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Knowledge of Hypertensive Disorders of Pregnancy and Associated Factors Among Antenatal-Care Attendees in Mbarara City, Southwestern Uganda: A Cross-Sectional Study

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Background: Hypertensive disorders of pregnancy (HDP) are important contributors to maternal and perinatal morbidity and mortality in sub-Saharan Africa. Women's knowledge of warning signs, risk factors, diagnosis, and prevention may support earlier care-seeking and timely diagnosis, yet data from primary-level antenatal-care settings in Uganda remain limited. We assessed knowledge of HDP and associated factors among antenatal-care attendees in Mbarara City, southwestern Uganda.

Methods: We conducted a cross-sectional study among pregnant women attending their third or later antenatal-care visit at six public health facilities in Mbarara City between January and March 2025. Participants were recruited by consecutive sampling. Knowledge was assessed using 41 scored knowledge items covering awareness, disease manifestations, risk factors, diagnosis, management, prevention, complications, and blood-pressure monitoring. Scores were expressed as percentages of correct responses; adequate knowledge was defined as $\geq 60\%$. Multivariable modified Poisson regression was used to estimate adjusted prevalence ratios.

Results: Among 426 antenatal-care attendees, 271 had adequate knowledge, giving a prevalence of 63.6% (95% CI: 58.8–68.2). Knowledge was highest for timing or frequency of blood-pressure checks (86.2%) and complications (76.1%), but lower for diagnosis (51.4%), timing of occurrence (53.3%), treatment and management (53.4%), and risk factors (56.8%). Adequate knowledge was more prevalent among women with secondary education (aPR=1.34; 95% CI: 1.10–1.64) or tertiary education (aPR=1.36; 95% CI: 1.04–1.78), compared with primary education or less; women with five or more pregnancies compared with primigravidas (aPR=1.77; 95% CI: 1.27–2.48); and women with family history of preeclampsia compared with those without (aPR=1.26; 95% CI: 1.06–1.50).

Conclusions: Approximately two-thirds of antenatal-care attendees had adequate knowledge of HDP, but important gaps remained in diagnosis, timing of occurrence, treatment and management, and risk-factor recognition. Health education during antenatal care should prioritize practical messages for women with lower educational attainment, primigravidas or limited pregnancy experience, and women without a family history of preeclampsia.

Keywords: hypertensive disorders of pregnancy, pre-eclampsia, antenatal care, knowledge, Uganda

Introduction

Hypertensive disorders of pregnancy (HDP), including pre-eclampsia and eclampsia, remain major contributors to maternal and perinatal morbidity and mortality globally, with a disproportionate burden in low- and middle-income

countries.^{1–3} Pre-eclampsia usually develops after 20 weeks of gestation and may progress to severe maternal complications, fetal growth restriction, preterm birth, stillbirth, and long-term cardiovascular risk after pregnancy.^{4–7} In Uganda and similar sub-Saharan African settings, the consequences of HDP are amplified by delayed recognition, late presentation, limited diagnostic capacity at lower-level facilities, and delays in referral and definitive management.^{8,9} Because antenatal care is the main point of contact between pregnant women and the health system, it offers an important opportunity for blood-pressure screening, risk identification, counselling, and early linkage to care.¹⁰

Improving outcomes from HDP requires not only facility readiness and provider competence, but also women's ability to recognize risk, understand warning signs, and seek timely care.¹¹ Previous studies from Ghana and other settings have shown that knowledge of pre-eclampsia among pregnant and postpartum women is often incomplete, particularly regarding symptoms, risk factors, diagnosis, complications, and future health implications.^{12,13}

Ugandan evidence on HDP has documented adverse maternal and perinatal outcomes, postpartum hypertension, referral challenges, and health-worker perspectives on diagnosis and care.^{5,8,14,15} However, evidence on women's knowledge remains more limited. Recent Ugandan studies have reported low knowledge of pre-eclampsia and its risk factors among antenatal-care attendees in Lango sub-region, mixed community understanding and misconceptions in Mbale City (eastern Uganda), and limited awareness as a barrier to early care-seeking among women with pre-eclampsia /eclampsia at a national referral hospital.^{16–18} These studies support the need for context-specific, multidomain evidence from lower-level public antenatal-care facilities in Uganda.

Although antenatal care is a key platform for screening and counselling on hypertensive disorders of pregnancy, there are limited data on what women attending lower-level public facilities in Uganda understand about these conditions. This is an important gap because without such data, health education may remain generic rather than targeted to the most important knowledge gaps and vulnerable groups. Context-specific data are needed to guide counselling messages and identify groups that require additional support. We therefore assessed knowledge of HDP and associated factors among pregnant women attending antenatal care at public health facilities in Mbarara City, southwestern Uganda.

Methods

Study Design and Setting

We conducted a health facility-based cross-sectional study among pregnant women attending antenatal care at public health facilities in Mbarara City, southwestern Uganda, between January, 2025 and March, 2025. This analysis was part of a broader study examining barriers and facilitators to screening and timely diagnosis of HDP.

