Identifying risk factors for perinatal death at Tororo District Hospital, Uganda: a case-control study

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Abstract

Background Sub-Saharan Africa faces a disproportionate burden of perinatal deaths globally. However, data to inform targeted interventions on an institutional level is lacking, especially in rural, non-academic settings. The objective of this study is to identify risk factors for perinatal death at a resource-limited hospital in Uganda.

Methods This is a case-control study at a district hospital in eastern Uganda using birth registry data. Cases were admissions with stillbirths or neonatal deaths within 7 days of birth. Controls were admissions immediately preceding and following each case. We compared demographic and obstetric factors between cases and controls to identify risk factors for perinatal death. Subgroup analysis of twin compared to singleton gestation was also performed. Chi square, Fisher's exact, T, and Wilcoxon-Mann-Whitney rank sum tests were utilized for bivariate analysis, and multiple logistic regression for multivariate analysis.

Results From January 2014 to December 2014, there were 185 cases of perinatal death, of which 36% (n=69) were macerated stillbirths, 40% (n=76) were fresh stillbirths, and 25% (n=47) were neonatal deaths. The rate of perinatal death prior to discharge was 35.5 per 1,000 deliveries. Factors associated with increased odds perinatal death included: prematurity (adjusted odds ratio (aOR) 19.7, 95% confidence interval (CI) 7.2-49.2), breech presentation (aOR 7.0, CI 1.4-35.5), multiple gestation (aOR 4.0, CI 1.1 - 13.9), cesarean delivery (aOR 3.8, CI 2.3 - 6.4) and low birthweight (aOR 2.5, CI 1.1-5.3). Fresh stillbirth and neonatal deaths were more associated with nulliparity (p = 0.03), grand multiparity (p = 0.01), low birthweight (p = 0.01) and cesarean delivery (p <0.001) than macerated stillbirths. Subgroup analysis of twin pregnancies revealed that compared to singletons, twins were more likely to have a fresh stillbirth (68.4% vs 36.8%, p = 0.01).

Conclusions The rate of perinatal death at a rural district hospital was higher than national
rates, and the 67% of cases were fresh stillbirths or neonatal deaths. Significant risk factors for perinatal death were prematurity, breech presentation, and multiple gestation. Targeted interventions to identify these higher risk pregnancies, such as the prenatal identification of twins, may reduce the rate of perinatal death in rural settings.

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Introduction

Perinatal deaths, defined as stillbirths and neonatal deaths within the first 28 days of life, are unequally distributed globally as evidenced by upwards of 98% occurring in low- and middle-income countries. Of the estimated 2.7 million neonatal deaths and 2.6 million stillbirths that occur annually, the majority, including up to 75% of neonatal deaths, are likely avertable. Efforts such as the Every Newborn Action Plan, which was launched in 2014 by the World Health Organization and United Nations International Children’s Emergency Fund, strive to promote progress in preventing perinatal deaths across the globe, but significant work remains to be done to close the gap between current circumstances and what is desired.
Uganda is among the top fifty countries with the highest burdens of perinatal deaths. (4, 5) In 2015 its stillbirth rate was 21.0 per 1,000 births in stark contrast to 3.0 in the United States. (5) The data on the neonatal deaths are no less striking with most recent rates in 2017 of 20.2 per 1,000 live births in Uganda and 3.6 in the United States. (4) While important advancements are happening on the national level such as the development of a strategic plan, facility-level efforts vary. (1) There are also notable differences between rural and urban populations with an estimated 52% of deliveries in rural Uganda occurring in hospital settings as compared to close to 90% in urban areas. This phenomenon suggests a high likelihood of different case mixes between rural care settings and urban ones in which many academic medical centers are based and thus the majority of studies are done. 

There is limited data on perinatal deaths from rural hospitals in Africa, including in Uganda despite over three quarters of its population living in rural locations. (6) The goal of our study was to identify risk factors for perinatal death in one of Uganda’s rurally located district hospitals.

Methods

Tororo District Hospital is a 200-bed government-owned facility located in eastern Uganda. According to the 2014 census, the population of Tororo was approximately 517,000 with 86% living in a rural households. (7) The hospital serves a catchment area of over 500,000 people extending to the Kenya-Uganda border and beyond. Supervised by the one to two physicians covering the hospital inpatient and outpatient service, two to three birth attendants staff the six-bed labor suite. One operating theatre with two rooms serves all surgical needs. Providers utilize fetoscopes for intermittent fetal heart rate, partographs to monitor labor progress, and limited equipment (e.g. ambubags) for neonatal resuscitation. The skilled birth attendants complete handwritten birth registers on
admission and discharge to collect maternal and neonatal data.

