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# The Association Between Maternal Hypertensive Disorders and Perinatal Mortality in Kigoma Region, Tanzania: 2011-2015

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ABSTRACT

The Association Between Maternal Hypertensive Disorders and Perinatal Mortality in Kigoma Region, Tanzania: 2011-2015

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**Background:** In Tanzania, about 60-70% of perinatal deaths occur during the intrapartum death period and these are most often linked to maternal complications. Maternal hypertensive disorders contribute to perinatal mortality and often cause preterm delivery, low birth weight and intrauterine fetal death. Women with hypertensive disorders in pregnancy, especially preeclampsia and eclampsia have a 3-5-fold increased risk of perinatal death.

**Objective:** This study examines the association between hypertensive disorders in pregnancy and perinatal mortality in Kigoma Region Tanzania and the confluence of other risk factors on this association from 2011-2015. It is hypothesized that maternal hypertensive disorders will affect perinatal outcomes of birthweight and mortality risks will be negatively impacted.

**Methods:** A retrospective descriptive analysis was conducted using secondary data from the Pregnancy Outcome Monitoring System (POMS) collected by the Global Reproductive Health Evidence Action Team at the Center for Disease Control and Prevention. POMS includes labor and delivery registry data from facilities in 8 districts (Buhigwe, Kakonko, Kasulu, Kasulu Township Authority, Kibondo, Kigoma Rural, Kigoma Municipal-Ujiji, and Uvinza) in the Kigoma Region of Tanzania from 2011-2015. The outcome variables of interest are "baby dead before discharge" to include live births but died before discharge and stillbirths (both fresh and macerated). The corresponding covariates of interest are weight of baby, mode of delivery, type of maternal hypertensive disorder (pregnancy-induced hypertension, pre-eclampsia, eclampsia, and generalized/unspecified hypertension), and any baby complications. Descriptive statistics were obtained for each variable of interest and were tested by maternal hypertensive disorder category. Mothers with maternal hypertensive disorder were compared to mothers with no documented complications regarding perinatal outcomes. The neonatal case fatality rates, stillbirth case fatality, rates and perinatal case fatality rates were calculated.

**Results:** Among mothers with any maternal hypertensive disorder, 33.87% of mothers had documented pregnancy-induced hypertension, 14.39% of mothers had documented preeclampsia, 49.09% of mothers had documented eclampsia, and 2.71% had documented generalized/unspecified hypertension. Specifically, 18.36% of mothers with pregnancy-induced hypertension, 17.55% of mothers with preeclampsia, 25.66% of mothers with eclampsia, and 9.09% of mothers with generalized hypertension had babies born in a weight classification of 2 kg or less, while 2.95% of mothers with no documented complication delivered a baby born in a weight classification of 2 kg or less. Fetal distress, birth asphyxia,

and prematurity were the most prevalent baby complications of babies born to mothers with documented maternal hypertensive disorders deliver by Cesarean section. For mothers with any documented hypertensive disorder in pregnancy, the still-birth specific case fatality rate is 7.4 per 1000, neonatal specific case fatality rate is 2.44 per 1000 and the perinatal specific case fatality rate is 9.84 per 1000. For mothers with no maternal complication, the stillbirth specific case fatality rate is 2.4 per 1000, neonatal case fatality rate is 0.005 per 1000, and the perinatal case fatality rate is 2.4 per 1000.

**Conclusion:** The results do not support the hypothesis that there is a direct association between maternal hypertensive disorders in pregnancy and perinatal mortality in Kigoma Region, Tanzania because the baby outcome by maternal hypertensive disorder status is not statistically significant. However, mothers with a documented maternal hypertensive disorder had increased rates of stillbirth, more low birth weight babies, and higher perinatal case fatality rates compared to mothers with no complication. More literature needs to be developed regarding sub-Saharan African to capture contextual information about social determinants and barriers specific to this population.

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APPROVAL PAGE

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Author's Statement Page

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# INTRODUCTION

## Perinatal Mortality: A global public health issue

Perinatal mortality is one of the most devastating global health issues of our time and global estimates indicate 5.9 million perinatal deaths per year of which 3.2 million stillbirths and 2.7 million are early neonatal death [1] According to the WHO (WHO), perinatal mortality is defined as a stillbirth or an early neonatal death that occurs before the first week of life [2, 3]. Furthermore, perinatal mortality is a significant public health issue because it is reflective of the slow progression of WHO Millennium Development Goals 4 (child mortality) and 5 (maternal mortality). These goals in part, are created to set a standard in perinatal and maternal care worldwide.

Prenatal care, intrapartum care, and postpartum care are associated with perinatal mortality with the highest risk for intrapartum death within the first 24 hours of birth [4]. Prenatal care is essential for the reduction of perinatal mortality. During this period, a rapport is built with the skilled birth attendant, the progression of the pregnancy is followed, development of the baby is tracked, and potential maternal complications can be monitored[5-8]. Likewise, intrapartum care can play a part in perinatal mortality. Depending on the skill of the birth attendant or physician, intrapartum care can be a crucial turning point in the health of the mother and baby[9, 10]. Where the baby is delivered is essential because in many developing countries women and babies are at higher risks during home deliveries where emergency obstetric complications are not

treated in a timely fashion.[11] After the delivery, postpartum care is necessary to maintain the health of the baby[12]. Often, the baby may need to receive resuscitation interventions to help them breathe after birth and may need to obtain lifesaving antibiotics if sepsis is suspected[4, 5, 13].

**Perinatal mortality in the developing world**

Perinatal mortality is disproportionately higher in developing countries like Tanzania than in developed countries [14, 15]. On a global scale, the most significant neonatal mortality rates and stillbirth rates occur in sub-Saharan Africa, followed by Asia and Latin America. In countries where the mortality is highest, almost 10 percent of babies do not survive more than one month [16]. Moreover, in developing countries the critical elements of perinatal mortality are a lack of skilled medical staff, access to emergency obstetric facilities, lack of or inadequate prenatal care, and distrust of the healthcare system due to cultural beliefs.

**Tanzania: A country with high rates of perinatal mortality**

In 2004, Tanzania's perinatal mortality rate was 69/100 live births and had not had any drastic improvement since. [3]. Limited resources in addition to shortages in medical staff have contributed to the quality of treatment and care in emergency obstetric complications. Additionally, 75% of the Tanzanian population live in rural areas making it difficult for women to travel to health centers and hospitals, with the most significant capacities in care. It is widely known that perinatal mortality is closely linked to maternal complications[3, 16-21]In Tanzania, about 60-70% of perinatal deaths occur during the

intrapartum death period and these are most often linked to maternal complications [4]. In a hospital-based study using data from Northern Tanzania, Mahande et al. found a perinatal mortality rate of 58 per 1000 live births among local non-referred births [6]. This perinatal mortality rate is about ten-fold the rates reported in western countries[22].

**Association between perinatal mortality and maternal hypertensive disorders**

This paper will address common causes and associations of perinatal mortality in developing nations like Tanzania, the association that hypertensive disorders in pregnancy have on perinatal mortality, and the detrimental effects that follow. Women with hypertensive disorders in pregnancy, especially preeclampsia and eclampsia have a 3-5 fold increased risk of perinatal death [23]. Associated maternal and neonatal complications from these hypertensive disorders include abruptio placentae, HELP, DIC, pulmonary edema, acute renal failure, cerebral etiology, maternal death, preterm delivery, low birth weight and intrauterine fetal death[24-30]. In addition, low socioeconomic status is associated with higher risks and complications due to maternal hypertensive disorders[31-33]. While a multitude of related conditions exist, this paper will focus on 3 categories of maternal hypertensive disorders: *pregnancy-induced hypertension, pre-eclampsia, eclampsia*. The reason this is the selected focus is because maternal hypertensive disorders in pregnancy cause devastating effects related to morbidity and mortality in sub Saharan Africa.

