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Impact of non-communicable diseases on maternal and perinatal outcomes in a low resource setting

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Abstract

Background Non-communicable diseases (NCDs) are increasingly prevalent among women of reproductive age and may pose significant risks to maternal and perinatal health. Despite their growing burden, data on their impact in low-resource settings remains limited. This study aimed to investigate the impact of pre-pregnancy NCDs on severe maternal and adverse perinatal outcomes among pregnant women admitted at Mbarara Regional Referral Hospital (MRRH) in southwestern Uganda.

Methods We prospectively enrolled pregnant women admitted to the maternity ward of MRRH from July 2022 to October 2023. We consecutively included all women with one or more NCDs and next two admissions without NCDs. Baseline sociodemographic and clinical documentation of pre-pregnancy NCDs including chronic hypertension, pre-gestational diabetes, cardiac disease, chronic kidney disease, sickle cell disease, asthma, and epilepsy. Participants were followed from admission through delivery, puerperium, and post-discharge with phone calls at 2, 4, and 6 weeks, and severe maternal and adverse perinatal outcomes were documented. We compared outcomes between women with and without NCDs and performed multivariable logistic regression analyses to determine the association between NCDs and these outcomes, adjusting for potential confounders, including maternal age, gravidity, employment status, HIV serostatus and delivery mode.

Results We enrolled a cohort of 300 pregnant women (100 with NCDs and 200 without NCDs) with a mean age of 27.8 ± 5.9 years. Severe maternal outcomes occurred in 80/300 participants (26.7%), with a significantly higher incidence among those with NCDs (36.0%, $n = 36/100$) compared to those without (22.0%, $n = 44/200$), including maternal death (4.0%, $n = 4$ vs. 0.5%, $n = 1$), acute heart failure (7.0%, $n = 7$ vs. 0%), ICU admission (9.0%, $n = 9$ vs. 2.0%, $n = 4$), pulmonary embolism (4.0%, $n = 4$ vs. 0%) and sepsis (7.0%, $n = 7$ vs. 1.0%, $n = 2$). At least one adverse perinatal outcome occurred in most participants (52.7%, $n = 158/300$). Women with NCDs also experienced significantly higher rates of adverse perinatal outcomes (69.0%, $n = 69/100$) than those without NCDs (44.5%, $n = 89/200$), including miscarriage (11.0%, $n = 11$ vs. 1.0%, $n = 2$), neonatal death (11.5%, $n = 9$ vs. 4.5%, $n = 8$), and NICU admission (48.7%,

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$n = 38$ vs. 20.3%, $n = 36$). In multivariable analysis, having one or more pre-pregnancy NCD (adjusted odds ratio [aOR]: 2.02, 95% CI [1.10, 3.68]) and attending fewer than four antenatal care (ANC) visits (aOR: 2.25, 95% CI [1.26, 4.04]) were significantly associated with increased risk of both severe maternal and adverse perinatal outcomes (NCDs: aOR: 2.39, 95% CI [1.34, 4.26]; <4 ANC visits: aOR: 1.95, 95% CI [1.12, 3.38]).

Conclusions Pre-pregnancy NCDs and inadequate antenatal care are linked to severe maternal and adverse perinatal outcomes. Strengthening early identification, integrating NCD management into routine maternal care, and ensuring adequate antenatal visit coverage are critical to mitigating these risks. These findings underscore the need for targeted, multidisciplinary interventions to improve outcomes in resource-limited settings.

Keywords Pre-pregnancy non-communicable diseases, Severe maternal outcomes, Severe maternal morbidity, Maternal mortality, Adverse perinatal outcomes, Sub-Saharan Africa, Low-resource setting

Introduction

Non-communicable diseases (NCDs) such as diabetes, hypertension, and cardiovascular conditions have emerged as critical health challenges, particularly in sub-Saharan Africa (SSA) [1]. Globally, NCDs contribute to 15% of maternal deaths, with the figure rising to 19% in SSA [2, 3]. Although classified as indirect causes of maternal mortality, their effects extend beyond the mother and could increase the risk of adverse perinatal and child health outcomes. In SSA, the increasing incidence and prevalence of NCDs suggest an ongoing epidemiological transition. However, the extent to which this shift impacts maternal and perinatal outcomes remains insufficiently explored [4, 5]. During pregnancy, pre-existing NCDs can exacerbate obstetric conditions, leading to complications such as preeclampsia, gestational diabetes, and preterm birth [6, 7]. Limited research in the region suggests that the rise in NCDs correlates with increased rates of these complications [5–7].

The growing prevalence of NCDs in low- and middle-income countries (LMICs) has been met with inadequate healthcare responses at both national and international levels [8, 9]. The screening, diagnosis, and management of NCDs during pregnancy are insufficient, leading to poor outcomes for both mothers and their infants [10–12]. Challenges such as fragmented data, underreporting, and insufficient surveillance systems, along with healthcare providers' lack of necessary training and resources, and a shortage of policy guidelines and funding, hinder efforts to effectively manage NCDs in pregnancy [7, 11, 13]. In Uganda, research focused on NCDs during pregnancy and their effects on maternal and fetal health is limited. Existing studies are constrained by small sample sizes, methodological limitations, and a lack of comprehensive national data, making it difficult to fully assess the impact of NCDs on maternal and perinatal outcomes [6, 7, 14–16]. Therefore, this study aimed to explore the association between pre-pregnancy NCDs and severe maternal and adverse perinatal outcomes among women admitted to a tertiary referral health facility in Uganda.

