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Incidence and factors associated with immediate adverse neonatal outcomes among emergency obstetric referrals in labor at a tertiary hospital in Uganda: a prospective cohort study

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Abstract

Background High rates of adverse neonatal outcomes in resource-limited settings are multifactorial, varying by country, region, and institution. In sub-Saharan Africa, the majority of adverse neonatal outcomes are intrapartum related, and studies in Uganda have shown that referral in labor is a major determinant of adverse neonatal outcomes. This study aimed to assess the incidence and factors associated with immediate adverse neonatal outcomes among emergency obstetric referrals in labor at a tertiary hospital in Eastern Uganda.

Materials and methods This was a prospective cohort study involving 265 women who were referred in labor to Jinja Regional Referral Hospital in Uganda with emergency obstetric complications. The exposure of interest was being referred with obstetrical emergency, and the outcome variable was adverse neonatal outcomes. The study was conducted between July 5, 2023, and October 5, 2023. Consecutive sampling was used, and data on sociodemographic and obstetric factors, referral related factors, as well as the primary outcome variable (adverse neonatal outcome) were collected via interviewer-administered questionnaires. The data were then cleaned, coded, and analyzed using STATA version 14. Log-binomial regression determined risk ratios and associations for factors related to adverse neonatal outcomes. Variables with p-values < 0.2 in bivariable analysis were included in the multivariable analysis, where significance was set at $p < 0.05$.

Results Of the 265 women exposed to emergency obstetrical referrals, 40% experienced adverse neonatal outcomes, a composite measure including neonatal intensive care admission (27.6%), low Apgar score (23.8%), fresh stillbirth (11.3%), early-onset neonatal infection (6.8%), and early neonatal death (2.3%). Factors significantly associated with adverse neonatal outcomes were; maternal age ≥ 35 years (aRR = 1.72, CI:1.194–2.477, p value = 0.004),

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APH (aRR = 2.48, CI: 1.859–3.311, p-value < 0.001), and non-reassuring fetal status (aRR = 1.90, CI: 1.394–2.584, p-value < 0.001).

Conclusions The study found a high rate of adverse neonatal outcomes among emergency obstetric referrals, with 40% of participants facing issues like ICU admissions, low Apgar scores and fresh stillbirth. Key factors included maternal age over 35, antepartum hemorrhage, and non-reassuring fetal status. These results highlight the urgent need for targeted interventions in emergency obstetric care. Strategies should enhance referral systems, improve facility preparedness, train healthcare providers, and educate communities on timely referrals and managing high-risk pregnancies.

Keywords Obstetrical emergency, Referrals, Adverse neonatal outcomes

Background

Globally, 2.5 million neonates die annually, 80% in sub-Saharan Africa and Asia with 1.2 million in the intrapartum period, two-thirds in the first day of life, and three-quarters in the first week [1]. Notably, 80% of the leading causes of these deaths are preventable through cost-effective interventions such as an organized primary health care system, and timely, appropriate, and accessible referral services [1, 2].

In sub-Saharan Africa, progress in reducing newborn mortality has been slow, with neonates accounting for 45-50% of under-five deaths. However, scaling up early referrals and responsive care could prevent around 71% of these deaths [3].

Reports indicate that over 6700 newborn deaths occur per day with 1 million within the first 24 h, accounting for 50% of under-five mortality [4] At this rate, it is unlikely to meet the Sustainable Development Goals (SDGs) of reducing under-5 mortality by 50% in the African Region [5].

Emergency obstetric referrals account for more than 30% of all referrals and contribute greatly to adverse neonatal outcomes, mostly in low-resource settings [6], especially those referred in labor [6, 7]. Obstetric referrals in low-income countries are compounded by a majority third delay (delay in getting the right care) and a second delay (delay in reaching the referral site) [8, 9]. This has been seen in Rwanda with 37% experiencing a third delay [10] and in Ethiopia in which 52.3% and 74.7% experienced a second and third delays [11].

The incidence of adverse neonatal outcomes among obstetric referrals varies between countries and settings, ranging from 10–45% [10, 12]. For instance, the Netherlands, Malawi, and Kenya demonstrated this [8, 13–15], Nepal indicated a range of 18 to 42%, India 7.3–47%, Nigeria 16.4–47%, Ethiopia 16 to 37.4%, and Rwanda 10 to 37.1% [10–12, 16–20]. Reported incidences in Uganda vary from region to region, 0.6 to 19.2% (Western Uganda) and 8.1 to 33.3% (North and Eastern Uganda) for low APGAR score, FSB, Early neonatal deaths and NICU admissions [21–23].