A retrospective case-control study was performed from January 2014 to December 2014. Cases were maternal admissions that resulted in perinatal death, defined as stillbirth or neonatal death within seven days after delivery. Control patients, collected in a 2:1 ratio, were the admissions immediately prior and immediately after the perinatal death case that had a normal delivery outcome. We utilized this approach to account for temporal factors such as hospital census, staffing ratios, and medication availability which can be more variable in resource-limited settings. Stillbirths were defined as fetal death at or after 22 weeks gestation that occurred before delivery. Fresh stillbirths were those with findings suggestive of death within hours of delivery whereas macerated stillbirths were those with findings suggestive of death substantially prior to delivery (e.g. skin discoloration). For this study, neonatal deaths were defined as death of liveborn neonates within seven days after delivery. Illegible data in birth registers were excluded from the database.

Data on maternal factors including maternal age, parity, prior uterine scar and human immunodeficiency virus (HIV) status were collected. Grand multiparity was defined as having four births preceding index pregnancy. Pregnancy level data collected included multiple gestation, preeclampsia, antepartum hemorrhage, infection, breech presentation, cord prolapse, mode of delivery, and preterm gestation. Birthweights were collected, and low birthweight was defined as less than 2500 grams. Data was only excluded if it was illegible.

This study was approved by the Tororo General Hospital Ethics Committee and the Medical Superintendent. The study was considered exempt from the University of California San Francisco Institutional Review Board review as the data was de-identified. Descriptive statistics were done using StataSE 15 (StataCorp, College Station, TX). Continuous
variables were analyzed using T tests if parametric and Wilcoxon-Mann-Whitney rank sum tests if non-parametric. Categorical variables were analyzed using Chi square and Fisher’s exact tests as was indicated by cell frequencies. Multiple logistic regression was done with the following predictor variables, which were also assessed for their individual association with the outcome of perinatal morbidity: maternal age, nulliparity, twin pregnancy, and prematurity. We employed an available case analysis to missing data and thus include revised denominators to note data for variables with missing data. A p value of <0.05 was considered statistically significant.

No funding was received for the realization of this study. We utilized Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for case-control studies for preparation of this manuscript.

Results

Tororo General Hospital had approximately 5,210 deliveries from January 2014 to December 2014. During this time period, there were 185 cases perinatal death and 354 control pregnancies, corresponding to a perinatal death rate of 35.5 per 1,000 deliveries. There was a total of 24 sets of twins, 19 of which were cases with loss of both twins in 7 (36.8%) and loss of one twin in 12 (63.2%). The distribution of perinatal deaths by type (i.e. macerated stillbirth, fresh stillbirth, or neonatal death) is shown in Figure 1. Comparison between cases and control pregnancies of the variables analyzed is shown in Table 1. The mean age for women who experienced a perinatal loss was 1.4 years older than those who did not (p = 0.02), but there was no significant difference in the proportion of who were at or above 35 years old (controls 8.4% vs cases 11.7%, p = 0.23). The following factors were associated with increased odds of perinatal death: prematurity, low birth weight, multiple gestation, breech presentation, antepartum hemorrhage, cesarean delivery and cord prolapse. Factors associated with decreased odds of perinatal
death included grand multiparity and presenting in spontaneous labor. There were no significant associations between perinatal death and nulliparity, HIV infection, preeclampsia, or prior uterine scar. Multiple logistic regression controlling for maternal age, nulliparity, twin pregnancy, and prematurity demonstrated that the adjusted OR for all of the proceeding associations remained statistically significant with the sole exception of antepartum hemorrhage.