Materials and methods

Study design and setting

We conducted a prospective cohort study of pregnant women admitted to the maternity ward of MRRH from July 2022 to December 2023. Located in Mbarara city in southwestern Uganda, MRRH is a government-funded public hospital situated 260 km from Kampala, the capital city. The hospital serves a catchment population of nine million people across nearly a dozen districts and has a capacity of 494 beds. MRRH also functions as a teaching hospital for Mbarara University of Science and Technology (MUST) and other tertiary health training institutions in the region. Additionally, patients from neighboring countries seek medical care at MRRH.

The Obstetrics and Gynecology Department at MRRH includes the maternity ward and a high-risk obstetrics unit located about 20 m from the neonatal unit and an operating theatre roughly 40–50 m away. The high-risk obstetrics unit manages women with complicated pregnancies, providing specialized care for those facing severe medical and obstetric conditions. Routine antenatal care is provided by nurse-midwives, who manage low-risk pregnancies, while the high-risk clinic is staffed daily by two postgraduate trainees in obstetrics and gynecology (residents) working in consultation with a specialist obstetrician. The maternity ward handles approximately 8,000 to 10,000 deliveries annually, reporting a maternal mortality rate of 375 per 100,000 live births from 2015 to 2019, and a perinatal mortality rate of 33 per 1,000 live births in 2020 [17, 18]. The obstetrics department comprises 14 obstetricians and gynecologists, 38 postgraduate students (residents), 6–10 intern doctors and 28 midwives. MRRH offers a wide range of preventive and curative services and acts as a key referral center. It also houses the region's only operational adult intensive care unit (ICU), equipped for life support, and a functioning neonatal intensive care unit (NICU) that caters to newborns with complications [19, 20].

Study population and eligibility criteria

This prospective cohort study included pregnant women admitted to the maternity ward of MRRH—including the high-risk obstetrics unit, antenatal ward and ICU. We included women with a documented diagnosis of a pre-pregnancy NCD, including chronic hypertension, pre-gestational diabetes, cardiac disease, chronic kidney disease (CKD), sickle cell disease, asthma, and epilepsy. Pre-pregnancy NCD diagnosis was based on documentation in patient care books or printed evidence of diagnostic investigations or ongoing treatment related to each NCD, or by patient self-report. For patients who reported NCDs but had no documentation of prior investigations or ongoing treatment, confirmatory assessments and investigations were carried out, including blood pressure measurements for those with chronic hypertension, fasting blood sugar and glycosylated hemoglobin for those with pre-gestational diabetes, cardiac echocardiography for those with cardiac disease, and serum creatinine and urea for those with CKD. For every participant with a pre-pregnancy NCD, we enrolled two successive pregnant women without NCDs. Women who met the inclusion criteria and consented to participate were enrolled at admission and followed up until 6 weeks postpartum. Recruitment occurred at the time of admission to the maternity ward, regardless of gestational age, provided the woman was still pregnant. This approach allowed inclusion of cases across the full spectrum of gestation, from early pregnancy complications to intrapartum presentations. All participants received routine clinical care according to maternity ward protocols, independently managed by the attending clinical team. Study procedures did not influence treatment decisions. Participants were interviewed by trained study staff after admission and discharge, as well as at 2, 4, and 6 weeks postpartum. Phone call interviews were conducted at 2 and 4 weeks postpartum, and an in-person follow-up visit was conducted at 6 weeks postpartum, except for those participants unable to attend physically, who were followed up by phone interview.

Data collection

After providing informed consent, participant baseline sociodemographic and clinical histories were collected.

Outcomes and predictors

The primary outcomes were occurrence of (1) severe maternal outcome and (2) adverse perinatal outcome during the participant's hospital stay or post-discharge through 6 weeks postpartum. A severe maternal outcome was defined as a composite of maternal mortality or one or more severe maternal morbidity (SMM) events, as defined based on the Center for Disease Collaboration (CDC) classification including one or more

of the following diagnoses or treatments: acute myocardial infarction, cardiac arrest or ventricular fibrillation, cardiopulmonary resuscitation (CPR)/cardioversion, heart failure or arrest during a procedure, acute heart failure/pulmonary edema, shock, acute kidney injury, disseminated intravascular coagulation, air and thrombotic embolism, blood transfusion, sickle cell anemia with crisis, amniotic fluid embolism, temporary tracheostomy, ventilation, puerperal cerebrovascular disorders (stroke), eclampsia, hysterectomy, severe anaesthesia complications, and sepsis [21]. An adverse perinatal outcome was defined as a composite of one or more of the following: miscarriage (spontaneous pregnancy loss before 26 weeks of gestation or birth weight below 800 g, consistent with Uganda's *Essential Maternal and Newborn Clinical Care Guidelines* (2022) [22]), stillbirth (a neonate born with no signs of life, including both macerated and fresh stillbirths [22, 23]), low birth weight (< 2.5 kg), preterm birth (gestational age < 37 weeks [22, 23]), low Apgar score < 7 at 5 min, admission to the neonatal intensive care unit (NICU), or neonatal death within the first 28 days of life [24].