Obstetric factors, sociodemographic factors, and obstetric delays are the key attributes of adverse neonatal outcomes and their variation in incidences regionally and per country [11, 12, 18, 19]. Low socioeconomic status, low levels of education, rural residency, large family size, delays in reaching & receiving care at referral site, and obstetric factors such as prolonged labor, antepartum hemorrhage (APH), obstructed labor, fetal distress, hypertensive disorders are the great influencers of adverse neonatal outcomes in low-income settings like Uganda [6–8, 13–15]. For example, a study indicated 7.7 times the risks of adverse neonatal among women with APH [9, 10], and in western Uganda, attributes were made to malpresentation and previous cesarean section. [24]

East and Northern Uganda have the highest incidences compared to other regions, and attributes to this have been made to, lower socioeconomic status, lower education level, maternal age ≥ 35years or age ≤ 20 years, referral delays (especially third and second delays), under-resourced facilities, and understaffing of critical cadres [21, 23–27].

Uganda has reduced the neonatal mortality ratio from 27 to 22 per 1,000 live births between 2016 and 2022 through local maternal systems, MPDSR and SDG-3 interventions. However, regional and district-level disparities in neonatal outcomes remain [28, 29].

The MPDSR report for 2022/2023 highlighted the Eastern region—especially Busoga, where the study was conducted—and Bukedi as having the highest perinatal mortality ratios: 19.2 per 1000 and 24.9 per 1000 live births, respectively, compared to other regions [29]. These elevated rates were attributed to gaps in intrapartum care, inadequate neonatal resuscitation practices, and suboptimal referral systems. Predisposing factors common to obstetric referrals, such as birth asphyxia, antepartum hemorrhage (APH), hypertensive disorders, and obstructed labor, were identified as key drivers for these adverse outcomes [29, 30].

Given the critical importance of maternal and newborn health and the regional burden, we hypothesized that emergency obstetrical referrals would enhance

neonatal outcomes. Thus, this study aimed to evaluate the incidence, common types, and contributing factors of adverse neonatal outcomes among emergency obstetric referrals at Jinja Regional Referral Hospital.

Materials and methods

Study setting and design

This prospective cohort study was conducted at Jinja Regional Referral Hospital (JRRH), a tertiary 24/7 public facility in Jinja City, Eastern Uganda, which provides free emergency obstetric care. JRRH receives referrals from 22 health center IVs and district hospitals in Jinja and 11 neighboring districts, commonly for obstructed labor, antepartum hemorrhage, non-reassuring fetal status, preterm labor, and the absence of key staff, supplies, and commodities.

As a peri-urban facility, it faces challenges such as insufficient medical equipment and supplies, limited emergency response systems, transport issues, and variability in referral protocols, leading to delays, inefficiencies, and confusion. The hospital has a 500-bed capacity and handles approximately 5,124 deliveries annually, including 1,104 (21.5%) emergency obstetric referrals, with a cesarean section rate of 35%.

The obstetrics department is staffed by three obstetricians, two senior medical officers, four senior house officers, six intern doctors, and twelve midwives. The maternity ward features four delivery beds and two operating theaters with four operating tables. Upon arrival, referrals are assessed by attending obstetricians, senior house officers, and medical officers who then initiate emergency obstetric care (EmOC) protocols.

Adjacent to the maternity ward is a Neonatal Intensive Care Unit (NICU) managed by a pediatrician, two medical officers, two senior house officers, and rotating intern and critical care nurses. Preterm babies, and babies with acute neonatal complications admitted at the unit are majorly from referral cases.

Study population and sampling information

All participants in labor who were exposed to emergency obstetric referral and were received at Jinja Regional Referral Hospital were included. Those participants with multifetal gestation, preterm labor, or those who were unconscious or hemodynamically unstable were excluded. Those referred due to facility related factors as well as self-referrals were also excluded from the study.

Sample size calculation

To identify the common adverse neonatal outcomes among emergency obstetric referrals, Daniels WW,1999 was used.

$$N = \frac{(z_\alpha)^2 p\,(1-p)}{e^2}$$

where N=the desired sample size for a population greater than 10,000.