Table 1 Maternal, pregnancy, fetal and neonatal characteristics of case and control pregnancies
|                     | Control pregnancies N = 354\(^1\) n (%) or Mean (SD) | Case pregnancies N= 185\(^1\) n (%) or Mean (SD) | Unadjusted Odds Ratio (Confidence Interval) | Adjusted Odds Ratio\(^2\) (Confidence Interval) | P value Multi Regre |
|---------------------|----------------------------------------------------|-------------------------------------------------|------------------------------------------|------------------------------------------------|---------------------|
| **MATERNAL FACTORS**|                                                    |                                                 |                                          |                                                 |                     |
| Maternal Age (years) | 24.4 (6.3)                                        | 25.8 (6.6)                                      | --                                       | --                                              | --                  |
| Advanced Maternal Age >= 35 years | 29/345 (8.4%)                                     | 21/180 (11.7%)                                  | 1.4 (0.8 - 2.7)                          | 1.2 (0.6 - 2.3)                                 | 0.63                |
| Nulliparity         | 132/344 (38.4%)                                   | 62/179 (34.6%)                                  | 0.9 (0.6 - 1.3)                          | 1.1 (0.7 - 1.1)                                 | 0.65                |
| Grand multiparity   | 277/344 (80.5%)                                   | 116/179 (64.8%)                                 | 0.4 (0.3 - 0.7)                          | 0.3 (0.2 - 0.7)                                 | 0.001               |
| Prior Scar          | 8/348 (2.3%)                                      | 4 (2.2%)                                        | 0.9 (0.2 - 3.6)                          | 1.3 (0.4 - 4.7)                                 | 0.67                |
| HIV                 | 26/342 (7.6%)                                     | 9/176 (5.1%)                                    | 0.7 (0.3 - 1.5)                          | 0.5 (0.2 - 1.2)                                 | 0.13                |
| **PREGNANCY FACTORS**|                                                    |                                                 |                                          |                                                 |                     |
| Twin pregnancy      | 5 (1.4%)                                          | 19 (10.3%)                                      | 7.9 (2.8 -- 27.7)                        | 4.0 (1.1 - 13.9)                                 | 0.03                |
| Preeclampsia        | 2/343 (0.6%)                                      | 0/179 (0%)                                      | --                                       | --                                              | --                  |
| Antepartum hemorrhage | 4/343 (1.2%)                                     | 8/179 (4.5%)                                    | 4.0 (1.0 - 18.2)                         | 3.2 (0.9 - 12.2)                                | 0.09                |
| Infection           | 7/343 (2.0%)                                      | 7/179 (3.9%)                                    | 2.0 (0.6 - 6.6)                          | 2.5 (0.8 - 7.7)                                 | 0.11                |
| Breech              | 2/348 (0.6%)                                      | 8 (4.3%)                                        | 7.8 (1.5 - 76.0)                         | 7.0 (1.4 - 35.5)                                | 0.02                |
| Cord prolapse       | 0/343 (0%)                                        | 7/179 (3.9%)                                    | --                                       | --                                              | --                  |
| Normal labor        | 317/343 (92.4%)                                   | 97/179 (54.2%)                                  | 0.1 (0.1 - 0.2)                          | 0.1 (0.1—0.2)                                   | <0.00C              |
| Cesarean delivery   | 35/347 (10.0%)                                    | 46/182 (25.3%)                                  | 3.0 (1.8 - 5.0)                          | 3.8 (2.3 - 6.4)                                 | <0.00C              |
| **FETAL/NEONATAL FACTORS**|                                                |                                                 |                                          |                                                 |                     |
| Prematurity         | 5/348 (1.4%)                                      | 40/179 (22.2%)                                  | 19.7 (7.5 - 65.1)                        | 18.9 (7.2 - 49.2)                               | <0.00C              |
| Birthweight (mean in grams\(^3\)) | 3046.9 (463.8)                                  | 2496.2 (941.1)                                  | --                                       | --                                              | --                  |
| Low birth weight (<2500g)\(^3\) | 21/338 (3.7%)                                  | 56 (37.3%)                                      | 9.0 (5.0 - 16.4)                         | 2.5 (1.1 - 5.3)                                 | 0.02                |

\(^1\) Denominators noted when distinct from these secondary to missing data

\(^2\) Adjusted for maternal age (except for adjusted odds for the dichotomous variable of advanced maternal age), nulliparity, twin pregnancy, and prematurity