The study was conducted at six public health facilities providing antenatal care in Mbarara City: Mbarara City Health Center IV, Biharwe Health Center III, Kakoba Health Center III, Kyarwabuganda Health Center III, Nyakayojo Health Center III, and Nyamitanga Health Center III as have been described elsewhere.¹⁵ These facilities represent lower-level public maternal-health service delivery points where routine antenatal screening, counselling, and referral decisions are commonly initiated. Health center III facilities provide antenatal care and basic emergency obstetric care, while the health center IV provides more comprehensive emergency obstetric care and referral support.

Study Population and Eligibility Criteria

The study population comprised pregnant women attending antenatal care at the selected public health facilities. Women were eligible if they were attending their third or later antenatal-care visit, were able to provide informed consent, and were not too ill to participate in the interview. The third-or-later-visit eligibility criterion was used because the parent study aimed to assess knowledge among women who had already had at least two prior opportunities for routine antenatal-care contact and counselling. Women who were critically ill or unable to complete the study procedures were excluded.

Sampling and Sample Size

Participants were recruited using consecutive sampling. Eligible women attending antenatal care at each participating facility were approached, informed about the study, and invited to participate until the required sample size was reached.

The study targeted approximately equal recruitment across the six facilities to ensure representation from both health center III and health center IV settings. The sample size was estimated using OpenEpi for a single population proportion. In the absence of a prior local estimate of poor knowledge of hypertension in pregnancy, we used a conservative expected proportion of 50%, which gives the largest sample size when the true proportion is unknown.¹⁹ With a 95% confidence level, 5% margin of error, and 10% allowance for non-response, the required sample size was 427 women, with approximately equal recruitment targeted across the six facilities.

Data Collection

Data were collected using a structured interviewer-administered questionnaire. The tool captured sociodemographic characteristics, obstetric history, previous experience of high blood pressure in pregnancy, family history of preeclampsia, and knowledge of HDP. The questionnaire ([Supplementary file 1](#)) was developed from the study objectives and relevant literature, reviewed by the study team, translated into Runyankole, and pretested before data collection. Interviews were conducted in Runyankole by trained research assistants to ensure participant comprehension and consistency in administration.

Knowledge Assessment and Scoring

Knowledge of HDP was assessed using 41 scored knowledge items covering key domains, including awareness, disease manifestations, risk factors, diagnosis, management, prevention, complications, and blood-pressure monitoring. Each correct response was assigned one point, while incorrect responses and “do not know” responses were assigned zero points. The total knowledge score was calculated as the percentage of correct responses out of the 41 scored items. Internal consistency of the 41 scored items was assessed using the Kuder-Richardson Formula 20 (KR-20), equivalent to Cronbach’s alpha for dichotomous items.

Knowledge level was initially classified using the modified Bloom’s cut-off approach as poor knowledge (<60%), moderate knowledge (60–79%), and good knowledge (80–100%). For the primary analysis, knowledge was dichotomised as adequate or inadequate. Participants with moderate or good knowledge were classified as having adequate knowledge ($\geq 60\%$), while those with poor knowledge were classified as having inadequate knowledge (<60%).¹² Because the questionnaire was study-specific and multidomain, this cut-off was used as a pragmatic classification approach and was interpreted alongside domain-specific and item-level findings. Domain-specific knowledge scores were calculated as the percentage of correct responses within each domain.

Explanatory Variables

The main explanatory variables were selected a priori based on conceptual relevance and previous literature. These included age group, gestational-age group, marital status, education level, occupation, pregnancy history, previous high blood pressure in pregnancy, family history of preeclampsia, and health facility. Education was categorized as primary or less, secondary, and tertiary. Pregnancy history was categorized as first pregnancy, two to four pregnancies, and five or more pregnancies.

Data Management and Analysis

Data were entered into MS-Excel 2016 and exported for cleaning and analysis in R version 4.3.1 (2023-06-16 ucrt; R Foundation for Statistical Computing, Vienna, Austria). All enrolled participants with complete knowledge-score data were included in descriptive analyses. “Do not know” responses to knowledge questions were scored as incorrect. For explanatory variables where “Do not know” or not-recorded responses were available, these categories were retained in descriptive analyses. Regression models comparing Yes vs No categories for previous high blood pressure in pregnancy and family history of preeclampsia used complete-case analysis, excluding “Do not know” or not-recorded responses for those variables.

Participant characteristics were summarized using frequencies and percentages because all explanatory variables used in the analysis were categorical. Participant characteristics were presented descriptively by knowledge status; these comparisons were used to describe the study population and were not used for variable selection. The total knowledge

score was summarized using the mean and standard deviation. The prevalence of adequate knowledge was calculated as the proportion of participants with a total knowledge score of $\geq 60\%$, with a 95% confidence interval. Domain-specific knowledge scores were summarized as the percentage of correct responses within each domain, and item-level results were presented for all 41 scored knowledge items in [Supplementary Table S1](#).