Z=1.96. Standard normal deviation. Z is the level of significance in the Z scores (assuming a 95% confidence interval).

p=Incidence of adverse neonatal outcomes (19.2%) in a study in western Uganda among emergency obstetric referrals.

q=1-p; therefore, q=1-0.192.

e=0.05 is the absolute precision (taking a 95% confidence interval).

$$\text{Therefore, N} = \frac{(1.96)\,2 \times 0.81 \times 0.192}{(0.05)\,2} = 239$$

The minimum sample size required was 239, however, to cater for non-response and reliability, a 10% addition was made. Therefore, the sample size considered was **265**.

Study procedure

All women referred for emergency obstetric care were educated about the research, its study objectives, and the inclusion and exclusion criteria, including the benefits of the study to the institution, the community, and all referred women in labor with obstetrical emergencies. A consecutive sampling technique was employed, and all women who met the eligibility criteria were approached to participate in the study. Those who agreed to participate provided consent and were given the appropriate privacy and confidentiality. The researcher and two research assistants administered a structured questionnaire confidentially to each participant in either English or Lusoga, as understood by the participant. All neonates of the referred women receiving or received EmOC services were monitored for 72 h, which time was adequate to detect symptoms of early onset-neonatal infections and other adverse outcomes. Blood samples for complete blood count (CBC) from neonates who showed clinical signs and symptoms of early-onset neonatal infection were obtained aseptically by a laboratory technologist after all the reasons for the procedures and techniques were explained to and understood by the mothers. Every 10th sample was taken to the Lancet laboratory for independent analysis to ensure quality.

The study investigated the influence of independent variables encompassing sociodemographic factors;maternal age, marital status, place of residence, education level, occupation, family size, and decision maker, referral related factors; such as facility distance from home, time taken to reach the referral site, and obstetrical factors; gravidity, prolonged/obstructed labor

(this was combined because prolonged labor might end up as obstructed and vice vasa), APH, previous cesarean, nonreassuring fetal status, and hypertensive disorders, on the dependent variable, immediate adverse neonatal outcomes, which included low Apgar of less than 7 at 5 min, any newborn of women referred with obstetrical emergency admitted in NICU, Fresh stillbirth, early-onset neonatal infections occurring within the first 72 h of life, and any death of a neonate occurring within 72 h after delivery (early neonatal deaths). The above data were collected using structured interviewer-administered questionnaires.

To ensure that the data collection tools were appropriate, simple English was used as opposed to technical terms. The questionnaires were created based on available literature and factors within the study settings, translated into the local language (Lusoga), and translated back to English for accuracy. The questionnaires were administered by trained research assistants conversant with the local language. A pretest of the data collection tool was performed to ascertain the reliability of the tool. All data collection processes were monitored by the researcher, and immediate cross-checking of the completed questionnaires was carried out to ensure the accuracy and completeness of the information. A content validity index was used on data obtained from five participants who were not part of the study, and interparticipant agreement was measured, with an agreement of 83%.

Data management and analysis

The collected data were entered into Epi info software version 7.2. Subsequently, a data extract was created in Microsoft Excel (2019) format and imported into the STATA version 14 statistical package. Within STATA, the data were further cleaned, coded, and analyzed. The incidence of adverse neonatal outcomes was determined by dividing the total number of participants who experienced adverse outcomes (numerator) by the overall study participants (denominator), then expressed in percentage. This calculation helped identify common adverse outcomes, where each specific adverse outcome's total occurrence (numerators) was divided by the total number of participants with adverse outcomes (denominator) also expressed as a percentage. For factors associated with adverse neonatal outcomes, log-binominal regression analysis was used for risk ratios and associations. Statistical significance was set at a p-value of less than 0.05. The results were presented in pie charts, tables, and bar graphs and discussed for effective understanding and interpretation.

Results

The study took place in the maternity ward and neonatal intensive care units of Jinja Regional Referral Hospital over a three-month period from July to September 2023. The study flow chart is depicted in Fig. 1 below.