The primary predictor was the presence of one or more pre-pregnancy NCDs. Additional characteristics collected included sociodemographic details, obstetric history, medical history including other NCDs, and HIV serostatus which was collected as self-report and confirmed with standard diagnostic testing for those at the time of study enrolment for those who reported being HIV seronegative. Delivery-related variables were abstracted from clinical records; however, information on the cadre of birth attendant was not systematically recorded and was therefore excluded from analysis. Data were entered into a REDCap database hosted at the Department of Obstetrics and Gynecology at MUST [25].

Sample size estimation and sampling

The sample size for this study was determined using the OpenEpi online software, applying the Fleiss formula for comparing two independent proportions. Based on published estimates indicating a 13% incidence of adverse maternal-fetal outcomes among women without NCDs and 27% among those with NCDs [14, 26, 27], and assuming a 95% confidence level, 80% power, and a 1:2 ratio of exposed to unexposed participants, a total of 300 women (100 with NCDs and 200 without) were enrolled, providing sufficient power to detect a 2.0-fold or greater increase in risk. Participants were recruited using consecutive stratified sampling: all eligible women with one or more pre-pregnancy NCDs were enrolled, followed by the next two eligible admissions without NCDs. This approach ensured balanced group comparisons and alignment with the calculated sample size targets.

Data analysis

Data were exported from REDCap to STATA 17 (Stata-Corp, College Station, Texas, USA) for cleaning and analysis. We summarized continuous variables as mean and standard deviation (SD) and described categorical variables as frequencies and percentages. We compared the proportion of severe maternal outcomes and adverse perinatal outcomes among women with and without NCDs using Chi-square and Fisher exact tests statistics as deemed appropriate. We performed univariable and multivariable logistic regression analysis to assess the association between pre-pregnancy NCDs and severe maternal outcomes and adverse perinatal outcomes, and reported both crude and adjusted odds ratios. In the final

multivariable models, we included the primary exposure variable (pre-pregnancy NCDs), along with covariates that showed a p -value < 0.20 in univariable analysis. We also incorporated clinically relevant variables—such as maternal age, education level, employment status, ANC attendance, parity, referral status, HIV serostatus, and mode of delivery—as potential confounders. To check for multicollinearity, we applied the variance inflation factor (VIF) method and flagged any variable with a $VIF > 5$. We considered variables statistically significant if they had a p -value < 0.05 in the final model.

Results

During the study period from July 2022 to October 2023, 12,910 pregnant women were admitted to the maternity ward at MRRH. Of these, 338 women were screened for enrolment and 29 (9%) declined consent to participate in the study. Consequently, we enrolled 309 women into the cohort (109 with NCDs and 200 without NCDs). Of these, 9 participants with NCDs were later disenrolled due to discharge from hospital before delivery and inability to be reached by phone. The final cohort therefore included 300 women (100 with NCDs and 200 without) who were followed from admission, through delivery, and through six weeks postpartum. Of the 100 women with pre-pregnancy NCDs, 36.0% ($n = 36$) had chronic hypertension, 39.0% ($n = 39$) had pre-gestational diabetes mellitus, 8.0% ($n = 8$) had cardiac disease (rheumatic heart disease), 12.0% ($n = 12$) had sickle cell disease, 6.0% ($n = 6$) had epilepsy, 2.0% ($n = 2$) had chronic kidney disease (CKD), and 2.0% ($n = 2$) had asthma. Four women had more than one pre-pregnancy NCD (2 with diabetes mellitus and chronic hypertension, 1 with chronic hypertension, diabetes and CKD, and 1 with asthma and chronic hypertension).

Baseline participant characteristics

The mean age of study participants was 27.8 ± 5.9 years, with the majority being married (92.7%), employed (70.0%) and multigravida (53.3%). There was a significant difference in the distribution of pre-pregnancy NCDs in terms of maternal age, referral history, and parity—with a higher proportion of women with NCDs aged ≥ 35 (29.0% vs. 10.0%), multiparous (≥ 2) and referred from another facility (49.0% vs. 30.5%) and as shown in Table 1.

Comparative incidence of severe maternal outcomes among women with or without pre-pregnancy non-communicable disease

Out of the 300 participants, severe maternal outcomes occurred in 80 participants (26.7%), with higher incidence among those with NCDs (36.0%, $n = 36$) compared to those without (22.0%, $n = 44$, $p = 0.01$, Table 2). Maternal deaths were more frequent among those with NCDs