*Pregnancy-induced hypertension* is the least severe out of the three types of maternal hypertensive disorders. It is defined as hypertension that develops after week

20 in pregnancy and usually goes away after delivery [24]. This type of hypertension is easily treatable and if monitored during prenatal visits, doesn't pose a significant health risk. If treated, pregnancy-induced hypertension may not progress to preeclampsia. In a study conducted by the Network of Maternal-Fetal Medicine Units for the National Institutes of Child Health and Human Development, women who had preeclampsia as opposed to pregnancy-induced hypertension had higher rates of preterm delivery and low birth weight babies. ***[34]***

*Preeclampsia* is defined as a persistent diastolic blood pressure >90 mm Hg) with the presence of protein in the urine or proteinuria at >0.3 g/24 h [24]. In a study by Smiegelow et al., preeclampsia is a crucial risk factor for perinatal death in Northern Tanzania [9]. It accounted for 27% of the perinatal deaths and was found to be statistically significant as being a risk factor. In this study, the risk of death for a pregnant woman with severe preeclampsia is 0.5 percent, and the risk of perinatal mortality for her baby is 13 percent. If the preeclampsia remains untreated, a severe disorder called eclampsia can develop. Furthermore, if eclampsia develops, the risk of death for the mother increases to 5 percent and 28 percent for the baby"[16].

*Eclampsia* is the most severe form of hypertension disorder during pregnancy. It is characterized by the occurrence of seizures in women with pre-eclampsia, provided that the mother doesn't have existing epilepsy [24]. In a study by Barbosa, women with eclampsia were more likely to give birth to a low birth weight baby, more likely to have a baby in respiratory distress, and higher mortality rates [26]. In addition, women who had pre-eclampsia and chronic hypertension faired the best in perinatal outcomes among

all hypertensive disorders. As a result, eclampsia poses the most significant risk for perinatal mortality. The earlier the detection, the better and the less likely hypertension will progress to more severe forms such as preeclampsia or eclampsia [31].

**Purpose of Study**

In Tanzania, there are several risk factors that can be attributed to perinatal mortality to include access to obstetric health care facilities and weak infrastructure, maternal education level, lack of quality prenatal care, lack of skilled and financial barriers [31, 35, 36]. These risk factors are the most commonly cited in the literature for perinatal mortality and provide a robust foundation to understand the social determinants of this issue. These risks can be categorized as occurring any time during the antepartum, intrapartum, or postpartum periods through the birthing process. Access to emergency services, lack of or inadequate prenatal care, and subsequently unmonitored maternal complications throughout the duration of the pregnancy are risk factors for perinatal that occur during the antepartum period. Competent medical staff, adequate birthing supplies, and baby complications such as birth asphyxia and APGAR scores during delivery and immediately following birth greatly contribute to perinatal mortality. Risk factors associated during the postpartum period leading to perinatal mortality include low birth weight and prematurity.

Because the burden of perinatal is higher in the Kigoma Region of Tanzania than many other locations worldwide, further research is necessary to investigate possible causes and associations specific to that region for targeted preventative intervention. Furthermore, there is very little literature on the association between maternal hypertensive disorders and perinatal mortality in this region of Tanzania. This study will examine the association between hypertensive disorders in pregnancy and perinatal mortal in Kigoma Region Tanzania and the confluence of other risk factors on this association from 2011-2015. It is hypothesized that with increasing severity of the maternal hypertensive disorder the perinatal outcomes of birthweight and mortality risks will be negatively impacted. The risk factors as previously stated include perinatal comorbidities, mode of delivery, and birthweight of the baby, access to emergency services, maternal complications, perinatal comorbidities, mode of delivery, and birthweight of the baby.

## Additional risk factors to be considered in the association between maternal hypertensive disorders and perinatal outcomes

### Access to emergency services

Women in rural Tanzania are four times more likely to die during childbirth than those who are within 5 km of emergency obstetric facilities and the same can be said about perinatal deaths[20]. These women were more likely to have experienced inadequate prenatal care and most often had a late presentation to the hospital. [20]. To evaluate quality of obstetric care Emergency Obstetric Care and Newborn Care (EmONC),

there are two categories commonly cited in the literature: Basic Emergency Obstetric and Newborn Care (BEmONC), Comprehensive Quality Emergency Obstetric Care (CEmONC).

Basic Emergency Obstetric and Newborn Care facilities can provide primary lifesaving care to stabilize mothers during an emergency delivery. These facilities can provide assisted vaginal delivery, manual removal of the placenta, administer medications such as antibiotics, magnesium sulfate for eclampsia, and oxytocin for obstructed labor [35]. Comprehensive Quality Emergency Obstetric Care or CEmONC facilities provide interventions for women during childbirth that are experiencing life-threatening complications such severe hemorrhage, sepsis, birth asphyxia, and eclampsia [35]. These facilities can also perform cesarean sections, blood transfusions, and have capacities for resuscitation efforts of newborns. These types of facilities are ideal for emergency situations because they a variety of resources and staff readily equipped. The introduction of CEmONC level facilities at health centers has dramatically worked to reduce both maternal and perinatal mortality and morbidity in Tanzania [35]. CEmONC has also begun to encourage more women to deliver their babies at a health center or hospital instead of delivering at home where there is an increased chance of death.

**Lack of or inadequate prenatal care**

Prenatal care is essential for the health of the mother and baby. During these check-ups many of the maternal complications that can subsequently lead to perinatal mortality and fetal complications can be prevented and monitored during prenatal care. Additionally, lack of prenatal care is an essential indicator of perinatal mortality in developing countries. According to the Centers for Disease Control, during an 8-year

study inadequate of prenatal care (defined by the Adequacy of Prenatal Care Utilization Index) was found to be associated with an increased risk for stillbirth, prematurity, and early neonatal deaths. Young mothers with the lowest education levels were at the most significant risk [37]

## Common causes of perinatal mortality

There are maternal and fetal complications that can contribute separately or synergistically to a stillbirth or an early neonatal death [38]. Maternal causes of perinatal can include gestational diabetes, pregnancy hypertensive disorders, hemorrhaging disorders during the birthing process, sepsis, and obstructed labor. Furthermore, baby complications that can contribute to death can be congenital birth defects, low birth weight, prematurity, failure to thrive, sepsis [3].

The following section describes some common causes of perinatal mortality in developing countries:

### *Birth Asphyxia and APGAR Scoring*

According to global estimates, birth asphyxia is the most common cause of perinatal death (stillbirth or early neonatal death) in Tanzania. It is estimated that 60-70 percent of infant deaths in Tanzania occur during the first hour of life [4]. Of those deaths, about one-third are due to birth asphyxia, a condition where the neonate does not receive sufficient oxygen from the placenta during the birthing process [4, 31, 39]. Birth asphyxia can be harmful to the developing brain and is often fatal. Furthermore, this condition is less likely to be treated in rural, poor, and developing nations such as Tanzania with fewer

health resources [21]. Maternal complications like hypertensive disorders in pregnancy can lead to a cascade of events during intrapartum care that can contribute to birth asphyxia such as abruptio placentae, HELP syndrome (hemolysis, elevated liver enzymes) and DIC (disseminated intravascular coagulation)[40].