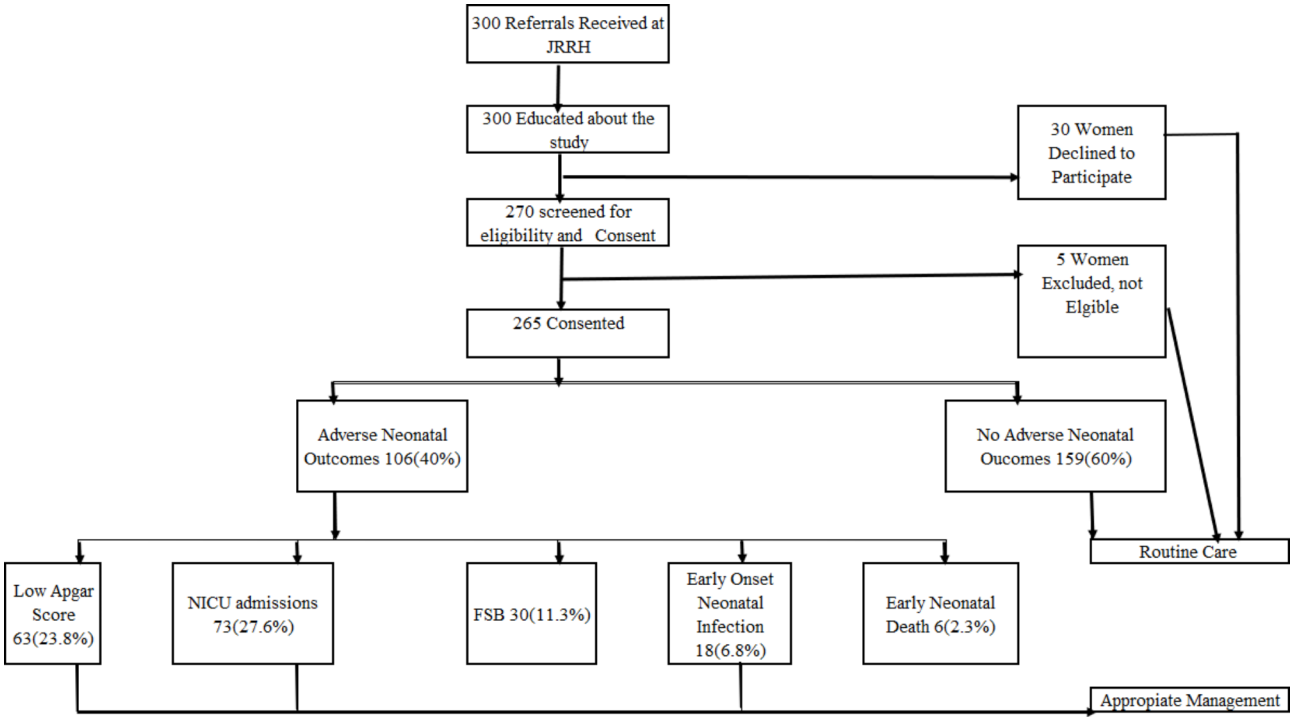

Fig. 1 Study flowchart

Table 1 Present the sociodemographic, referral, and obstetric characteristics of the participants ($n=265$)

Variables	Category	Frequency (*n*)	Percentage (%)
Sociodemographic			
Maternal age	< 20 years	59	22.6
	20–34 years	181	68.3
	35 years above	25	9.4
Marital status	Single	39	14.7
	Married	72	27.2
	Cohabiting	154	58.1
Place of residence	Urban	57	21.5
	Rural	208	78.5
Education level	Primary	91	34.3
	Secondary	108	40.8
	Tertiary	66	24.9
Occupation	Peasant	105	39.6
	Formal employment	50	18.9
	Business	110	41.5
Family size	≤ 5 People	201	75.9
	> 5 People	64	24.1
Decision maker	Husband	50	18.9
	Wife	42	15.9
	Both	173	65.2
Referral related factors			
Distance to referring facility	< 5 km	185	69.8
	5–10 km	74	27.9
	> 10 km	6	2.3
Time to the referral site	< 2 h	234	88.3
	> 2 h	31	11.7
Obstetrics factors			
Gravidity	Primigravida	108	40.8
	Multigravida	157	59.2
Obstetric emergencies	Prolonged/Obstructed labor	175	66.0
	Antepartum hemorrhage	17	6.4
	Previous Cesarean Section	18	6.8
	Non-Reassuring fetal status	34	12.8
	Hypertensive disorder	21	7.9