Table 1 Baseline participant characteristics

Characteristics	One or more pre-pregnancy NCDs			P-value
	Total (N = 300)	Yes (n = 100)	No (n = 200)	
	n (%)	n (%)	n (%)	
Age (years) [mean (SD)]	27.8 (5.9)	30.1 (6.3)	26.7 (5.4)	$< 0.001^*$
Maternal age (years)				$< 0.001^*$
< 20	12 (4.0)	4 (4.0)	8 (4.0)	
20–<24	88 (29.3)	17 (17.0)	71 (35.5)	
25–<35	151 (50.3)	50 (50.0)	101 (50.5)	
≥ 35	49 (16.3)	29 (29.0)	20 (10.0)	
Level of education				0.11
No school	15 (5.0)	8 (8.0)	7 (3.5)	
Primary	96 (32.0)	28 (28.0)	68 (34.0)	
Secondary	124 (41.3)	37 (37.0)	87 (43.5)	
Tertiary	67 (21.7)	27 (27.0)	38 (19.0)	
Employment status				0.38
Unemployed	90 (30.0)	34 (34.0)	56 (28.0)	
Formal	43 (14.3)	16 (16.0)	27 (13.5)	
Informal	167 (55.7)	50 (50.0)	117 (58.5)	
Married	278 (92.7)	91 (91.0)	187 (93.5)	0.43
Referred/transferred from another facility	110 (36.7)	49 (49.0)	61 (30.5)	0.002*
HIV seropositive	15 (5.0)	8 (8.0)	7 (3.5)	0.09
Parity				$< 0.001^*$
Primipara (1)	169 (56.3)	39 (39.0)	130 (65.0)	
Multipara (2–4)	107 (35.7)	46 (46.0)	61 (30.5)	
Grand multipara (≥ 5)	24 (8.0)	15 (15.0)	9 (4.5)	
Number of ANC visits				0.44
< 4	108 (36.0)	39 (39.0)	69 (34.5)	
≥ 4	192 (64.0)	61 (61.0)	131 (65.5)	
Gestational age at birth (weeks)[§]				0.059
Pre-term (< 37)	86 (30.0)	33 (37.1)	53 (26.8)	
Early-term (37–<39)	90 (31.4)	33 (37.1)	57 (28.8)	
Full-term (39–<41)	84 (29.2)	17 (19.1)	67 (33.8)	
Late-term (41–<42)	19 (6.6)	4 (4.5)	15 (7.6)	
Post-term (≥ 42)	8 (2.8)	2 (2.3)	6 (3.0)	

* p -value < 0.05 , SD: standard deviation, ANC: antenatal care, NCDs: non-communicable diseases; [§]($n = 287$), less miscarriages

Table 2 Comparative incidence of severe maternal outcomes by pre-pregnancy non-communicable disease status

Maternal outcomes	Total (N=300) n (%)	Pre-pregnancy NCDs		P-value
		Yes (n=100) n (%)	No (n=200) n (%)	
Severe maternal outcomes (≥ 1)	80 (26.7)	36 (36.0%)	44 (22.0%)	0.01*
Maternal death	5 (1.7%)	4 (4.0%)	1 (0.5%)	0.03*
Acute kidney injury (AKI)	9 (3.0%)	1 (1.0%)	8 (4.0%)	0.15
Acute heart failure	7 (2.3%)	7 (7.0%)	0 (0.0%)	<0.001*
Cardiac arrest	3 (1.0%)	2 (2.0%)	1 (0.5%)	0.22
Cardiopulmonary resuscitation	3 (1.0%)	2 (2.0%)	1 (0.5%)	0.22
Stroke	1 (0.3%)	1 (1.0%)	0 (0.0%)	0.16
HELLP syndrome in pre-eclampsia	9 (3.0%)	3 (3.0%)	6 (3.0%)	1.00
Convulsions	15 (5.0%)	6 (6.0%)	9 (4.5%)	0.57
ICU admission	13 (4.3%)	9 (9.0%)	4 (2.0%)	0.005*
Sepsis	9 (3.0%)	7 (7.0%)	2 (1.0%)	0.004*
ARDS	1 (0.3)	1 (1.0)	0 (0.0)	0.16
Pulmonary Embolism	4 (1.3)	4 (4.0%)	0 (0.0%)	0.004*
PPH-related outcomes[†]				
Hysterectomy	10 (3.3%)	1 (1.0%)	9 (4.5%)	0.11
Hemorrhagic shock	5 (1.7%)	1 (1.0%)	4 (2.0%)	0.52
Blood transfusion [†]	39 (13.0%)	16 (16.0%)	23 (11.5%)	0.27

*p-value < 0.05, HELLP: Hemolysis Elevated Liver Enzymes Low Platelets, ICU: Intensive Care Unit, ARDS: Acute Respiratory distress syndrome, NCDs: non-communicable diseases, [†]May reflect PPH; transfusions also occurred for antenatal anemia

(4.0%, $n=4$) compared to those without (0.5%, $n=1$) ($p=0.03$). Similarly, acute heart failure (7.0%, $n=7$ vs. 0%), ICU admissions (9.0%, $n=9$ vs. 2.0%, $n=4$), pulmonary embolism (4.0%, $n=4$ vs. 0%) and sepsis (7.0%, $n=7$ vs. 1.0%, $n=2$) were significantly more common among those with NCDs compared to those without NCDs ($p<0.05$ for all).

Although not statistically significant, convulsions (6.0% vs. 4.5%, $p=0.57$), hysterectomy rates (4.5% vs. 1.0%, $p=0.11$), were more common in those with NCDs versus those without. Rates of cardiac arrest, cardiopulmonary resuscitation (CPR), stroke, hemorrhagic shock and blood transfusion showed no significant variation between groups (Table 2).