Because adequate knowledge was a common outcome, modified Poisson regression with robust standard errors was used to estimate crude and adjusted prevalence ratios with 95% confidence intervals.²⁰ Crude prevalence ratios were estimated separately for each explanatory variable. The adjusted model included variables selected a priori based on clinical and public-health relevance: age group, gestational-age group, education level, occupation, pregnancy history, previous high blood pressure in pregnancy, family history of preeclampsia, and health facility. The primary adjusted model used complete-case analysis ($n=388$).

The modified Poisson model was fitted using a log link and robust variance estimator to account for misspecification of the Poisson variance structure when modelling a binary outcome.²⁰ Model results were reported as prevalence ratios rather than odds ratios to improve interpretability for a common outcome. Multicollinearity was assessed using generalized variance inflation factors. Health facility was included as a fixed covariate in the primary model. To assess robustness to potential correlation among participants recruited from the same facility, we conducted a sensitivity analysis using generalized estimating equations with exchangeable working correlation and facility as the clustering unit. Additional sensitivity analyses modelled pregnancy history using alternative categorizations and modelled the knowledge score as a continuous outcome. All statistical tests were two-sided.

Results

Participant Characteristics

All 426 enrolled antenatal-care attendees were included in the analysis. Participants were predominantly aged 25–34 years (51.9%), married (96.0%), and in the third trimester (73.9%). Secondary education was the most common highest education level (43.9%), and most women had had 2–4 pregnancies (59.6%). Previous high blood pressure in pregnancy was reported by 8.9% of participants, and 17.8% reported a family history of preeclampsia ([Table 1](#)).

Compared with women with inadequate knowledge, women with adequate knowledge were less likely to have primary education or less (32.1% vs 50.3%) and more likely to have secondary (48.0% vs 36.8%) or tertiary education (19.9% vs 12.9%). Previous high blood pressure in pregnancy was more common among women with adequate knowledge than those with inadequate knowledge (12.5% vs 2.6%), as was family history of preeclampsia (22.5% vs 9.7%). The distribution of knowledge status also varied across facilities, with adequate knowledge accounting for a higher share of participants from Mbarara City HCIV and Nyamitanga HCIII than from Kakoba HCIII and Kyarwabuganda HCIII ([Table 1](#)).

Overall and Domain-Specific Knowledge

Overall, 271 of 426 participants had adequate knowledge, corresponding to a prevalence of 63.6% (95% CI: 58.8–68.2). The mean knowledge score was 62.7% (SD: 13.9), and the median score was 65.9% (IQR: 56.1–73.2). The 41 scored knowledge items had acceptable internal consistency (KR-20/Cronbach's $\alpha=0.788$). Using modified Bloom categories, 155 women (36.4%) had poor knowledge, 237 (55.6%) had moderate knowledge, and 34 (8.0%) had good knowledge ([Figure 1](#)).

Knowledge was uneven across domains. The highest mean scores were observed for timing or frequency of blood-pressure checks (86.2%) and complications (76.1%). In contrast, lower scores were observed for diagnosis (51.4%), timing of HDP occurrence (53.3%), treatment and management (53.4%), and risk factors (56.8%) ([Figure 2](#)).

Item-Level Knowledge Scores

Item-level analysis showed important gaps across prevention, diagnosis, management, and risk-factor recognition. The lowest-scoring items were knowledge that low-dose aspirin may reduce risk in eligible high-risk women (7.7%), medication alone is not sufficient management (11.7%), urine protein testing is used for diagnosis (31.5%), nausea/

Table 1 Participant Characteristics by Knowledge Status

Characteristic	Overall (N=426)	Inadequate Knowledge <60% (n=155)	Adequate Knowledge ≥60% (n=271)
Age group (years)			
<20	34 (8.0%)	17 (11.0%)	17 (6.3%)
20–24	129 (30.3%)	41 (26.5%)	88 (32.5%)
25–34	221 (51.9%)	80 (51.6%)	141 (52.0%)
≥35	42 (9.9%)	17 (11.0%)	25 (9.2%)
Gestational age group			
<20 weeks	18 (4.2%)	7 (4.5%)	11 (4.1%)
20–27 weeks	93 (21.8%)	40 (25.8%)	53 (19.6%)
28–36 weeks	252 (59.2%)	89 (57.4%)	163 (60.1%)
≥37 weeks	63 (14.8%)	19 (12.3%)	44 (16.2%)
Marital status			
Married	409 (96.0%)	146 (94.2%)	263 (97.0%)
Not married	17 (4.0%)	9 (5.8%)	8 (3.0%)
Occupation			
None/unemployed	92 (21.6%)	40 (25.8%)	52 (19.2%)
Peasant farmer	94 (22.1%)	39 (25.2%)	55 (20.3%)
Business	159 (37.3%)	48 (31.0%)	111 (41.0%)
Employed	81 (19.0%)	28 (18.1%)	53 (19.6%)
Education level			
Primary or less	165 (38.7%)	78 (50.3%)	87 (32.1%)
Secondary	187 (43.9%)	57 (36.8%)	130 (48.0%)
Tertiary	74 (17.4%)	20 (12.9%)	54 (19.9%)
Pregnancy history			
First pregnancy / primigravida	139 (32.6%)	56 (36.1%)	83 (30.6%)
2–4 pregnancies	254 (59.6%)	92 (59.4%)	162 (59.8%)
≥5 pregnancies	33 (7.7%)	7 (4.5%)	26 (9.6%)
Previous high blood pressure in pregnancy			
No	379 (89.0%)	147 (94.8%)	232 (85.6%)
Yes	38 (8.9%)	4 (2.6%)	34 (12.5%)
Do not know/not recorded	9 (2.1%)	4 (2.6%)	5 (1.8%)
Family history of preeclampsia			
No	319 (74.9%)	131 (84.5%)	188 (69.4%)
Yes	76 (17.8%)	15 (9.7%)	61 (22.5%)
Do not know/not recorded	31 (7.3%)	9 (5.8%)	22 (8.1%)
Health facility			
Biharwe HCIII	71 (16.7%)	27 (17.4%)	44 (16.2%)
Kakoba HC III	74 (17.4%)	35 (22.6%)	39 (14.4%)
Kyarwabuganda HCIII	72 (16.9%)	35 (22.6%)	37 (13.7%)
Mbarara City HCIV	81 (19.0%)	21 (13.5%)	60 (22.1%)
Nyakayojo HCIII	61 (14.3%)	20 (12.9%)	41 (15.1%)
Nyamtanga HCIII	67 (15.7%)	17 (11.0%)	50 (18.5%)