As shown in Table 1 above, out of the 265 study participants, the majority were aged 20–34 years 81(63.3%), cohabiting 154 (58.1%), and lived in rural settings 208 (78.5%). Most had attained secondary education 108 (40.8%) and worked as businesswomen 110(41.5%). Their family size was typically less than five 201(75.9%). Spousal decision-making was common 173 (65.2%), and the majority lived within 5 km of the nearest health facility 185(69.8%), taking less than 2 h to reach the referral site 234 (88.3%). Majority were multigravidas 157(59.2%), while the most common obstetrical emergency was prolonged/obstructed labor 175 (66.0%)

Participant characteristics

Immediate adverse neonatal outcomes

Figure 2 below illustrates the incidence of immediate adverse neonatal outcomes among obstetrical emergency referrals.

Of the 265 respondents, 106 (40%) experienced immediate adverse neonatal outcomes.

Common neonatal adverse outcomes

Figure 3 below shows the distribution of common adverse neonatal outcomes among women referred for obstetrical emergencies.

Among the 106 who experienced adverse outcomes, NICU admission occurred in 73 cases (27.6%), followed by a low Apgar score in 63 cases (23.8%), a fresh stillbirth rate of 30 (11.3%), and early-onset neonatal infections in 18 (6.8%). The lowest occurrence was early neonatal deaths, with 6 cases (2.3%).

Factors associated with immediate adverse neonatal outcomes

Table 2 below presents the results of a multivariate analysis examining the relationships between the various participant characteristics and immediate adverse neonatal outcomes. The information included both unadjusted (crude) and adjusted risk ratios (RRs) along with 95% confidence intervals (CIs) for each characteristic.

Multivariable analysis revealed that maternal age 35 years and above (aRR=1.72, CI: 1.194–2.477, p value=0.004), antepartum hemorrhage (aRR=2.48, CI: 1.859–3.311, p-value<0.001) and nonreassuring fetal status (aRR=1.90, CI: 1.394–2.584, p-value<0.001) were significantly associated with adverse neonatal outcomes among emergency obstetric referrals in labor at Jinja Regional Referral Hospital. Women aged 35 years and above had a 1.72-fold greater risk of having adverse neonatal outcomes than their counterparts aged less than 35 years (p-value<0.05). Additionally, women referred with antepartum hemorrhage at 2.48 times the risk of having adverse neonatal outcomes (p-value<0.05) and nonreassuring fetal status at 1.90 times the risk of having adverse neonatal outcomes (p value<0.05) compared to mothers referred without APH or nonreassuring fetal status respectively.

Discussion

The study conducted at Jinja Regional Referral Hospital revealed that maternal age, antepartum hemorrhage, and non-reassuring fetal status significantly increase the risk of immediate adverse neonatal outcomes among obstetric emergency referrals.

The 40% incidence of adverse neonatal complications in our study aligns with findings from sub-Saharan African settings such as Ethiopia [11], and Rwanda [10] and other Low-resource Settings such as Nepal [12], where the incidences were, 42%, 37.4%, and 37.1% respectively. The observed similarity may arise from the fact that all these studies were hospital-based, sharing similar study settings and characteristics. For instance, in each study, the majority of the participants hailed from rural areas and encountered various referral delays. For instance in Ethiopia [11], 52.4% experienced a second delay, and

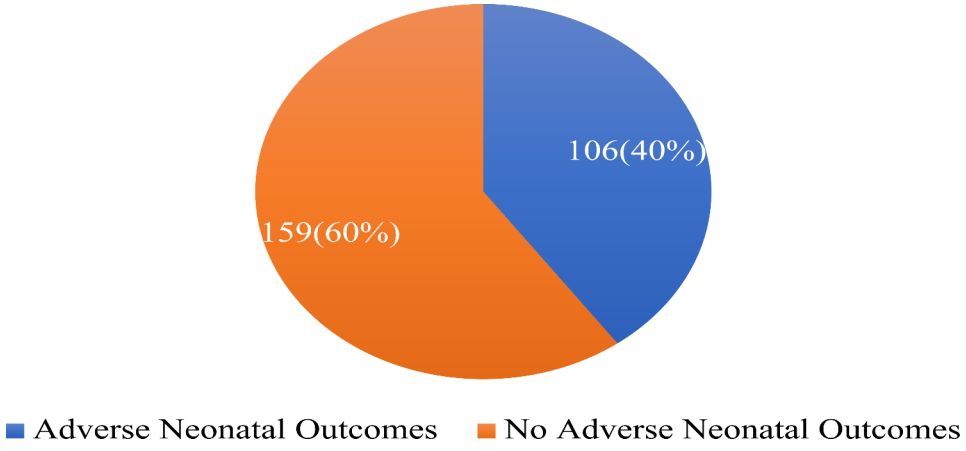

Fig. 2 Pie charts showing the incidence of immediate adverse neonatal outcomes (*n* = 265)