The APGAR scoring system has often been used an indicator to measure birth asphyxia [39]. APGAR measures heart rate, skin color, respiratory effort, reflexes, and muscle tone. This score is integral in determining the health status of the neonate and in preparing for resuscitation if needed. In this scoring system, values range from 0-10 and are usually performed at one and five minute intervals following birth with each of the five indicators receiving a score between zero and two. [41]. According to the American Academy of Pediatrics, APGAR scores 7 to 10 are normal, scores 4 to 6 are moderately abnormal, and scores of 0-3 are low and are a cause for concern and immediate action[41],

### *Low Birth Weight and Prematurity*

Prematurity and low birth weight are other complications associated with perinatal mortality [15, 42, 43]. This condition can lead to birth asphyxia, other breathing difficulties, vision problems, cerebral palsy, and other developmental delays from decreased blood flow to the baby. The most prominent cause for concern with preterm labor is undeveloped lungs and low birth weight. In addition, low birth weight is prevalent in African countries are often characterized by high perinatal mortality rates [42].Moreover, low birth weight can be a consequence of maternal hypertensive

disorders. It is estimated that preeclampsia is responsible for up to 20% of the 13 million preterm births each year worldwide[15].

**Multiple Birth**

A multiple birth is defined as having two or more babies during a pregnancy. A pregnancy that has multiple births can be at higher risk for mortality than a pregnancy of a single birth [15, 44]. In general, twin populations tend to have lower birth weight and worst outcomes. According to Habib et al., perinatal mortality rates of twins were increasing independently of the birth rate. Preeclampsia was also found to be 2.5 times more prevalent in twin populations than in single births [42].

**Still Birth**

A stillbirth is defined as the loss of a baby after 20 weeks gestation. There is no known single cause of a stillbirth. However, stillbirths have been associated with a variety of ailments to include maternal hypertensive disorders in pregnancy, older maternal age, congenital birth defects, sepsis during pregnancy, lack of nutrition, clotting disorders, problems with the umbilical cord and the placenta. There are two main types of stillbirths: fresh stillbirths (FSB) and macerated stillbirths (MSB). Fresh stillbirths occur within 12 hours of delivery. Macerated stillbirths happen earlier on in the pregnancy and occur in utero. These stillbirths show changes and breakdown in the skin and tissues which indicate that the stillbirth occurred earlier in the pregnancy. In Tanzania, there is little information about the predictors of stillbirth. However, we can gather information from similar countries. In a retrospective cohort study conducted at Kilimanjaro Christian

Medical Centre in Tanzania, pre-eclampsia (AOR 3.99; 95% CI: 3.31–4.81) and placental abruption (AOR 22.62; 95% CI: 15.41–33.19) were the most influential maternal risk factors associated with stillbirth.[15]

At Lower Umfolozi War Memorial Regional Hospital (LUWMRH) in South Africa, 35% of stillbirths were due to abruptio placentae, and a large proportion was associated with gestational hypertension, pre-eclampsia and/or eclampsia during a one year period [40]. Of those stillbirths, 20% were related to inappropriate monitoring or management of the obstetric condition at the district hospital [40]. This study further details the costs of inadequate prenatal and intrapartum care.

At Regional Medical Center of the University of Tennessee, a study was conducted to assess apparent stillbirths, where the APGAR score at 1 minute was 0, and the neonate was successfully resuscitated. After exclusion of fetal heart rate criteria, logistic regression found gestational age (odds ratio [OR] 0.8 per week), male gender (OR 2.5), preeclampsia (OR 3.9), and abruptio placentae (OR 13.6) to be independent risk factors for the delivery of an apparent stillborn infant.[45]. Preeclampsia was a significant risk factor in perinatal deaths.

According to Maaloe et.all, the overall facility-based stillbirth rate at a hospital in Zanzibar was 59 per 1000 total births. Of those births, poor quality of care during labor was the principal determinant of 71 (99 %) intra-hospital stillbirths. Furthermore, among women experiencing stillbirth, 27 (19 %) had severe hypertensive disorders (4 % among controls; OR 5.76, 95 % CI 2.70–12.31), but 18 (67 %) of these did not receive antihypertensives. [46]

### *Mode of Delivery: Home Birth/ Traditional Birth and Perinatal Mortality*

Home births are conducted by traditional birth attendants and can have some costly risks for the mother and baby. These risks are especially true for women who have a high-risk pregnancy and complications such as hypertensive disorders in pregnancy and gestational diabetes. Many of the health facilities are long distances away from the villages, so if an emergency arises, it is difficult to get the mother and the baby to care leaving an increased risk for death in these cases [11]. About 50% of mothers of mothers deliver in health facilities in Tanzania. However, traditional birth attendants are a clear link between the community and rural health centers and are trusted members of African society. Traditional birth attendants usually live in the community or close by where they can deliver babies at homes. Previously, traditional birth attendants have just been trained in basic obstetric care. The number of neonatal and maternal deaths suggest that these birth attendants need more specialized training to deal with more emergent birthing complications. By providing traditional birth attendants with specialized/targeted skills to combat birth asphyxia, neonatal hypothermia, and sepsis, the perinatal mortality rates in have been reduced in similar resource-poor countries such as Zambia [11]. These traditional birth attendants have been trained to administer antibiotics if a neonate shows signs of sepsis, provide adequate drying of the baby to reduce neonatal hypothermia and to provide resuscitation efforts with the use of a mask to act in a respiratory emergency caused by birth asphyxia [13].

# METHODS

## Study Location

Located in Norwest Tanzania, Kigoma region is adjacent to Lake Tanganyika, the Democratic Republic of Congo, and Burundi. Kigoma is characterized as rural from an estimated 83% of households with the region spanning 45,066 square kilometers[47]. Primarily, the region contains arable and grazing land with small of forest and water. Administratively, the region is divided into eight districts. The 2012 National Census of Population and Housing states that Kigoma Region had a population of 2,127,930 with 374,479 households, an average household size of 5.7, and an annual population growth rate of 2.4%[47]. Kigoma Region consists of districts districts(Buhigwe, Kakonko, Kasulu, Kasulu Township Authority, Kibondo, Kigoma Rural, Kigoma Municipal-Ujiji, and Uvinza). [47]

## Data Source

A retrospective analysis was conducted using secondary data from the Pregnancy Outcome Monitoring System (POMS) collected by the Global Reproductive Health Evidence Action Team at the Center for Disease Control and Prevention. POMS includes labor and delivery registry data in Kigoma Region of Tanzania from 2011-2015. Within these districts, pregnancy outcome monitoring is conducted from 127 health facilities including hospitals, health centers, and dispensaries. The Pregnancy Outcomes Monitoring System (POMS) uses abstraction of data from the labor & delivery registry, triangulation of the data from multiple sources (operating theatre information from

obstetric surgeries, death registers, case notes, nurse reports, admission and discharge paperwork and other sources) and the documentation of all maternal and infant deaths. Rapid Ascertainment Process for Institutional Deaths (or RAPID) is the process used to verify all maternal and perinatal deaths reported and not reported from death registers and multiple sources. This process enhances accuracy and credibility. The original register in Swahili and is translated into English after data collection. Mother variables abstracted from the labor and delivery registers include age, parity, maternal complications, and alive or dead at discharge. For obstetric complications of the mother, up to 3 complications are recorded. Baby Variables include pregnancy outcome, birthweight, Apgar score, helping babies breathe (HBB) score, breastfed within 1 hours, fresh or macerated stillbirth, baby complications, and alive or dead at discharge. Delivery variables include the date of delivery, mode of delivery, the performance of neonatal resuscitation, administration of uterotonic drugs (or AMSTL) and use of blood transfusion. However, for purposes of the current study, we narrowed the focus in terms of our variables of interest.

