.

Depending on the time elapsed between the event and the interview, participants may struggle to recall their family's medical history, potentially resulting in misclassification. This could influence the findings related to the family history of hypertension and preeclampsia risk. In our analysis, we conducted a logistic regression; however, we acknowledge that we did not control for all potentially relevant confounders, such as obesity, socioeconomic status, and diabetes. The uncontrolled confounding factor could have affected the observed associations in various ways.

7. Implications of the Study

Preeclampsia is a pregnancy complication characterized by elevated blood pressure and organ damage, which significantly increases the risk of adverse maternal and perinatal outcomes. This study has identified various maternal risk factors that contribute to these outcomes, including a family history of hypertension, chronic hypertension, and previous eclampsia. Therefore, the findings of this study are essential for the early detection and management of preeclampsia. Targeted preventive measures may improve maternal and newborn outcomes for women with preeclampsia, reducing the risk of complications and enhancing the overall quality of maternal and newborn care.

By implementing the findings from this study, healthcare professionals can bet-

ter identify at-risk women and provide timely interventions, ultimately fostering healthier pregnancies and promoting positive health trajectories for both mothers and their infants.

8. Conclusion

Preeclampsia remains a significant public health issue in Unguja, Zanzibar, affecting maternal and neonatal health outcomes considerably. This research identified a family history of hypertension, chronic hypertension, and previous eclampsia as key risk factors. These results highlight the necessity of early detection, proactive antenatal care, and focused health education. It is also advised to enhance maternal healthcare systems with screening protocols, preventive measures, and management guidelines customized to the recognized risk factors. Furthermore, the study indicates that timely interventions can effectively alleviate the burden of preeclampsia and enhance pregnancy outcomes in comparable low-resource environments.

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Ethical Considerations

The study has been approved by the Kilimanjaro Christian Medical University College Research and Ethical Review Committee (CRERC) with a certificate number 2495. Permission to conduct the study was obtained from the Zanzibar Medical Research Council (ZAHREC). A written consent form was obtained from participants to confirm their willingness to participate in the study.

Availability of Data and Materials

The data supporting this study's findings are available from the corresponding author.

Consent for Publication

Not applicable.

Conflicts of Interest

The authors declare no competing interests in this work.

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Authors' Contributions

NIY originated the study, contributed to the study design, analysis, and drafted

the manuscript. JS, RNM, and MJM contributed to the design of the study and critically revised the draft manuscript, providing constructive comments, ideas, and reviews. All authors read and approved the final manuscript.

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List of Abbreviations

ANC	Antenatal Care
AOR	Adjusted Odds Ratio
COR	Crude Odds Ratio
CI	Confidence Interval
SD	Standard Deviation
LMICs	low and middle-income countries
PE/E	Preeclampsia/Eclampsia
ANC SBP	Antenatal clinic systolic blood pressure
ANC DBP	Antenatal clinic Diastolic blood pressure
EDDs	expected date of delivery
Ras	research assistants