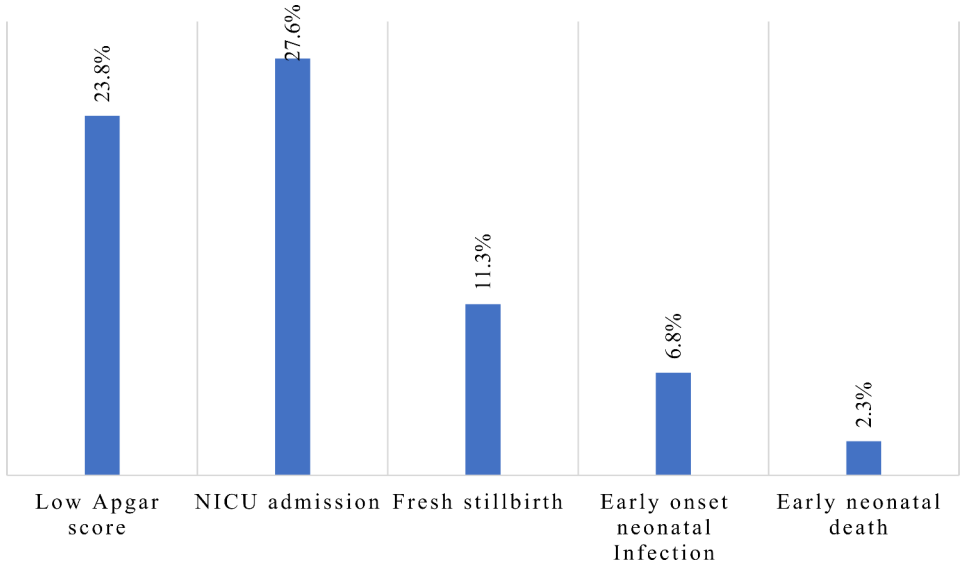

Fig. 3 The common adverse neonatal outcomes (*n* = 106)

Table 2 Multivariable analysis of factors associated with adverse neonatal outcomes

Variable	Category	cRR(95%CI)	*p*-value	aRR(95%CI)	*p*-value
Sociodemographic					
Maternal age	20–34 years	Ref	-	-	-
	35 years above	1.96(1.461–2.639)	< 0.001	1.72(1.194–2.477)	**0.004***
Education level	Primary	1.31(0.973–1.750)	0.075	1.02(0.868–1.523)	0.304
	Secondary	Ref	-	-	-
Family size	≤ 5 People	Ref	-	-	-
	> 5 People	1.36(1.001–1.842)	0.049	1.24(0.582–1.645)	0.579
Referral factors					
Distance to referring facility	< 5 km	1.27(0.892–1.794)	0.187	1.04(0.878–1.710)	0.233
	> 10 km	Ref	-	-	-
Obstetric factors					
Obstetric emergencies	Hypertensive disorder	Ref	-	-	-
	Prolonged/Obstructed labor	1.80(1.357–2.395)	< 0.001	1.58(0.609–4.099)	0.347
	Antepartum hemorrhage	2.22(1.689–2.918)	< 0.001	2.48(1.859–3.311)	**< 0.001***
	Previous Cesarean Section	1.86(0.773–2.467)	0.166	1.82(1.609–4.830)	0.228
	Nonreassuring fetal status	1.99(1.506–2.626)	< 0.001	1.90(1.394–2.584)	**< 0.001***

Ref Reference category *p value < 0.05, cRR, crude risk ratio; aRR, adjusted risk ratio; CI, confidence interval

74.7% faced a third delay. Similarly, in Rwanda [10] 37% encountered third delays. These factors likely contributed to the observed similarities.