Notes: Values are n (%) and percentages are column percentages within the Overall, Inadequate knowledge, and Adequate knowledge columns.

Abbreviation: HDP = hypertensive disorders of pregnancy.

vomiting may be a symptom or sign (33.6%), ultrasound may be used for fetal assessment (36.2%), and first pregnancy is a risk factor (36.6%) (Figure 3). Correct-response percentages for all 41 scored knowledge items are provided in [Supplementary Table S1](#).

Among the 426 antenatal-care attendees, knowledge was strongest for severe complications and blood-pressure-related aspects of care. Items with at least 80% correct responses included maternal death as a complication (98.4%),

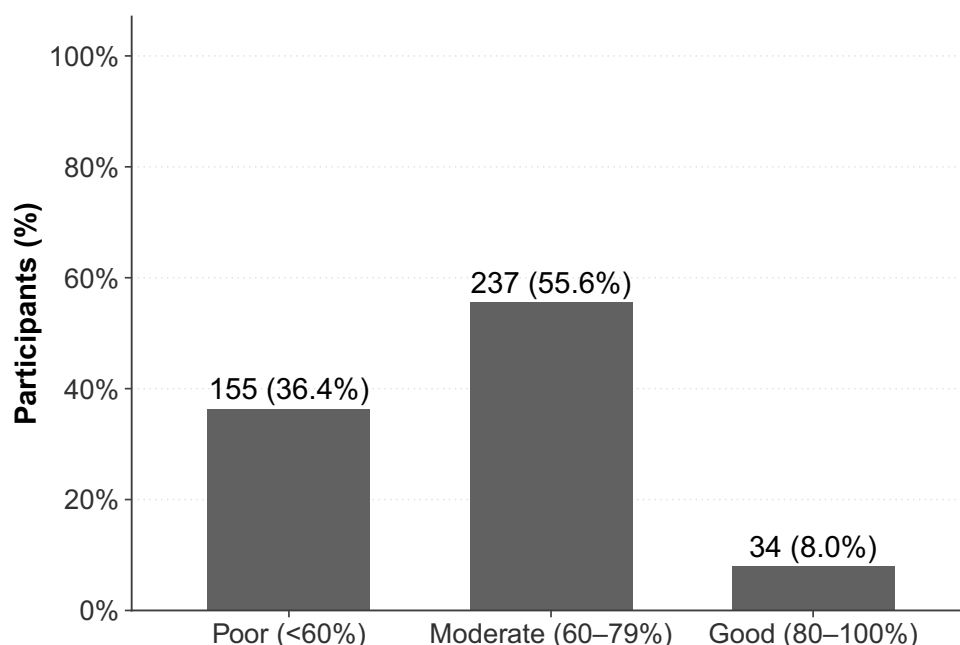


Figure 1 Distribution of knowledge of hypertensive disorders of pregnancy among antenatal-care attendees in Mbarara City, southwestern Uganda, using modified Bloom categories. Poor knowledge was defined as <60%, moderate knowledge as 60–79%, and good knowledge as 80–100%.