Comparative incidence of adverse perinatal outcomes among women with and without NCD

Women with non-communicable diseases (NCDs) experienced significantly higher rates of adverse perinatal outcomes compared to those without NCDs. Among the 300 participants, 52.7% ($n=158$) had at least one adverse outcome, with the NCD group showing a significantly

Table 3 Comparative incidence of adverse perinatal outcomes by maternal pre-pregnancy non-communicable disease status

Perinatal outcomes	Total (N=300) n (%)	Pre-pregnancy NCDs		P-value
		Yes (n=100) n (%)	No (n=200) n (%)	
≥ 1 adverse perinatal outcome	158 (52.7)	69 (69.0)	89 (44.5)	<0.001*
Miscarriage	13 (4.3)	11 (11.0)	2 (1.0)	<0.001*
Stillbirth [§]	32 (11.1)	11 (12.4)	21 (10.6)	0.66
Low birthweight [§]	87 (30.3)	24 (27.0)	63 (31.8)	0.41
Preterm births [§]	86 (30.0)	33/89 (37.1)	53 (26.8)	0.08
Low Apgar score at 5 min (< 7) [§]	13 (5.1)	5/78 (6.4)	8 (4.5)	0.53
Neonatal deaths [§]	17 (6.7)	9/78 (11.5)	8 (4.5)	0.04*
NICU admission [§]	74 (29.0)	38/78 (48.7)	36 (20.3)	<0.001*

*p-value < 0.05; [§]($n=287$), less miscarriages; [§]($n=255$, less miscarriages and still birth); NICU: neonatal intensive care unit; NCDs: non-communicable diseases

higher incidence (69.0%, $n=69$) compared to the non-NCD group (44.5%, $n=89$, $p<0.001$). Miscarriage (11.0%, $n=11$ vs. 1.0%, $n=2$), neonatal death (11.5%, $n=9$ vs. 4.5%, $n=8$), and NICU admission (48.7%, $n=38$ vs. 20.3%, $n=36$) were significantly more frequent among the women with NCDs compared to those without ($p<0.05$). Although not statistically significant, preterm birth (37.1% versus 26.8%, $p=0.08$) were also higher in the NCD compared to the non-NCD group (Table 3).

In multivariable analysis, having 1 or more pre-pregnancy NCDs was significantly associated with an increased risk of severe maternal outcomes (adjusted OR: 2.02, 95% CI [1.10, 3.68], $p=0.023$). Similarly, the number of ANC visits significantly impacted the maternal outcomes; fewer than four ANC visits were linked with higher odds of severe maternal outcomes (adjusted OR: 2.25, 95% CI [1.26, 4.04], $p=0.006$). Age, marital status, employment, level of education, HIV serostatus and parity did not show significant associations with severe maternal outcomes (Table 4).

In multivariable analysis, the presence of one or more pre-pregnancy NCDs was significantly associated with an increased risk of adverse perinatal outcome (adjusted OR: 2.39, 95% CI [1.34, 4.26], $p=0.003$).

Additionally, attending fewer than four ANC visits was linked with higher odds of adverse perinatal outcomes (adjusted OR: 1.95, 95% CI [1.12, 3.38], $p=0.02$) (Table 5).

Discussion

This study evaluated the incidence and associations between pre-pregnancy NCDs and adverse maternal and perinatal outcomes. Pre-pregnancy NCDs were a significant predictor of severe maternal outcomes such as maternal deaths and ICU admissions, and adverse perinatal outcomes, including as neonatal deaths, miscarriages and NICU admissions. These findings underscore

Table 4 Multivariable regression analysis of associations between pre-pregnancy Non communicable diseases and severe maternal outcomes

Predictors	Severe maternal outcomes		Univariable analysis		Multivariable analysis	
	Yes (n = 80) n (%)	No (n = 220) n (%)	Crude OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
One or more pre-pregnancy NCDs						
No	44(55.0)	156(70.9)	1.00		1.00	
Yes	36(45.0)	64(29.1)	1.99[1.18,3.38]	0.01*	2.02[1.10,3.68]	0.02*
Age (years)						
< 20	2(2.5)	10(4.5)	0.57[0.12,2.74]	0.49	0.32[0.05,2.10]	0.23
20–<24	23(28.7)	65(29.5)	1.22[0.56,1.85]	0.96	1.22[0.52,2.85]	0.65
25–<35	39(48.8)	112(50.9)	1.00		1.00	
≥ 35	16(20.0)	33(15.0)	1.39[0.69,2.80]	0.35	0.43[0.14,1.33]	0.14
Marital status						
Married	70(87.5)	208(94.5)	1.00		1.00	
Unmarried	10(12.5)	12(5.5)	2.48[1.03,5.98]	0.04*	1.89[0.52,6.88]	0.34
Employment						
Unemployed	22(27.5)	68(30.9)	1.22[0.51,2.94]	0.65	0.68[0.17,2.78]	0.59
Formal	9(11.3)	34(15.5)	1.00		1.00	
Informal	49(61.3)	118(53.6)	1.57[0.70,3.51]	0.27	0.55[0.14,2.21]	0.40
Level of education						
Primary	41(51.3)	70(31.8)	2.10[0.64,6.87]	0.22	1.35[0.27,6.91]	0.72
Secondary	26(32.5)	98(44.5)	0.93[0.28,3.06]	0.90	0.66[0.13,3.26]	0.62
Tertiary	13(16.3)	52(23.6)	1.00		1.00	
HIV serostatus						
Negative	73(91.3)	212(96.4)	1.00		1.00	
Positive	7(8.8)	8(3.6)	2.54[0.89,7.25]	0.08	1.87[0.48,7.19]	0.37
Parity						
Primipara (1)	40(50.0)	129(58.6)	0.80[0.46,1.38]	0.42	0.69[0.30,1.60]	0.39
Multipara (2–4)	30(37.5)	77(35.0)	1.00		1.00	
Grand multipara (≥ 5)	10(12.5)	14(6.4)	1.83[0.73,4.58]	0.19	2.37[0.60,9.43]	0.22
ANC visits						
< 4	42(52.5)	66(30.0)	2.25[1.26,4.04]	< 0.001*	2.25[1.26,4.04]	0.006*
≥ 4	38(47.5)	154(70.0)	1.00		1.00	
Delivery mode						
Vaginal	27(38.0)	80(37.2)	1.00		1.00	
Caesarean	44(62.0)	135(62.8)	0.97[0.56,1.68]	0.90	1.25[0.64,2.45]	0.51