It is worth noting that the high incidence observed in this study occurred among the study population living within 5 km of the referring facility (68.8%) and reaching the referral site within 2 h of referral (88.2%). This can be attributed to potential gaps in the quality of care at the referral site, including third delays in interventions, decision-making, and considerations related to modes of deliveries. This aligns with the national annual MPDSR reports of 2022/2023 [29] which identify gaps in intrapartum care at referral sites as one of the major drivers of adverse outcomes in national and regional referral hospitals.

However, some studies reported lower incidences than our study. For instance, in India [17] the incidence was 7.3%, Nigeria [18] 16.4%, Ethiopia [19] 26.7%, and Uganda [21] at 13.9%. While all these studies were institutional-based, discrepancies may arise from differences in study designs and methodologies. For example, the study conducted in Uganda [21] was a retrospective cohort study that utilized data from the integrated maternity register over one year. However, this reliance on records introduced the possibility of errors and missing data. Additionally, the study had a larger sample size of 780 participants compared to our study's 265, which could account for the lower incidence observed. In contrast, the studies in Nigeria [18], and Ethiopia [20] employed prospective cohort designs with shorter follow-up periods (24 h). Consequently, some adverse outcomes might have been missed due to the limited observation window. Lastly, the study in India India [17] was a population-based multicenter prospective study spanning four years and involving a substantial sample size of 34,319 participants. As a result, the denominator was significantly larger.

Common adverse neonatal outcomes among emergency obstetrics referrals

This study found that common adverse outcomes included NICU admissions, low Apgar scores, fresh stillbirths, early-onset neonatal infections, and early neonatal deaths. These findings align with research conducted in Ethiopia [20] where the Low Apgar score was 23.1% and in Western Uganda [22] at 19.2% Similarly, other Ethiopian studies [14] and [20] reported NICU admissions rates of 23.5% and 34.8%, respectively.

Additionally, comparable results regarding fresh stillbirths were found in studies conducted in India [16], Ghana [6], and Uganda [22], with incidences of 17.4%, 16.4% and 8.1% respectively. Furthermore, studies in Nepal [12] and Uganda [21] respectively reported early neonatal death rates of 4.3% and 1.8%.

The similarities across these studies can be attributed to their common settings: all were conducted in tertiary hospitals within low-resourced environments, and many had similar sample sizes. For instance, the studies in Ethiopia [20], Uganda [22], and Nepal [12] had sample sizes of, 270, 177, and 212 respectively similar to our study's sample size of 265, resulting in comparable denominators.

However, despite these similarities, other studies have demonstrated varying incidences of common adverse outcomes. For instance, studies in Uganda [22] reported lower NICU admission of 14% and Ethiopia [13] at 12.5%. In contrast, India [17] reported lower incidence of fresh stillbirth 6.8% and Uganda [22] at 7.3%. Additionally, a study in Western Uganda [24] reported a lower incidence of early neonatal deaths (0.6%). Meanwhile, a study in the Netherlands [30] found low Apgar scores (2.7%).

These discrepancies in the incidence rates can be explained by the specific study characteristics. The Ugandan study [22] employed a quasi-experimental design involving referral phone calls, potentially improving neonatal outcomes by facilitating timely referrals. In India [17], a population-based study with a longer duration (4 years) and a larger sample size (34,319 participants) contributed to a larger denominator. Conversely, the Dutch study [30] was a retrospective and conducted in a different context from African or low-income countries like Uganda, affecting the observed outcomes. Quality service provision during referrals likely played a role in shaping these outcomes.

Higher incidences of FSB were observed in Rwanda [10] (23.4%) and Eastern Uganda [23] (43.8%). Additionally, Kenya [15] reported a 37.0% increase in the incidence of low Apgar scores. Moreover, Nepal [12] documented a high incidence of NICU admission (40%), while Rwanda [10] and Eastern Uganda [23] reported higher incidences of early neonatal death (2.3%, and 37.2% respectively).

The disparities in the incidence rates can be explained as follows: The study in Uganda [23] employed a prospective cohort design similar to ours but focused exclusively on obstructed labor among referrals. This narrow focus attributed all adverse outcomes to a single variable, potentially introducing confounding factors. In contrast, the Rwanda study [18] used a different design (perinatal audits based on hospital records), which could have introduced errors.

Factors associated with immediate adverse neonatal outcomes

Maternal age of 35 years and above was significantly associated with adverse neonatal outcomes among emergency obstetric referrals. This finding aligns with a cohort study conducted in northern Uganda [25], where women

aged ≥ 35 years faced a 2.5-fold higher risk of adverse neonatal outcomes.