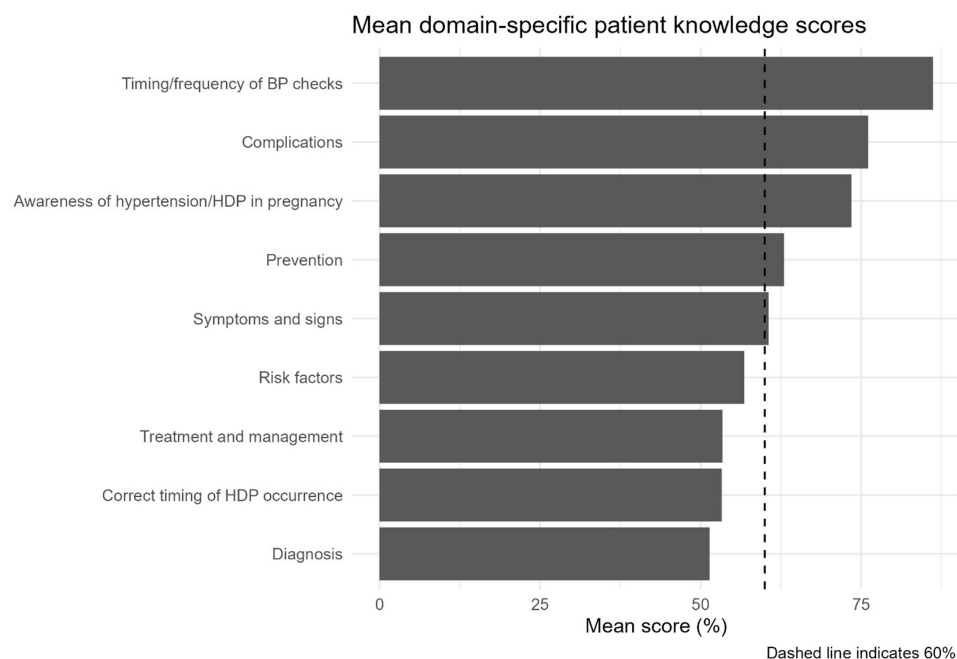


Figure 2 Mean domain-specific knowledge scores on hypertensive disorders of pregnancy among antenatal-care attendees in Mbarara City, southwestern Uganda. Bars show the mean percentage score for each knowledge domain. The dashed vertical line marks the 60% adequacy threshold.

blood-pressure measurement as part of diagnosis (94.4%), checking blood pressure at every antenatal-care visit (94.4%), blood-pressure monitoring as part of management (91.3%), regular blood-pressure checks for prevention or risk reduction (91.3%), and fetal death or stillbirth as a complication (91.3%). High blood pressure as a sign (88.7%), preterm birth as a complication (87.8%), and early screening as a preventive measure (81.2%) were also well recognized (Figure 4).

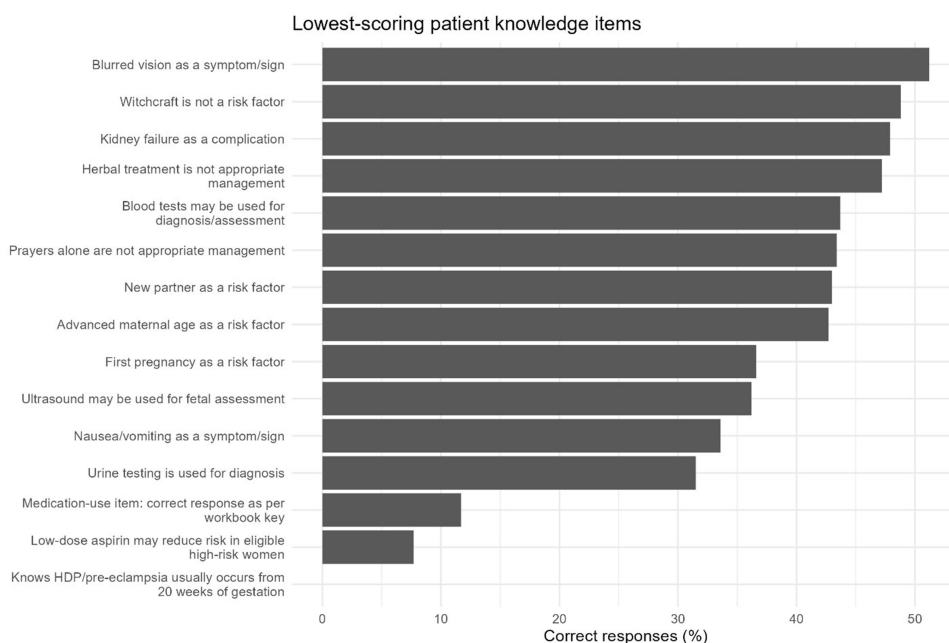


Figure 3 Lowest-scoring knowledge items on hypertensive disorders of pregnancy among antenatal-care attendees in Mbarara City, southwestern Uganda. Bars show the percentage of participants who answered each item correctly.