**Variables of Interest**

The independent variable of interest is maternal hypertensive disorder which will be explored by creating two groups: mothers with a documented maternal hypertensive disorder (any of the 4 conditions: pregnancy-induced hypertension, preeclampsia, eclampsia and generalized/unspecified hypertension) and mothers with no documented complications in the register. The outcome variables of interest are "baby dead before

discharge" to include live births but died before discharge and stillbirths (both fresh and macerated). The corresponding covariates of interest are weight of baby, mode of delivery, type of maternal hypertensive disorder (pregnancy-induced hypertension, pre-eclampsia, eclampsia, and generalized/unspecified hypertension), and any baby complications. If a multiple birth occurred, the twin with the worst outcome was included for analysis and the other twin was excluded. If the multiple birth is a triplet or more, it was treated as if it were a twin birth and the baby with the worst outcome was included in the analysis.

**Study Sample**

The total sample size per district of all births from the labor and delivery register from 2011-2015 is **n=51555**. The total sample size including all districts for the 4-year period combined is **n=206,222**. This surveillance data is collected on a monthly basis, and individuals are noted in the L&D registry. The women included in the registry are all women of reproductive age in the Kigoma Region of Tanzania that give birth in any health center, hospital, dispensary or reported at home by a traditional birth attendant. The age range varies from 15-49 years old.

**Data Analysis**

SAS 9.3 was used to analyze the data. Descriptive statistics were obtained for each variable of interest. Mothers with maternal hypertensive disorder were compared to mothers with no documented complications regarding perinatal outcomes. Relative risk was tabulated for mothers with any type of maternal hypertensive disorder and for mothers without maternal hypertensive disorder to determine the risk of perinatal

mortality by severity of the hypertensive disorder. The perinatal case fatality rate was calculated by a combination of the neonatal case fatality rate and the stillbirth case fatality rate. The neonatal case fatality rate was calculated by analyzing only the number of deaths occurring before discharge from the hospital from babies born alive.

## Ethical Considerations

This study was reviewed and approved by the CDC's Center for Global Health Human Subject Review Board and was determined not to comprise human subjects research.

## RESULTS

Descriptive statistics highlight demographics by maternal hypertensive disorder status. Modes for APGAR Score at 1 minute and 5 minutes are 9 and 10 respectively.

In terms of weight category, babies born to mothers with pregnancy-induced hypertension and eclampsia were more likely to be classified as low birth weight. Specifically, 18.36% of mothers with pregnancy-induced hypertension, 17.55% of mothers with preeclampsia, 25.66% of mothers with eclampsia, and 9.09% of mothers with generalized hypertension had babies born in a weight classification of 2 kg or less, while 2.95% of mothers with no documented complication delivered a baby born in a weight classification of 2 kg or less.

*Figure 1: Percentage by Classification of Maternal Hypertensive Disorder*

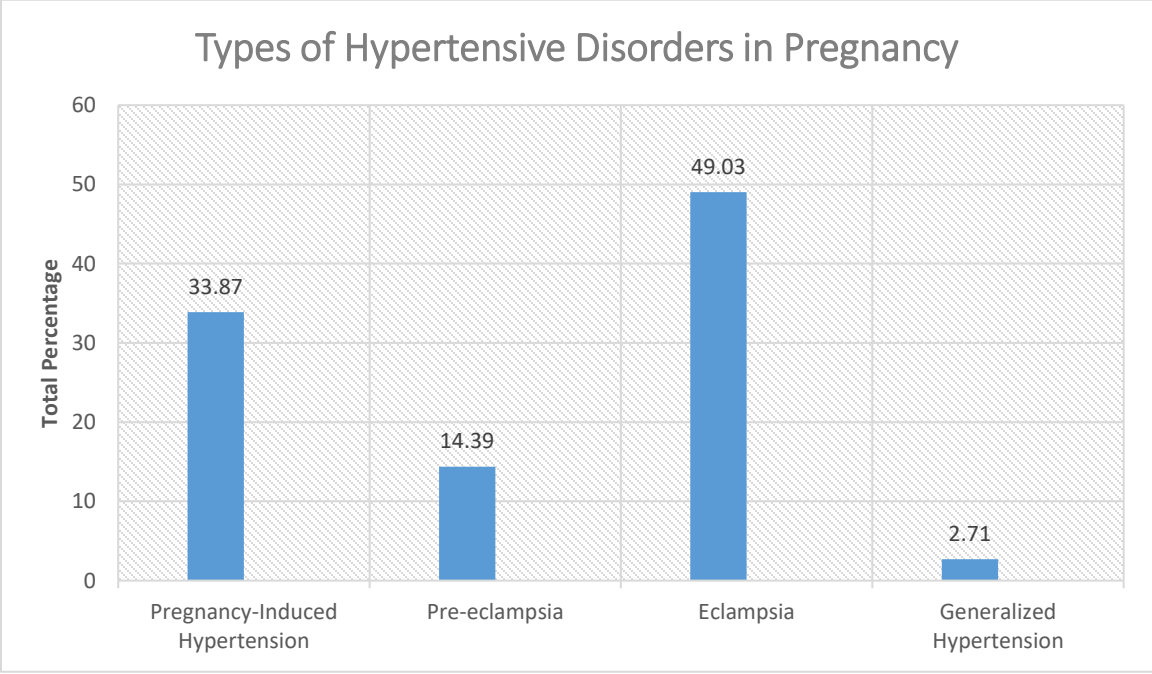


Figure 1 shows the prevalence of each maternal hypertensive disorder in Kigoma Region, Tanzania across all years. Among mothers with any maternal hypertensive disorder, 33.87% of mothers had documented pregnancy-induced hypertension. Among mothers with any maternal hypertensive disorder, 14.39% of mothers had documented preeclampsia. Among mothers with any maternal hypertensive disorder, 49.09% of mothers had documented eclampsia. Among mothers with any maternal hypertensive disorder, 2.71% had documented generalized/unspecified hypertension.