However, in contrast to our study, a separate study in Uganda [27] reported that women younger than 19 years were 1.9 times more likely to experience adverse neonatal outcomes than older mothers. Notably, that study focused solely on obstructed labor among referrals highlighting the high prevalence of obstructed labor in this younger age group. Additionally, most of the participants in that age category were primigravida's therefore an increased risk for adverse neonatal outcomes. Hence, this explains the increased risk of the adverse neonatal outcomes observed in this younger age compared to our study.

Additionally, our study revealed that antepartum hemorrhage was significantly associated with adverse neonatal outcomes among emergency obstetric referrals at Jinja Regional Referral Hospital. These findings are consistent with other research: an Ethiopian study [14] reported a 3.96-fold increased risk of adverse neonatal outcomes associated with APH, as well as a study in India [2]. Similarly in Afghanistan [9], a 7.7-fold increased risk of adverse outcomes was also observed in women with APH. The similarities in findings may stem from comparable study settings (low-resourced, tertiary hospital-based) and similar study designs (Cohort studies). Notably, the study in Afghanistan reported a 7.7-fold higher risk, attributed to major delays in reaching facilities and decision-making [9].

This study observed a significant association between nonreassuring fetal status and adverse neonatal outcomes, which aligns with Ethiopian studies [14] and [20] reporting an increased risk of adverse neonatal outcomes among women with nonreassuring fetal status. The consistency in findings may be attributed to similar study settings and sample sizes.

Conclusions

The study at Jinja Regional Referral Hospital in Uganda found a high incidence of adverse neonatal outcomes among emergency obstetric referrals, with 40% experiencing issues like ICU admissions and low Apgar scores and fresh stillbirth. Key factors included maternal age over 35, antepartum hemorrhage, and non-reassuring fetal status. These results highlight the urgent need for targeted interventions to improve maternal and neonatal health. Strategies should enhance referral systems, improve facility preparedness, train healthcare providers, and educate communities on timely referrals and managing high-risk pregnancies.

The study underscores the complex causes of adverse neonatal outcomes in resource-limited settings and stresses the need to address key risk factors to lower morbidity and mortality. Future research should focus on long-term outcomes and the effectiveness of interventions to ensure lasting improvements in neonatal health.

Limitations and strengths

This study's findings should be considered in light of several limitations. We were not able to access modes of delivery which potentially could modify the outcomes. Additionally, using nonprobability sampling could have introduced bias and potential under- or over-representation due to the non-random selection process. Despite its limitations, the prospective cohort design enables real-time data collection and outcome observation, minimizing recall bias and increasing reliability. Additionally, the study's sample size improves statistical power and the generalizability of findings within the context of emergency obstetric referrals at Jinja Regional Referral Hospital.

Abbreviations

ANC	Antenatal Care
APH	Antepartum Hemorrhage
CBC	Complete Blood Count
EMCS	Complete Blood Count
EmONC	Emergency Cesarean Section
FSB	Fresh Stillbirth
HMIS	Health Management Information System
IMNCI	Integrated management of Neonatal and Childhood Illnesses
LB	Live Birth
MDG	Millennium Development Goal
MOH	Ministry of Health
NICU	Neonatal Intensive Care Unit
PROM	Premature Rupture of Membranes
SDG	Sustainable Development Goal
WHO	World Health Organization

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Author contributions

G.O served as the principal investigator, responsible for designing the study, collecting and analyzing the data, and drafting the manuscript. M.K, F.P, and S.O contributed to discussions and drawing conclusions based on the study results. P.B and N.A.U served as supervisors for the study.

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Data availability

The datasets utilized in this study can be obtained from the corresponding author upon request. Please contact Geoffrey Okot via email at okjeff2008@gmail.com.

Declarations

Ethical approval and consent to participate

All research methodologies adhered to ethical principles and received approval from the Research Ethics Committee (REC) of Bishop Stuart University, under REC number BSU-REC-2023-113. Additionally, permission was granted by the Administration of Jinja Regional Referral Hospital. Prior to participation, all individuals were fully informed about the study's objectives, and their informed consent was obtained.

Consent for publication

Not applicable to this study.

Guarantor
Geoffrey Okot.

Competing of interest
The authors declare no competing interests.

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