\(^3\) Data was analyzed on the level of the fetus/neonate rather than pregnancy
To assess for factors more likely associated with perinatal death during or after labor, cases with fresh stillbirths and neonatal deaths were compared to macerated stillbirths as shown in Table 2. Only singleton pregnancies were included in this subgroup analysis given that some twin dyads had different types of perinatal death (e.g. twin A was a stillbirth, twin B was a neonatal demise). The mean age for women who experienced a macerated stillbirth was 1.9 years older than those who did not (p value 0.04), but there was no significant difference in the proportion of who were at or above 35 years old. Pregnancies with fresh stillbirths or neonatal deaths occurred more frequently among nulliparous women (41.2% vs 24.6%, p = 0.03), grand multiparous women (71.6% vs 52.5%, p = 0.01) and those delivered by cesarean section (38.6% vs 7.9%, p <0.0001). Pregnancies with macerated stillbirths were more likely to be associated with low birthweight (46.8% vs 25.8%, p = 0.01). There were no significant associations between macerated stillbirths as compared to fresh stillbirths and neonatal deaths for antepartum hemorrhage, cord prolapse, HIV infection, prior scar, preeclampsia, presenting in spontaneous labor, or prematurity. Table 2 Maternal, pregnancy, fetal and neonatal characteristics compared with macerated stillbirths versus fresh stillbirths and neonatal death cases in singleton pregnancies
### Cases with a Macerated Stillbirth

\[ n = 64 \]

| Cases with a Fresh Stillbirth or Neonatal Death | \[ n = 102 \] |
| --- | --- |
| n (%) or Mean (SD) | n (%) or Mean (SD) | \( P \) value |
| **MATERNAL FACTORS** | | |
| Maternal Age (years) | 26.8 (6.3) | 24.9 (6.4) | 0.04 |
| Advanced maternal age (\( \geq 35 \) years) | 7 (10.9%) | 10 (10.2%) | 0.88 |
| Nulliparity | 15/61 (24.6%) | 42 (41.2%) | 0.03 |
| Grand multiparity | 32/61 (52.5%) | 73 (71.6%) | 0.01 |
| Prior scar | 0 (0%) | 3 (2.9%) | 0.29 |
| HIV | 3/59 (5.1%) | 3 (3.1%) | 0.67 |
| **PREGNANCY FACTORS** | | |
| Preeclampsia | 0 (0.0%) | 0 (0.0%) | -- |
| Antepartum hemorrhage | 2/62 (3.2%) | 5/100 (5.0%) | 0.71 |
| Infection | 1/62 (1.6%) | 5/100 (5.0%) | 0.41 |
| Breech | 2 (3.1%) | 6 (5.9%) | 0.71 |
| Cord prolapse | 2 (3.2%) | 5 (5.0%) | 0.71 |
| Spontaneous Labor | 36/62 (58.1%) | 82 (80.3%) | 0.05 |
| Cesarean section | 5/63 (7.9%) | 39/101 (38.6%) | <0.001 |
| **FETAL/NEONATAL FACTORS** | | |
| Prematurity | 15 (23.4%) | 20 (19.6%) | 0.56 |
| Birthweight (grams)\(^1\) | 2431.9 (937.2) | 2722.7 (864.9) | 0.07 |
| Low birth weight (<2500g)\(^1\) | 22/47 (46.8%) | 23/89 (25.8%) | 0.01 |

\(^1\) Analyzed on the level of fetus/neonate

Given the significantly increased risk of perinatal death noted with twin pregnancies, subgroup comparison of singleton and twin cases pregnancies was undertaken to see if there were any additional risk factors that were distinct to multiple gestation (Table 3).

Notably, twin perinatal deaths were more likely to be fresh stillbirths than singleton perinatal deaths (68.4% vs 36.8%, \( p = 0.01 \)). The only factor analyzed that was associated with increased risk of perinatal death in twin cases over singleton was birthweight both as a mean (singleton mean 2622.2 grams vs twin mean 1594.7 grams) and as a proportion of
low birth weight (singleton 33.1% vs twin 82.4%, p <0.001).

Table 3 Maternal, pregnancy, fetal and neonatal characteristics among singleton and multiple pregnancies with perinatal deaths

| TYPE OF PERINATAL DEATH\(^1\)                          | Singleton Cases n = 166 n (%) or Mean (SD) | Twin Cases n = 19 n (%) or Mean (SD) | P value |
|------------------------------------------------------|---------------------------------------------|--------------------------------------|---------|
| Stillbirth, macerated                                 | 64 (38.6%)                                  | 3 (15.8%)                            | 0.08    |
| Stillbirth, fresh                                     | 61 (36.8%)                                  | 13 (68.4%)                           | 0.01    |
| Neonatal death                                        | 41 (24.7%)                                  | 4 (21.1%)                            | 0.49    |