* $p < 0.05$, OR: odds ratios, C.I: confidence intervals, ANC: antenatal care, NCDs: non-communicable diseases

the critical need for targeted intervention strategies before, during and after pregnancy to manage NCDs among women in SSA. Additionally, attending fewer than four ANC visits was also a significant predictor of both severe maternal and adverse perinatal outcomes emphasizing the crucial role of regular ANC visits in monitoring and mitigating health risks during pregnancy.

Impact on maternal health

The significantly higher incidence of severe maternal outcomes among women with pre-pregnancy non-communicable diseases (NCDs) highlights the amplified challenges these conditions pose during pregnancy, delivery and postpartum [6, 7, 28]. Severe maternal outcomes, including maternal deaths, acute heart failure, ICU admissions, and sepsis, were notably more common

among women with NCDs. While these findings are consistent with prior research, it is important to note that most prior studies were conducted outside SSA, highlighting a gap in region-specific evidence [29–33]. This emphasizes the urgent need for targeted interventions, including timely recognition and effective management of NCDs before, during pregnancy, and after pregnancy, to mitigate these risks and enhance maternal health outcomes [11, 13]. Subspecialty training in fetal-maternal (obstetric) medicine and a consideration of a multidisciplinary approach to ensure integrated care service could improve outcomes [11, 12, 34–37].

Perinatal health concerns

The significantly high occurrence of adverse perinatal outcomes, including miscarriages, neonatal deaths, and

Table 5 Association between maternal pre-pregnancy Non communicable disease and adverse perinatal outcomes

Predictors	Adverse perinatal outcomes		Univariable analysis		Multivariable analysis	
	Yes (N = 158)	No (N = 142)	Crude OR	P-value	Adjusted OR	P-value
	n (%)	n (%)	(95% CI)		(95% CI)	
One or more pre-pregnancy NCDs						
No	89(56.3)	111(78.2)	1.00		1.00	
Yes	69(43.7)	31(21.8)	2.78[1.67,4.61]	< 0.001*	2.39[1.34,4.26]	0.003*
Maternal age (years)						
< 20	8(5.1)	4(2.8)	2.19[0.63,7.60]	0.22	2.52[0.62,10.26]	0.20
20–<24	41(25.9)	47(33.1)	0.96[0.56,1.62]	0.87	1.26[0.65,2.44]	0.50
25–<35	72(45.6)	79(55.6)	1.00		1.00	
≥ 35	37(23.4)	12(8.5)	3.38[1.64,6.99]	0.001*	1.78[0.73,4.37]	0.21
Employment						
Unemployed	47(29.7)	43(30.3)	0.85[0.50,1.42]	0.53	1.01[0.38,2.68]	0.99
Formal	17(10.8)	26(18.3)	0.51[0.26,1.01]	0.05	1.33[0.52,3.43]	0.55
Informal	94(59.5)	73 (51.4)	1.00		1.00	
Level of education						
Primary	61(44.9)	40(28.2)	1.97[1.04,3.75]	0.04*	1.69[0.67,4.24]	0.26
Secondary	58(36.7)	66(46.5)	1.01[0.43,2.37]	0.77	1.01[0.43,2.37]	0.97
Tertiary	29(18.4)	36(25.4)	1.00		1.00	
HIV serostatus						
Negative	148(93.7)	137(96.5)	1.00		1.00	
Positive	10(6.3)	5(3.5)	1.85[0.62,5.55]	0.27	1.50[0.45,4.98]	0.51
Parity						
Primipara (1)	80(50.6)	89(62.7)	0.73[0.45,1.19]	0.21	0.87[0.46,1.66]	0.67
Multipara (2–4)	59(37.3)	48(33.8)	1.00		1.00	
Grand multipara (≥ 5)	19(12.0)	5(3.5)	3.09[1.08,8.89]	0.03*	1.46[0.41,5.20]	0.56
Delivery mode						
Vaginal	51(35.4)	56(39.4)	1.00		1.00	
Caesarean	93(64.6)	86(60.6)	1.19[0.74,1.92]	0.48	1.38[0.81,2.35]	0.24
Number of ANC visits						
< 4	73(46.2)	35(24.6)	2.63[1.60,4.30]	< 0.001*	1.95[1.12,3.38]	0.02*
≥ 4	85(53.8)	107(75.4)	1.00		1.00	