*Figure 2: Hypertensive Disorder in Pregnancy Status by Year*

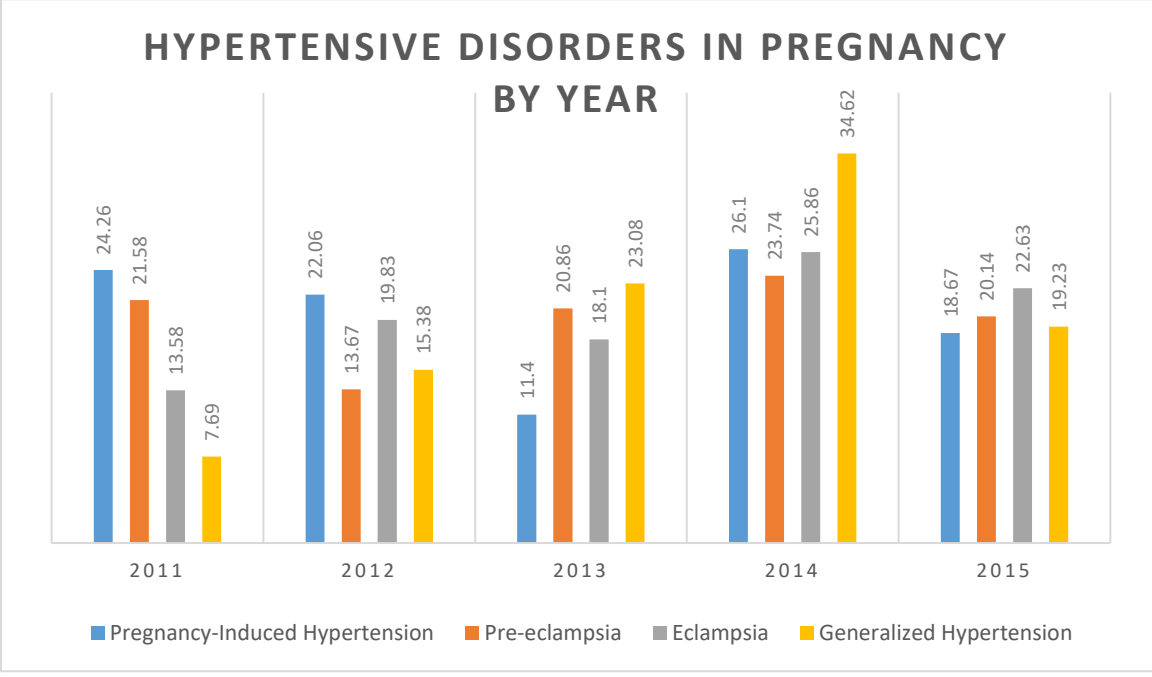
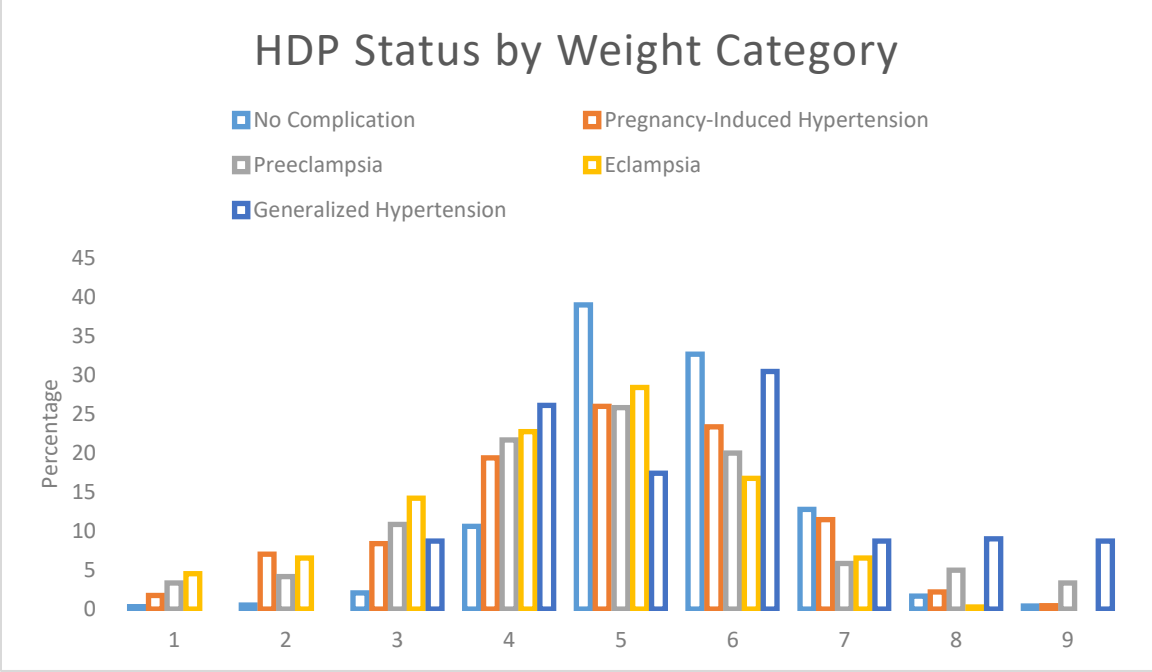


Figure 2 shows the percentage of each maternal hypertensive disorder in Kigoma Region, Tanzania by Year. In 2011, of mothers with a maternal hypertensive disorder 24.26% had pregnancy-induced hypertension, 21.58% of mothers had preeclampsia, 13.58% of mothers had eclampsia and 7.69% of mothers had generalized/unspecified hypertension. In 2012, of mothers with a maternal hypertensive disorder 22.06% of mothers had pregnancy-induced hypertension, 13.67% of mothers had preeclampsia, 19.83% of mothers had eclampsia, 15.38% of mothers had generalized/unspecified hypertension. In 2013, of mothers with a maternal hypertensive disorder 11.4% of mothers had pregnancy-induced hypertension, 20.86% of mothers had preeclampsia, 18.1% of mothers had eclampsia, 23.08% of mothers had generalized/unspecified hypertension. In 2014, of mothers with a maternal hypertensive disorder 26.1% of mothers had pregnancy-induced hypertension, 23.74% of mothers had preeclampsia, 25.86% of mothers had eclampsia, 34.62% of mothers had generalized/unspecified hypertension. In 2015, of mothers with a maternal hypertensive disorder 18.67% of mothers had pregnancy-induced hypertension, 20.14% of mothers had preeclampsia, 22.63% of mothers had eclampsia, 19.23% of mothers had generalized/unspecified hypertension.

*Figure 3: Hypertensive Disorder in Pregnancy Status by Weight Category*




The above weight categories in Figure 3 are as follows: **1**=<1 kg (2.2 lbs) , **2**=1.1-1.5kg, (2.5-3.3lbs) **3**=1.6-2.0 (3.5-4.4lbs), kg, **4**=2.1-2.5 (4.6-5.5lbs) kg, **5**=2.6-3.0 kg (5.73-6.61lbs), **6**=3.1-3.5 kg (6.8-7.71lbs), **7**=3.6-4.0 kg (7.9-8.8lbs), **8=**4.1-4.5 kg (9-9.9lbs), **9**=4.6+ kg (10+ lbs). In Figure 3, mothers with no documented complication on average delivered babies in weight categories 5 and 6. Mothers with pregnancy-induced hypertension delivered babies in weight categories 4 and 5. Mothers with preeclampsia and eclampsia on average delivered babies in weight while mothers with generalized/unspecified hypertension delivered babies in weight categories 5 and 6. Mothers with eclampsia and preeclampsia had the

highest percentage of babies born among the weight categories 1-4. Mothers with no complication delivered babies in the higher weight categories.

Out of the 10 districts in Kigoma region, KigomaTown_UjijiMC is the district with the highest documented cases of maternal hypertensive disorders followed by Kigoma district, Kasulu district, and Kasulu TC, and Kibondo district. In terms of type of facility, basic emergency obstetric and newborn care was the most prevalent facility type, followed by comprehensive obstetric and newborn care, and emergency obstetric and newborn care.

The total percentages for the standard vaginal mode of delivery are as follows: 47.59% of mothers with pregnancy-induced hypertension, 35.34% of mothers with preeclampsia, 39.64% of mothers with eclampsia, and 68% of mothers with generalized hypertension delivered by standard vaginal delivery. The total percentages for the cesarean mode of delivery are as follows: 45.78% of mothers with pregnancy-induced hypertension, 57.89% of mothers with preeclampsia, 44.10% of mothers with eclampsia, and 28% of mothers with generalized hypertension delivered by cesarean section. The total percentages for the assisted vaginal mode of delivery are as follows: 0.90% of mothers with pregnancy-induced hypertension, 3.01% of mothers with preeclampsia, 2.90% of mothers with eclampsia, and 4% of mothers with generalized hypertension delivered by assisted vaginal delivery. The total percentages for home births are as follows: 0.60% of mothers with pregnancy-induced hypertension, 0% of mothers with preeclampsia, 3.56% of mothers with eclampsia, and 0% of mothers with generalized hypertension had a home birth.