MATERNAL FACTORS

| Maternal Age (years)                                  | 25.7 (6.5)                                   | 26.9/18                              | 0.64    |
|------------------------------------------------------|---------------------------------------------|--------------------------------------|---------|
| Advanced Maternal Age (>= 35 years)                   | 17 (10.5%)                                  | 4 (22.2%)                            | 0.14    |
| Nulliparity                                           | 57/163 (35.0%)                              | 5/16 (31.3%)                         | 1.0     |
| Grand multiparity                                     | 105/163 (64.4%)                             | 11/16 (68.8%)                        | 0.79    |
| Prior scar                                            | 3 (1.8%)                                    | 1 (5.3%)                             | 0.35    |
| HIV                                                   | 6/156 (3.9%)                                | 1/18 (5.6%)                          | 0.54    |

PREGNANCY FACTORS

| Preeclampsia                                          | 0 (0%)                                      | 0 (0%)                               |         |
|------------------------------------------------------|---------------------------------------------|--------------------------------------|---------|
| Antepartum hemorrhage                                 | 7/162 (4.3%)                               | 1/17 (5.8%)                          | 0.56    |
| Infection                                             | 6/162 (3.7%)                               | 1/17 (5.9%)                          | 0.51    |
| Breech                                               | 8 (4.8%)                                   | 0 (0%)                               | 1.0     |
| Cord prolapse                                         | 7/162 (4.3%)                               | 0 (0%)                               | 1.00    |
| Spontaneous labor                                     | 84/162 (51.9%)                             | 13 (76.5%)                           | 0.07    |
| Cesarean delivery                                     | 44/164 (26.8)                              | 2/18 (11.1%)                         | 0.25    |

FETAL/NEONATAL FACTORS\(^2\)

| Prematurity                                           | 35 (21.1%)                                 | 6/16 (37.5%)                         | 0.44    |
|------------------------------------------------------|---------------------------------------------|--------------------------------------|---------|
| Birthweight (grams)                                   | 2622.2 (897.9)                             | 1594.7 (744.2)                       | <0.001  |
| Low birth weight (<2500g)                             | 45/136 (33.1%)                             | 14/17 (82.4%)                        | <0.001  |

\(^1\) Outcome present in one or both twins

\(^2\) Analyzed on the level of fetus/neonate

Discussion

In summary, we investigated risk factors for perinatal death in a rural hospital in Africa, a
common care setting from where there is limited patient-level data. We report perinatal death rate of 35.5 per 1000 deliveries, which is nearly 70% higher than the Ugandan national rate of 21 per 1000. The majority (67%) of cases were fresh stillbirths or neonatal deaths. Prematurity (aOR 19.7), breech presentation (aOR 7.0), and twin gestation (aOR 4.0) were the most significant risk factors for perinatal death. Our findings complement the limited data in literature on perinatal mortality in rural Uganda. Data from a cross sectional study conducted in rural Eastern Uganda in 2013 with women who delivered within the year prior found increased risk of neonatal death with grand multiparity, increasing maternal age and low birth weight, but women who experienced a stillbirth were notably excluded and limited obstetric data was assessed aside from number of antenatal visits and place of delivery.6

To our knowledge, we are the first group to analyze risk factors based on the type of perinatal death: stillbirth (macerated or fresh) and neonatal death. Of note, the majority (67%) of cases were fresh stillbirths or neonatal deaths, which suggests that quality improvement initiatives focusing on intrapartum and neonatology care may reduce these rates. For example, increased training on intrapartum management and vaginal delivery of breech presentation may improve outcomes. Twin pregnancies, which are most frequently not diagnosed until after the delivery of the first baby, had a higher rate of fresh stillbirth and neonatal death. Implementation of basic ultrasound to identify twins earlier in pregnancy, or at presentation in labor, is another potential intervention that could increase preparedness for a complicated delivery, and postnatal care. We also found that there was a high rate of cesarean delivery for cases of macerated stillbirth (8%), which may put the mother at increased risk of morbidity and mortality for no fetal benefit. Our findings however are distinct from studies in more urban settings in Uganda. In a prospective cohort study in 2013–2014 of referral hospitals in the urban capital Kampala
and the smaller semi-urban town of Jinja, obstructed labor, uterine rupture, antepartum hemorrhage and hypertensive disorders of pregnancy were noted to be the most frequent diagnoses associated with perinatal deaths. (8) Our findings also differ from a retrospective study from a rural hospital in southwestern Uganda that took place from 2009–2011 which did find similar associations of perinatal death with prematurity and birthweight but also with maternal HIV positive status, which we did not see in our study, which could be secondary to prevalence, which was higher in that cohort than ours. (9) Future prospective studies directly comparing different practice settings are needed to further investigate these differences.