*p-value < 0.05, OR: odds ratios, C.I: confidence interval, ANC: antenatal care, NCDs: non-communicable diseases

NICU admissions—demonstrates the significant impact of maternal NCDs on fetal and neonatal health. While these findings align with research conducted in other regions [38, 39], comprehensive studies specific to SSA remain scarce, limiting insights into region-specific challenges such as healthcare access and resource constraints on these outcomes. Addressing these gaps calls for tailored care strategies, including enhanced prenatal care designed to meet the unique needs of pregnant women with NCDs. Examples include community-based health education to raise awareness about NCDs and their risks, integrated antenatal services to screen and manage NCDs early, and subsidized access to essential medications. Further, task-shifting through training midwives and nurses in NCD management and leveraging mobile health (mHealth) solutions for remote monitoring could transform maternal and neonatal outcomes [40–42]. Additionally, expanding regional research within SSA is essential to inform evidence-based interventions and allocate healthcare resources effectively [12, 43, 44].

Need for pre-pregnancy interventions

The elevated odds of severe maternal morbidity and mortality among women with NCDs emphasize the critical need for early intervention. Preventive strategies such as NCD prevention, pre-pregnancy screening and management, and targeted counselling—including initiatives like community-based screening programs, accessible diagnostic and monitoring tools for hypertension and diabetes, pre-pregnancy optimization of medication regimens, and promotion of lifestyle changes like balanced diets and regular exercise—can markedly lower the risk of severe complications [6, 45, 46]. These proactive measures address the root causes contributing to adverse maternal and perinatal outcomes, ultimately enhancing overall pregnancy outcomes [47, 48].

Enhanced prenatal care

The higher likelihood of adverse perinatal outcomes in women with NCDs underscores the urgent need for enhanced prenatal care. Strengthening high-risk clinics

within ANC systems is crucial for early identification and management of complications in pregnant women with NCDs [49, 50]. These clinics provide targeted screening, comprehensive risk assessment, and timely referrals to specialists, facilitating early intervention and personalized care. In healthcare systems where midwives play a central role in ANC, integrating risk stratification protocols, multidisciplinary care approaches, and digital tools for monitoring key indicators like blood glucose and blood pressure could improve maternal and neonatal outcomes [50, 51]. Collaboration between midwives, general practitioners, and obstetricians ensures continuous care and timely medical intervention including optimized medication management for high-risk pregnancies. Additionally, task shifting could help optimize healthcare resources by equipping midwives with specialized training to conduct routine screenings, provide lifestyle counseling, and initiate referrals [40, 52, 53]. Strengthening both high-risk clinics and task shifting could improve the quality of prenatal care, close service gaps, and expand access to specialized care. Consistent with global findings, inadequate ANC visits significantly increase maternal and perinatal risks [54–56]. Although ANC attendance did not differ significantly by NCD status in this cohort, multivariable analyses identified fewer than four ANC visits as an independent predictor of adverse outcomes. This reinforces the importance of adequate ANC coverage across all exposure groups. Ensuring that pregnant women with NCDs receive timely and adequate ANC visits, alongside strengthened high-risk clinics, could improve maternal and neonatal health outcomes across diverse healthcare settings [44, 49, 57].

Intrapartum care considerations

Intrapartum management for women with NCDs should prioritize structured screening upon admission to identify high-risk individuals especially those with NCDs and ensure timely intervention [11, 58]. Continuous monitoring of maternal and fetal vitals—using tools like electronic fetal monitors, blood pressure and pulse oximetry—is essential for early detection of complications. A multidisciplinary approach involving obstetricians, anaesthesiologists, physicians and neonatologists familiar with managing chronic conditions can help optimize care during delivery [59, 60]. Predefined escalation protocols should address emergencies such as preeclampsia, pulmonary embolism, or heart failure, ensuring ICU preparedness when needed [11]. Proactive measures, including insulin for diabetes, magnesium sulphate and antenatal corticosteroids, could help mitigate risks and improve neonatal outcomes [58, 61]. Postpartum care requires specialized attention due to ongoing maternal risks, with NICU readiness being crucial for managing adverse perinatal outcomes [62, 63]. Implementing

these strategies could enhance maternal and neonatal outcomes, particularly in resource-limited settings, by improving risk management and preparedness during labor and delivery.

Policy implications

These findings suggest a need for healthcare policies that prioritize the prevention, routine screening with timely diagnosis and management of NCDs in women of reproductive age [11, 47, 64, 65]. Ensuring access to healthcare services and targeted education can help mitigate the risks associated with pre-pregnancy NCDs [66]. Policy-makers should focus on developing and implementing strategies to improve the management of NCDs among women planning to conceive [67]. This can include ensuring access to regular screenings, effective management, and counselling services that address the unique challenges faced by this high-risk group [12, 67].