Babies that were alive at discharge from the hospital consisted of 57.53% born to mothers with pregnancy-induced hypertension, 60.90% of mothers with preeclampsia, 49.89% of mothers with eclampsia, and 64% of mothers with generalized hypertension. Babies that were considered dead at discharge from the hospital consisted of 21.69% born to mothers with pregnancy-induced hypertension, 21.80% of mothers with preeclampsia, 20.49% of mothers with eclampsia, and 12% of mothers with generalized hypertension.

**Table 1: MATERNAL COMPLICATIONS AMONG ALL DELIVERIES**

| | **MATERNAL COMPLICATION #1** | | **MATERNAL COMPLICATION #2** | | | **MATERNAL COMPLICATION #3** |
|---|---|---|---|---|---|---|
| | Frequency | Percent % | Frequency | Percent % | Frequency | Percent % |
| **5 = "Antepartum hemorrhage"** | 567 | 0.25 | 145 | 0.06 | 6 | 0.00 |
| **6 = "Arm prolapse"** | 111 | 0.05 | 43 | 0.02 | 4 | 0.00 |
| **9 = "Bad obstetric history"** | 80 | 0.04 | 77 | 0.03 | 9 | 0.00 |
| **10 = "Big baby (large for gestational age)"** | 56 | 0.02 | 133 | 0.06 | 21 | 0.01 |
| **14 = "Cephalo-pelvic disproportion/Foeto-pelvic disproportion/macrosomia"** | 2347 | 1.05 | 227 | 0.10 | 11 | 0.00 |
| **23 = "Dystocia"** | 205 | 0.09 | 40 | 0.02 | 5 | 0.00 |
| **24 = "Eclampsia"** | 462 | 0.21 | 2 | 0.00 | | |
| **25 = "Ectopic pregnancy"** | 29 | 0.01 | 1 | 0.00 | | |
| **29 = "Failure to progress (poor progress, induction failure)"** | 304 | 0.14 | 53 | 0.02 | 8 | 0.00 |
| **34 = "HIV positive status"** | 620 | 0.28 | 68 | 0.03 | 19 | 0.01 |
| **35 = "Hypertension"** | 19 | 0.01 | 6 | 0.00 | 1 | 0.00 |
| **40 = "Intrauterine fetal death (fetal death in utero)"** | 159 | 0.07 | 91 | 0.04 | 22 | 0.01 |
| **53 = "Obstructed labor (OBS labor, obst labor, obstr labor)"** | 1925 | 0.86 | 325 | 0.14 | 20 | 0.01 |
| **57 = "Placenta previa"** | 446 | 0.20 | 78 | 0.03 | 11 | 0.00 |
| **60 = "Postpartum hemorrhage"** | 1913 | 0.85 | 163 | 0.07 | 5 | 0.00 |
| **61 = "Preeclampsia"** | 137 | 0.06 | 7 | 0.00 | | |
| **62 = "Pregnancy-induced hypertension"** | 267 | 0.12 | 39 | 0.02 | 6 | 0.00 |
| **63 = "Premature rupture of membranes"** | 169 | 0.08 | 44 | 0.02 | 1 | 0.00 |

| | MATERNAL COMPLICATION #1 | | MATERNAL COMPLICATION #2 | | | MATERNAL COMPLICATION #3 |
|---|---|---|---|---|---|---|
| **65 = "Preterm labor"** | 235 | 0.10 | 32 | 0.01 | 11 | 0.00 |
| **66 = "Previous scar (P/Scar)"** | 1084 | 0.48 | 1039 | 0.46 | 101 | 0.05 |
| **67 = "Prolonged 2nd stage of labor (delayed 2nd stage of labor, poor pushing, poor descent of head)"** | 622 | 0.28 | 62 | 0.03 | 2 | 0.00 |
| **68 = "Prolonged labor, prolonged obstructed labor"** | 1729 | 0.77 | 264 | 0.12 | 20 | 0.01 |
| **73 = "Repeat Cesarean section (2 previous scars)"** | 754 | 0.34 | 373 | 0.17 | 18 | 0.01 |
| **74 = "Retained placenta"** | 731 | 0.33 | 93 | 0.04 | 5 | 0.00 |
| **75 = "Retained second twin"** | 140 | 0.06 | 22 | 0.01 | 6 | 0.00 |
| **86 = "Uterine rupture"** | 494 | 0.22 | 3 | 0.00 | 1 | 0.00 |
| **88 = "Vaginal tear"** | 1659 | 0.74 | 108 | 0.05 | 2 | 0.00 |
| **92= "Anemia"** | 94 | 0.04 | 102 | 0.05 | 32 | 0.01 |
| **96= "Sepsis"** | 471 | 0.21 | 44 | 0.02 | 5 | 0.00 |

Table 1 documents all maternal complications from Kigoma Region labor and delivery registers. The most prevalent maternal complication in the general population is cephalo-pelvic disproportion/Foeto-pelvic disproportion/macrosomia (CPD). Obstructed labor, prolonged obstructed labor, vaginal tear, previous cesarean section scar, and antepartum hemorrhage were also maternal complications prevalent in Kigoma Region.

*Figure 4: Fresh and Macerated Still-Births by Maternal Hypertensive Disorder Status*

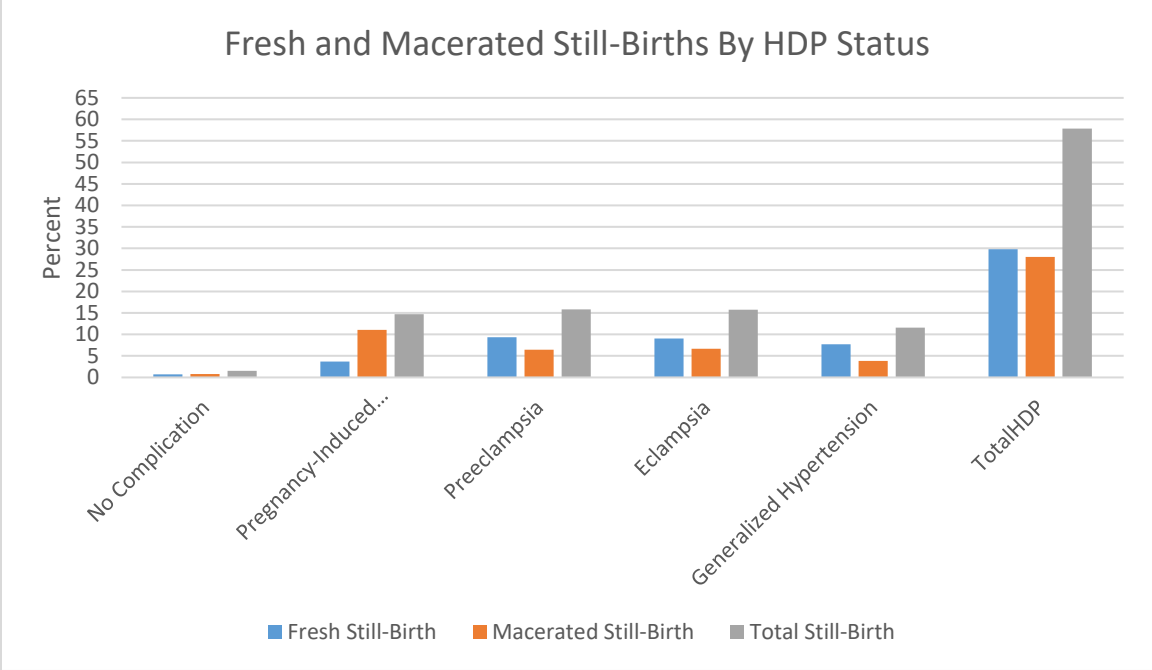



Figure 4 shows the percentage of stillbirths, both fresh and macerated by maternal hypertensive disorder status. Mothers with documented pregnancy induced-hypertension had the highest rates prevalence of macerated stillbirths followed by eclampsia, preeclampsia, generalized/unspecified hypertension, and no complication. Mothers with documented preeclampsia had the highest percentages of fresh stillbirths followed by eclampsia, generalized/unspecified hypertension, pregnancy induced-hypertension and no complication.