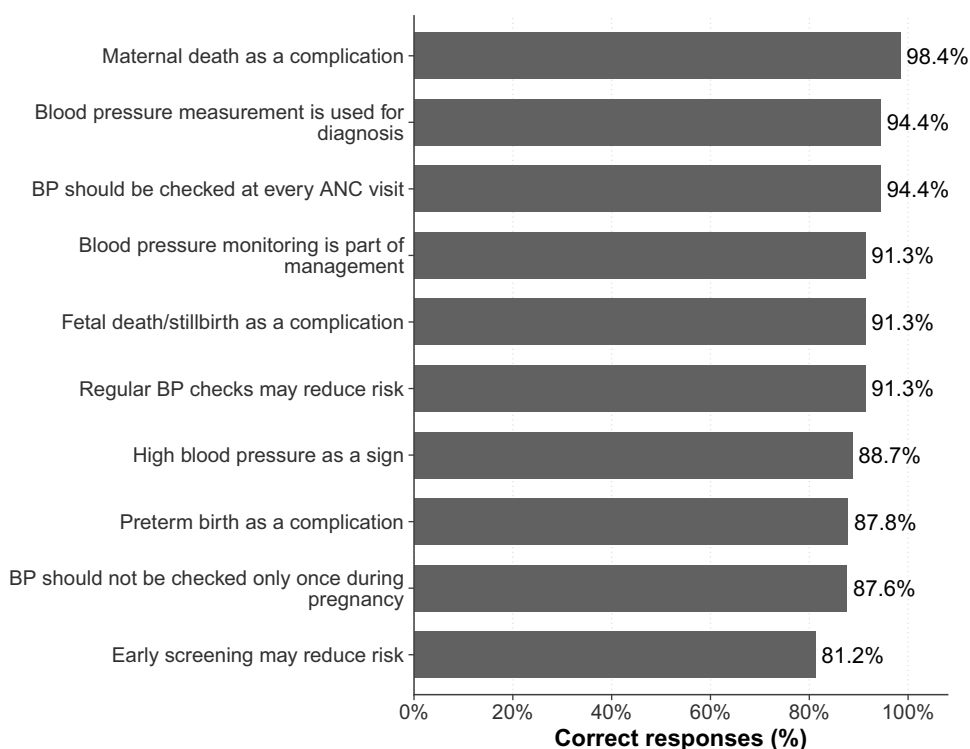


Figure 4 Highest-scoring knowledge items on hypertensive disorders of pregnancy among antenatal-care attendees in Mbarara City, southwestern Uganda. Bars show the percentage of participants who answered each item correctly.

Abbreviations: BP, blood pressure; ANC, antenatal care.

Factors Associated with Adequate Knowledge

The primary adjusted model included 388 participants with complete data for the regression variables. After adjustment, adequate knowledge remained more prevalent among women with secondary education than those with primary education or less (adjusted prevalence ratio [aPR]: 1.34; 95% CI: 1.10–1.64; $p=0.004$), women with tertiary education than those with primary education or less (aPR: 1.36; 95% CI: 1.04–1.78; $p=0.023$), women with five or more pregnancies than primigravidas (aPR: 1.77; 95% CI: 1.27–2.48; $p<0.001$), and women with a family history of

Table 2 Factors Associated with Adequate Knowledge of Hypertensive Disorders of Pregnancy Among Antenatal-Care Attendees in Mbarara City, Southwestern Uganda

Characteristic	Adequate Knowledge n/N (%)	Crude PR (95% CI)	Adjusted PR (95% CI)	Adjusted p-value
Age group (years)				
<20	17/34 (50.0%)	1.00	1.00	
20–24	88/129 (68.2%)	1.36 (0.96, 1.95)	1.05 (0.74, 1.48)	0.783
25–34	141/221 (63.8%)	1.28 (0.90, 1.81)	0.87 (0.61, 1.26)	0.469
≥35	25/42 (59.5%)	1.19 (0.78, 1.81)	0.75 (0.48, 1.17)	0.205
Gestational age group				
<20 weeks	11/18 (61.1%)	1.00	1.00	
20–27 weeks	53/93 (57.0%)	0.93 (0.62, 1.40)	0.91 (0.58, 1.43)	0.674
28–36 weeks	163/252 (64.7%)	1.06 (0.72, 1.55)	0.99 (0.65, 1.51)	0.958
≥37 weeks	44/63 (69.8%)	1.14 (0.76, 1.71)	1.03 (0.65, 1.62)	0.906
Education level				
Primary or less	87/165 (52.7%)	1.00	1.00	
Secondary	130/187 (69.5%)	1.32 (1.11, 1.57)	1.34 (1.10, 1.64)	0.004
Tertiary	54/74 (73.0%)	1.38 (1.13, 1.69)	1.36 (1.04, 1.78)	0.023
Occupation				
None/unemployed	52/92 (56.5%)	1.00	1.00	
Peasant farmer	55/94 (58.5%)	1.04 (0.81, 1.33)	1.16 (0.87, 1.53)	0.317
Business	111/159 (69.8%)	1.24 (1.00, 1.52)	1.23 (0.98, 1.55)	0.079
Employed	53/81 (65.4%)	1.16 (0.91, 1.47)	1.15 (0.88, 1.49)	0.312
Pregnancy history				
First pregnancy / primigravida	83/139 (59.7%)	1.00	1.00	
2–4 pregnancies	162/254 (63.8%)	1.07 (0.91, 1.26)	1.16 (0.95, 1.42)	0.143
≥5 pregnancies	26/33 (78.8%)	1.32 (1.06, 1.65)	1.77 (1.27, 2.48)	<0.001
Previous high blood pressure in pregnancy				
No	232/379 (61.2%)	1.00	1.00	
Yes	34/38 (89.5%)	1.46 (1.28, 1.67)	1.16 (0.94, 1.44)	0.161
Family history of preeclampsia				
No	188/319 (58.9%)	1.00	1.00	
Yes	61/76 (80.3%)	1.36 (1.18, 1.57)	1.26 (1.06, 1.50)	0.008
Health facility				
Biharwe HCIII	44/71 (62.0%)	1.00	1.00	
Kakoba HC III	39/74 (52.7%)	0.85 (0.64, 1.13)	0.88 (0.64, 1.22)	0.447
Kyarwabuganda HCIII	37/72 (51.4%)	0.83 (0.62, 1.11)	0.86 (0.62, 1.19)	0.358
Mbarara City HCIV	60/81 (74.1%)	1.20 (0.96, 1.49)	1.19 (0.91, 1.54)	0.200
Nyakayojo HCIII	41/61 (67.2%)	1.08 (0.84, 1.40)	1.15 (0.88, 1.51)	0.304
Nyamitanga HCIII	50/67 (74.6%)	1.20 (0.96, 1.51)	1.27 (0.96, 1.68)	0.097