Strengths of our study include the detailed review of the birth registry, a readily available and routinely updated resource whose maintenance preceded and continues beyond the study period. The number of stillbirths ascertained in the study database exceeded the number in the hospital annual report, which only noted 65 fresh stillbirths, 66 macerated stillbirths and 35 neonatal deaths before seven days of life in 2014. This finding suggests that the majority of perinatal births had been captured perhaps more successfully than other tracking systems used. Use of temporally related controls was another strength of the study to help ensure that cases and controls had similar circumstantial factors that are known to impact perinatal outcomes. The study population’s extrapolated annual stillbirth rate of 27.8 in 1,000 births, similar to hospitals across the country in a 2014 report, was higher than national rate, which supports the utility of focusing on in-facility perinatal deaths. (10)

An important limitation of our study was the quality of data that was available in the birth registers. While an assumption of the study was that all the fields were being accurately completed, there is the possibility that factors such as preeclampsia or antepartum hemorrhage were underreported if not known to the provider who did the delivery or
individual completing the birth register. Ability to interpret the handwriting on the registers limited the ability to include data. Additionally, possible factors that could be associated with a perinatal death such as congenital anomalies were not available in the register. Also, neonatal deaths that occurred after discharge but before day seven of life were likely not captured, thus resulting in under reporting of this outcome. These limitations highlight opportunities to advocate for strengthening the existing birth registry system (e.g. quality assurance mechanisms, postnatal follow up, digitization of records), a common issue in low-resource settings.

Conclusion

Our study in a district hospital in rural Uganda identified statistically higher risk of perinatal death associated with the following risk factors: breech presentation, cesarean delivery, low birth weight, multiple gestation, and prematurity. Interestingly, we found nulliparity, grand multiparity, multiple gestation and cesarean delivery to have higher association with fresh stillbirths and neonatal deaths than macerated stillbirths suggesting that these are associated with higher rates of intrapartum and postnatal complications. In their article on trends and risk factors of perinatal deaths in Eastern Uganda, Kujala et al write, “The slow decline in mortality rates and easily identifiable risk factors calls for improving quality of care at birth and a rethinking of how to address obstetric risks, potentially a revival of the risk approach of antenatal care.”(11) Our study found significant associations between routinely collected clinical data and perinatal deaths, which can be used to guide such a risk approach. For example, a focused project at our study site to examine all breech deliveries can be undertaken to determine if accuracy of antenatal assessment of fetal lie, comfort in execution of breech maneuvers, access to forceps to assist in delivery of the fetal head, or access to cesarean section contribute to perinatal morbidity and mortality. This in turn can be leveraged to inform use of
ultrasound to assess fetal position, simulation sessions of fetal malpresentation, or equipment procurement based on the gaps identified. Use of existing data to hone in on risk factors within a unique care setting to guide quality improvement initiatives not only increases the relevance of such efforts to providers but also provides crucial baseline data from which to set feasible targets.

In summary, we report that the rate of perinatal death in a non-academic rural hospital setting is higher than that based on regional reports, and identified potential risk factors for adverse outcome. These findings are important for prioritizing low-cost interventions to improve perinatal outcomes in similar, low-resource settings.

List Of Abbreviations

aOR Adjusted odds ratio
CI Confidence interval
HIV Human immunodeficiency virus
OR Odds ratio, adjusted

Declarations

Ethics approval and consent to participate

This study was approved by the Tororo General Hospital Ethics Committee and the Medical Superintendent. The study was considered exempt from the University of California San Francisco Institutional Review Board review as the data analyzed was de-identified.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.
Competing interests
The authors declare that they have no competing interests.

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Authors’ contributions
MAT analyzed data and drafted the manuscript. PN designed the study, collected data and edited the manuscript. ND collected data and edited the manuscript. OT reviewed study design and edited the manuscript. SLG designed the study, oversaw data collection and analysis, and edited the manuscript. All authors read and approved the final manuscript.

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Figures
Figure 1

Type of perinatal deaths among case pregnancies on the level of neonate

(percentage of total number of perinatal deaths)