*Figure 5: Baby Outcome by Maternal Hypertensive Disorder Status*

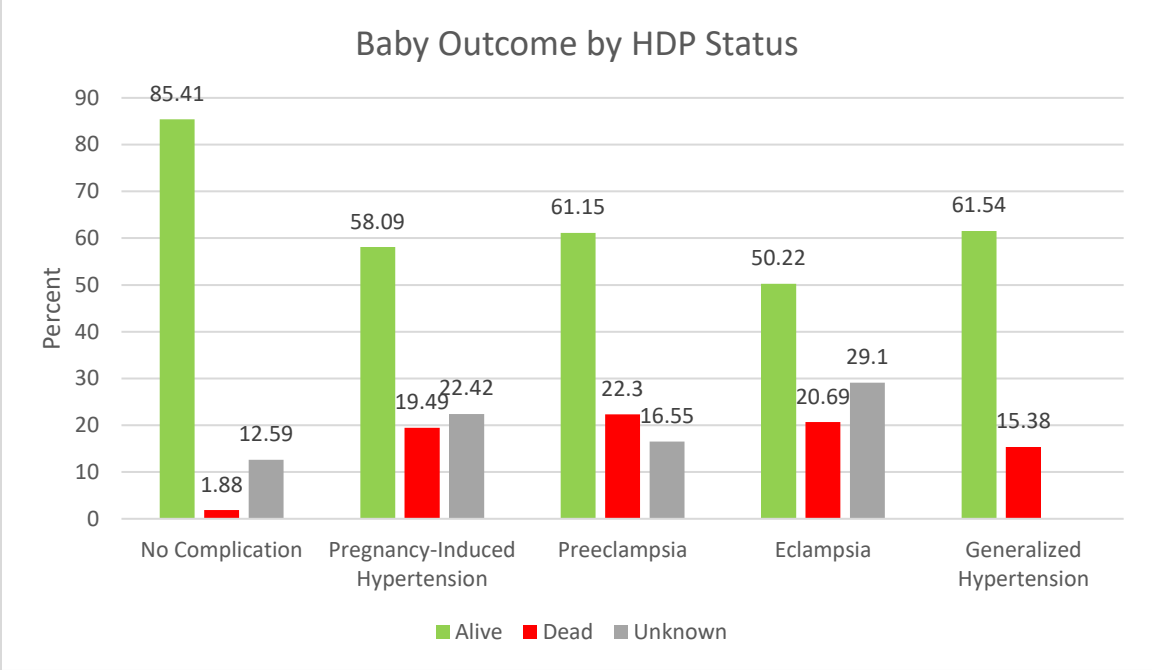



Figure 5 outlines baby outcome by maternal hypertensive disorder status. The status is documented as either alive at discharge, dead at discharge (stillbirths and live births), or unknown. The percentage of deaths varied by complication For babies documented as alive at discharge, 85.41%% had a perinatal death for mothers with no complication, 58.09% had death for mothers with pregnancy induced hypertension, 61.15% had death for mothers with mothers with preeclampsia, 50.22% had death for mothers with mothers with eclampsia, and 61.54% had death for mothers with generalized/unspecified hypertension. For babies documented as dead at discharge, 1.88% had death for mothers with no complication, 19.49% had death for mothers with pregnancy-induced hypertension, 22.3% had death for mothers with preeclampsia, 20.69% had death for mothers with eclampsia, and 15.38% had death for mothers with generalized/unspecified hypertension.

| Table 2: Total List of Total Baby Complications Among All Deliveries | | |
|---|---|---|
| | Frequency | Percent% |
| **1. Malpresentation (AMP, MPRE, MPOS, TVL, NUCD)** | 1170 | 0.52 |
| **2. Birth Asphyxia/ Acute Respiratory Distress Syndrome/ Aspiration/ Dyspnea** | 1186 | 0.53 |
| 3. Big Baby/ Large for Gestational Age | 163 | 0.07 |
| 4. Birth Defect (BD. NTD. Omophalacele) | 254 | 0.11 |
| 5. Breech | 664 | 0.30 |
| 6. Fetal Distress | 1098 | 0.49 |
| 7. Fresh Still-Birth | 102 | 0.05 |
| 8. Hypoglycemia | 4 | 0.00 |
| **9. Intrauterine Fetal Death** | 950 | 0.42 |
| 10. Macerated Still-Birth | 165 | 0.07 |
| 11. Neonatal Death | 300 | 0.13 |
| **12. Prematurity** | 1255 | 0.56 |
| 13. Cord Prolapse (PROCD) | 288 | 0.13 |
| 14. Retained Second Twin | 2 | 0.00 |
| 15. Cardiac related: Bradycardia | 2 | 0.00 |
| 16. Prolonged Labor: (Dys, P2S | 7 | 0.00 |
| 17. Brain related: Brain damage, Anancephaly, Encephalitis | 3 | 0.00 |
| 18. Hypothermia | 1 | 0.00 |
| 19. Low Birth Weight | 151 | 0.07 |
| 20. Pneumonia | 2 | 0.00 |
| 21. Premature Rupture of Membranes | 9 | 0.00 |
| 22. Sepsis | 59 | 0.03 |
| 23. Unspecified | 9 | 0.00 |
| 99. Other | 104 | 0.05 |

Table 2 details the total list of baby complications in the general population regardless of maternal hypertensive disorder status. Prematurity, malpresentation, birth asphyxia, fetal distress, and intrauterine fetal death are the most prevalent types of baby complications.