Notes: Modified Poisson regression with robust standard errors. Outcome: adequate knowledge defined as score ≥60%. Adjusted model complete-case N=388.

Abbreviations: HDP, hypertensive disorders of pregnancy; PR, prevalence ratio; aPR, adjusted prevalence ratio.

preeclampsia than those without such history (aPR: 1.26; 95% CI: 1.06–1.50; $p=0.008$) (Table 2). Previous high blood pressure in pregnancy was associated with adequate knowledge in crude analysis but was not independently associated after adjustment (aPR: 1.16; 95% CI: 0.94–1.44; $p=0.161$) (Table 2).

Multicollinearity diagnostics did not indicate problematic collinearity; adjusted generalized variance inflation factors were low for all variables, including pregnancy history, previous high blood pressure in pregnancy, family history of preeclampsia, and health facility. In sensitivity analyses, the direction of association for pregnancy history was consistent but varied by categorization. Women with four or more pregnancies had a higher prevalence of adequate knowledge than primigravidas (aPR: 1.50; 95% CI: 1.11–2.02), and each additional pregnancy was associated with higher prevalence of adequate knowledge when pregnancy number was modelled continuously (aPR: 1.12; 95% CI: 1.05–1.20). However, the broader comparison of any multigravidity vs primigravidity was not statistically significant. A facility-clustered GEE sensitivity analysis showed similar directions for education, five or more pregnancies, and family history of preeclampsia (Supplementary Table S2).

Discussion

In this study among antenatal-care attendees in southwestern Uganda, nearly two-thirds of women had adequate knowledge of hypertensive disorders of pregnancy. Knowledge was strongest for blood-pressure monitoring and complications, but important gaps remained in diagnosis, timing of disease occurrence, treatment and management, and risk-factor recognition. Adequate knowledge was more common among women with secondary or tertiary education, those with five or more pregnancies, and those with a family history of preeclampsia. Overall, these findings show that although many women reached the overall threshold for adequate knowledge, practical knowledge was uneven across domains and items.

Our finding that knowledge was strongest for blood-pressure checks and severe complications may reflect greater retention of basic messages about the seriousness of high blood pressure in pregnancy. This pattern is consistent with studies from Ghana showing that women may recognize pre-eclampsia as serious but still have incomplete knowledge of its symptoms, risk factors, diagnosis, and management.^{12,13} In this study, weaker knowledge of diagnosis, timing of occurrence, treatment and management, and risk factors suggests that counselling may be too general. This matters because diagnosis and management of HDP rely on more than blood-pressure measurement alone; they also require assessment for proteinuria, maternal organ dysfunction, fetal wellbeing, risk status, and timely referral when indicated.²¹ Antenatal counselling in this setting, could therefore shift from broad messages to practical, action-oriented education on when HDP can occur, how it is detected, why additional tests may be needed, and when urgent care or referral is required.

The low item-level knowledge on low-dose aspirin, urine protein testing, fetal assessment, and medication-only management highlights gaps in knowledge that are directly relevant to prevention and early detection. Low-dose aspirin is recommended for selected women at increased risk of pre-eclampsia, but its benefit depends on timely risk assessment, initiation, and counselling.^{22,23} Similarly, urine protein testing, blood tests, and fetal assessment are central to disease classification and management decisions, rather than optional investigations.²⁴ Antenatal education, in this setting and similar contexts, should therefore explain why these tests are done, what abnormal findings may imply, and why referral may be necessary even when symptoms are mild or absent.

Although the modified Bloom cut-off provided a standardized way to classify overall knowledge, it should not be interpreted as evidence of comprehensive practical understanding. Overall adequate knowledge may coexist with important gaps in specific domains, particularly when the score is derived from multiple heterogeneous items. In this study, lower scores for diagnosis, timing of disease occurrence, treatment and management, and risk-factor recognition indicate areas that may require more focused counselling. These findings support reporting and interpreting domain- and item-level results alongside the overall knowledge category.