Strengths and limitations

This study focuses on a high-risk population of women with pre-existing NCDs, a group that experiences significant adverse maternal and perinatal outcomes. Given the limited research on this subject in low-resource settings, our findings contribute valuable insights. The prospective nature of our study enhances the validity of our findings by reducing recall bias and allowing direct observation of maternal and perinatal outcomes over time—ensuring a more accurate assessment of associations between pre-pregnancy NCDs and adverse outcomes. Additionally, confirmatory assessments conducted for the most frequent NCDs, such as chronic hypertension and diabetes mellitus, strengthen data reliability by validating self-reported diagnoses with diagnostic investigations, thus minimizing inaccuracies.

Despite these strengths, several limitations may affect the interpretation and broader applicability of the findings. Since the study was conducted at a single tertiary referral hospital, selection bias may have influenced enrollment, as women with more severe cases were likely referred for specialized care to our study site from the surrounding health facilities. This potentially could have excluded less severe cases or those delivering in lower-level health facilities and hence underestimated the occurrence of adverse outcomes, limiting generalizability to other settings. However, given the hospital's role as a major referral center, it is likely that a significant proportion of women with NCDs in the region were included in the study and therefore outcomes obtained. While confirmatory assessments were performed for some NCDs, underreporting remains a concern, particularly for conditions requiring advanced diagnostic tools. Additionally, data on the cadre of birth attendant was not systematically collected for either vaginal or caesarean deliveries.

In our setting, midwives typically conduct normal deliveries, while residents and specialist obstetricians manage complicated cases. The absence of complete provider-level data limits our ability to assess outcome differences by delivery cadre, and future studies should incorporate structured documentation of this variable to enable more nuanced analysis. We also acknowledge that some participants in the no-NCD arm developed pregnancy-related conditions such as preeclampsia, which may have contributed to adverse outcomes. Related complications including HELLP syndrome, convulsions, and acute kidney injury were captured as maternal adverse outcomes. However, we did not stratify outcomes by emergent diagnoses and therefore cannot infer causality between these conditions and observed outcomes. Future studies should consider disaggregating outcomes by both pre-existing and pregnancy-onset conditions to better delineate their respective contributions to maternal risk. The short follow-up period of six weeks postpartum further restricts insights into long-term maternal and child health effects, which could be critical for understanding the full impact of NCDs on both maternal and child health outcomes. These limitations emphasize areas for further research, including larger sample sizes, multicenter studies, extended follow-up periods, and improved diagnostic strategies to enhance data accuracy and applicability across diverse healthcare settings.

Conclusions

This study underscores the profound impact of NCDs on pregnancy outcomes in sub-Saharan Africa. Women with NCDs face significantly heightened risks of severe maternal complications including maternal deaths and ICU admissions, and adverse perinatal outcomes such as miscarriage, neonatal death, and NICU admission. Fewer than four antenatal care visits were also independently associated with poor outcomes. These findings highlight the urgent need for targeted interventions across the continuum of care—before, during, and after pregnancy. Strengthening the integration of routine NCD screening and management into maternal care, alongside ensuring comprehensive antenatal care with adequate visit coverage, could mitigate these risks. Although our study did not directly evaluate preconception counseling, structured intrapartum monitoring, or fetal-maternal medicine specialist care, these remain critical components of comprehensive care for high-risk pregnancies and point to areas where health systems in resource-limited settings require strengthening. While the modest sample size and single-center design warrant cautious interpretation, these findings contribute to the growing evidence base on NCDs and pregnancy outcomes in sub-Saharan Africa, and underscores the need for future larger, multicenter studies to validate the observed associations,

refine context-specific interventions, and close region-specific data gaps to guide policy and improve maternal and neonatal outcomes.

Abbreviations

ANC	Antenatal care
CVD	Cardiovascular diseases
DVT	Deep venous thrombosis
DM	Diabetes mellitus
HTN	Hypertension
ICU	Intensive care unit
LMIC	Low- and middle-income countries
MMR	Maternal mortality ratio
MRRH	Mbarara Regional Referral Hospital
MUST	Mbarara University of Science and Technology
NCDs	Non-communicable diseases
NICU	Neonatal Intensive Care Unit PE: Pulmonary embolism
PPH	Postpartum hemorrhage
VTE	Venous thromboembolic events

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Author contributions

LT, AAB, AO and JN contributed to the conception and design of the study. LT performed the formal data analysis and drafted the manuscript. LT, AAB, and JN were involved in study implementation and data acquisition. AO, JPV, YJ, ECA, LMB, HK, FB, MK, and YFT critically reviewed and revised the manuscript for key content. All authors read and approved the final manuscript.

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Data availability

The datasets used during this study are available from the corresponding author upon reasonable request.

Declarations

Ethical approval and consent to participate

The study was approved by the Mbarara University Research Ethics Committee (MUST-2021-143) and the Uganda National Council for Science and Technology (HS1734ES). Participants provided written informed consent. The principles of data transfer and the protection of human research participants as outlined in the Declaration of Helsinki were strictly followed.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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