Higher educational attainment was associated with adequate knowledge of hypertensive disorders of pregnancy. This finding is consistent with previous studies showing that education improves access to health information, comprehension of counselling messages, and retention of information on pre-eclampsia and related pregnancy risks.^{12,13,25,26} This

finding supports the need for simple, low-literacy, local-language counselling materials that do not assume prior biomedical knowledge.

Women with five or more pregnancies had a higher prevalence of adequate knowledge, but this result should not be interpreted causally. The subgroup was small ($n=33$), and the study did not measure the content, frequency, or quality of antenatal counselling across pregnancies. Sensitivity analyses showed that the association remained in the same direction when pregnancy history was modelled using alternative specifications, but the binary comparison of multi-gravidas with primigravidas was not statistically significant. These findings suggest that the observed association may be concentrated among women with higher pregnancy numbers and may reflect accumulated pregnancy experience, repeated antenatal-care contact, or greater perceived relevance of pregnancy complications, rather than a direct causal effect of parity.^{27,28}

Family history of preeclampsia was also associated with adequate knowledge, consistent with previous findings.²⁹ This may reflect greater perceived personal relevance, because family history is a recognized risk factor for preeclampsia and is used in clinical risk assessment.³⁰ Women with affected relatives may therefore be more likely to notice, discuss, or remember hypertension-related messages.³¹ However, women without such personal or family exposure should not be assumed to understand the condition; they may require more deliberate explanation of risk factors, warning symptoms, diagnostic tests, and when urgent care is required.³²

These findings have programmatic implications, but they should be interpreted as hypotheses for intervention design rather than evidence that any specific educational strategy will improve outcomes. The study identified practical knowledge gaps that could be addressed in future antenatal education interventions, but it did not evaluate the effectiveness of specific counselling strategies. Future work could test local-language materials covering warning signs, risk factors, diagnostic tests, prevention, and referral, using approaches such as structured counselling scripts, visual aids, group health talks, or teach-back methods. Such strategies should be evaluated for acceptability, feasibility, effectiveness, and potential impact on care-seeking or screening behaviour before being recommended for scale-up. Strengthening provider capacity may also be relevant, because patient education depends partly on what health workers know, prioritize, and communicate during antenatal care.^{33,34}

This study has limitations. First, the cross-sectional design limits causal interpretation of the associations observed; for example, higher parity and family history may be markers of previous exposure to health information rather than direct determinants of knowledge. Second, eligibility was limited to women attending their third or later antenatal-care visit, which may have selected participants with greater exposure to routine antenatal-care messages and may limit generalizability to women initiating care or attending fewer visits. Third, the study was facility-based and included women attending public antenatal-care facilities in Mbarara City, so findings may not generalize to women who do not attend antenatal care, those attending private facilities, or women in more rural settings. Fourth, consecutive sampling may have introduced selection bias because participants were recruited among women who attended facilities during the data-collection period. Fifth, knowledge was assessed using an interviewer-administered questionnaire, which may be affected by social desirability or interviewer bias. Sixth, although the 41 scored knowledge items had acceptable internal consistency overall, the instrument was developed for this study and had not undergone extensive psychometric validation; domain scores were therefore interpreted descriptively rather than as validated subscales. Finally, the study measured knowledge but did not directly assess counselling exposure, counselling quality, provider practices, care-seeking behaviour, referral completion, or maternal and perinatal outcomes.

Conclusion

Approximately two-thirds of antenatal-care attendees in Mbarara City, southwestern Uganda, had adequate knowledge of hypertensive disorders of pregnancy, but important gaps remained in diagnosis, timing of disease occurrence, prevention, treatment and management, and risk-factor recognition. Adequate knowledge was more common among women with higher education, five or more pregnancies, and family history of preeclampsia. Antenatal-care counselling could therefore prioritize practical, local-language messages for women with less formal education, primigravidas or limited pregnancy experience, and women without a family history of preeclampsia. Further studies could assess the quality of

antenatal counselling, test targeted health-education interventions, and examine whether improved knowledge translates into earlier care-seeking, better screening uptake, and improved maternal and perinatal outcomes.

Abbreviations

ANC, antenatal care; aPR, adjusted prevalence ratio; BP, blood pressure; CI, confidence interval; HCIII, Health Centre III; HCIV, Health Centre IV; GVIF, generalized variance inflation factor; HDP, hypertensive disorders of pregnancy; IQR, interquartile range; KR-20, Kuder-Richardson Formula 20; PR, prevalence ratio; REDCap, Research Electronic Data Capture; SD, standard deviation; WHO, World Health Organization.

Data Sharing Statement

The datasets generated and analyzed during the current study are not publicly available because they contain participant-level health information, but de-identified data may be made available from the corresponding author on reasonable request.

Ethics Approval and Informed Consent

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Ethical approval was obtained from the Mbarara University of Science and Technology Research Ethics Committee (MUST-2024-1817) and the Uganda National Council for Science and Technology (HS5524ES). Administrative clearance was obtained from the leadership of the health facilities prior to data collection. Written informed consent was obtained from all participants before enrolment.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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