*Figure 4: Baby Complications by Maternal Hypertensive Disorder Status*

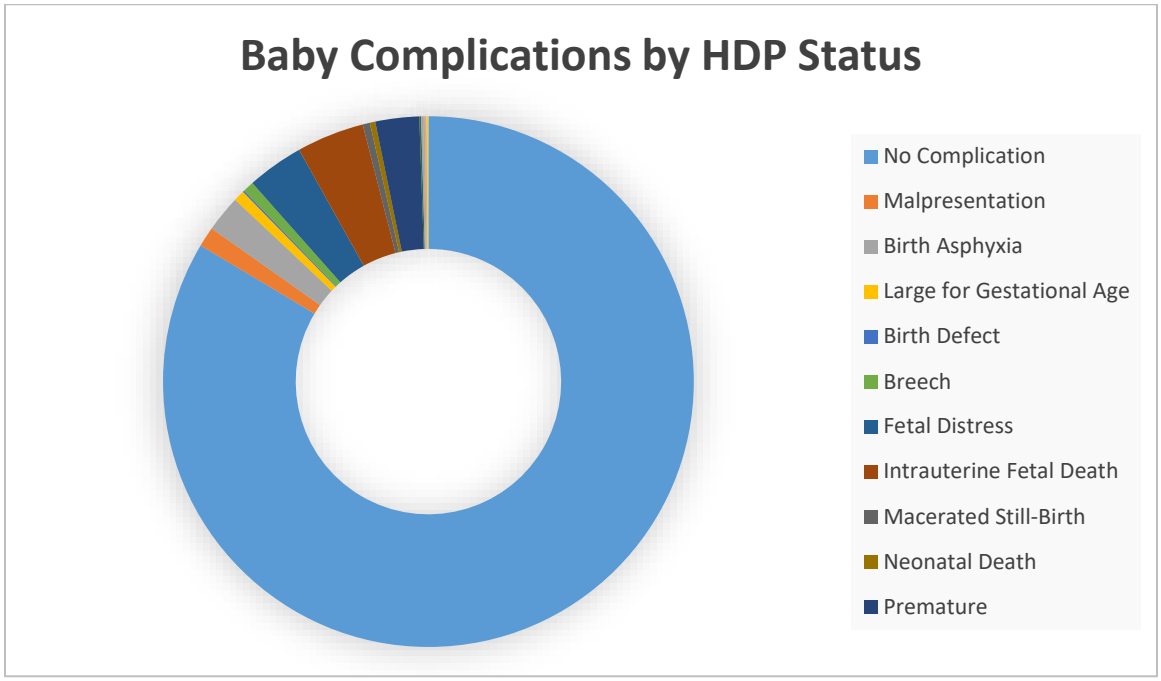



Figure 6 builds upon the baby complication list in Table 2. This figure is documenting the baby complications among those born to mothers with any documented maternal hypertensive disorder. Most babies born to mothers with any documented maternal hypertensive did not have any complication (84%). However among those babies with complications, the most prevalent complication among those born to mothers with any documented maternal hypertensive disorder is intrauterine fetal death (4%) . Other prevalent baby complications among this population are fetal distress (3%), prematurity (3%),

| Table 3: Case Fatality Rates by Still-birth, Neonatal, and Perinatal Status | | | |
|---|---|---|---|
| | **Still-Birth Specific Case Fatality Rate** | **Neonatal Specific Case Fatality Rate** | **Perinatal Specific Case Fatality Rate** |
| **HDP STATUS** | | | |
| Yes (Any HDP) | 7.4 | 2.4 | 9.9 |
| No (No Complication) | 2.4 | 0.005 | 2.4 |

Table 3 outlines the case fatality rates by overall status, still birth neonatal, and perinatal fatality status. For mothers with any documented hypertensive disorder in pregnancy, the overall case fatality rate is 21.8 per 1000. The still-birth specific case fatality rate is 7.4 per 1000, neonatal specific case fatality rate is 2.44 per 1000 and the perinatal specific case fatality rate is 9.84 per 1000. For mothers with no maternal complication, the overall case fatality rate is 1.7 per 1000. The stillbirth specific case fatality rate is 2.4 per 1000, neonatal case fatality rate is 0.005 per 1000, and the perinatal case fatality rate is 2.4 per 1000.

# DISCUSSION

This study examined the association between hypertensive disorders in pregnancy (ie. Pregnancy-induced hypertension, preeclampsia, eclampsia, and generalized/unspecified hypertension) and perinatal mortal in Kigoma Region Tanzania and the confluence of other risk factors on this association from 2011-2015. It was hypothesized that with increasing severity of the maternal hypertensive disorder the perinatal outcomes of birthweight and mortality risks will be negatively impacted.

The results do not support the hypothesis that there is a direct association bectween maternal hypertensive disorders in pregnancy and perinatal mortality in Kigoma Region, Tanzania. However, the case fatality rates can provide insight into the difference between perinatal case fatality comparing mothers with hypertensive disorder and mothers with no compication. Additionally, mothers with a documented maternal hypertensive disorder had increased rates of stillbirth, both macerated and fresh compared to mothers with no complication. Although the data does not allude to a direct association between maternal hypertensive disorder status and perinatal mortality, there is also an increased risk of morbidty for the neonate. This is especially true in babies born to mothers with eclampsia and pregancy-induced hypertension. Eclampsia is the most severe form of maternal hypertensive disorder in pregnancy and therefore as expected, has the highest rates of morbiditiy. Babies born to mothers with eclampsia had the highest rates of low birth weight/ preterm birth, along with fetal distress and birth asphyxia. The high percentages of low birth weight/preterm birth, prematurity, birth asphyxia,

intrauterine fetal death and fetal distress were consistent with previous literaure on the types maternal hypertensive disorders.

Consistent with the literature, a majority of the babies born to mothers with a hypertensive disorder in pregnancy had a low birth weight and or were premature. The mechanism behind this is that nutrients pass to the placenta with more difficulty in mothers with with hypertension[17, 26, 34]. Additionally, the results indicate that with increasing severity of hypertension in pregnancy the low birth weight will be more pronounced which is also consistent with the literature. There is an increased risk of stillbirth for mothers who have hypertension in pregnancy than for mothers without hypertension cited in the literature. This is consistent with the results as mothers with maternal hypertensive disorders had almost 4 times the rate of stillbirth as opposed to mothers without complication[48].

Compared to other resource-limited countries this data aligns with the literature associated with hypertensive disorders in pregnancy and perinatal morbidities. In a study done at 2 clinics in Accra, Ghana the percentage of mothers with hypertensive disorders in pregnancy in the population were a rare occurrence conistent with the results of mothers in Kigoma, Tanzania with these disorders. According to the study assessing perinatal outcomes of maternal hypertensive disorders showed that 7.5% developed pregnancy-induced hypertension, 2.0% had chronic hypertension, and 1.7% developed preeclampsia[49]. A total of 88.7% of womendid not have a documented HDP. Additionally, babies of whom had mothers with a hypertensive disorder in pregancy in Accra, Ghana had an increased risk for low birth weight and ceasarean section mode of

delivery. In Burma, Thailand, Vietnam, and China, there is a strong association between low birth weight and pre-term birth according to the WHO (RR 1.64) [50]. In a hospital in rural South India, the most common neonatal complication associated with hypertensive disorders in pregnancy was prematurity which was 23.65%[51]. Better antenatal care, treatment of anemia from increased risk of hemorrhage, and monitoring of women with these disorders were suggested to reduce the associated perinatal morbidity and mortality.

## CURRENT PUBLIC HEALTH INTERVENTIONS IN PLACE TO ADDRESS PERINATAL MORATALITY

### Kangaroo Mother Care

Kangaroo Mother Care (KMC) is a technique that is widely practiced in Tanzania and is spearheaded by The Maternal and Child Survival Program affiliated with USAID[52]. The goal of the Maternal and Child Survival Program is to create interventions with the intention of reducing child and maternal deaths globally. The Kangaroo Mother Care program is aimed at bringing warmth to pre-term and low birth weight babies and helping these babies to breastfeed, therefore encouraging growth. The premise of this technique is skin-to-skin contact between the mother and baby to facilitate bonding and thriving. This method can increase chances for survival and reduce morbidity after birth among those low birth weight/ pre-term babies born to mothers of maternal hypertensive disorders[52-54].

This program has been associated with reduced morbidity and mortality in low birth infants in resource-limited countries such as India countries in Latin-America, and Malawi [52, 54]. In Malawi, Kangaroo Mother Care is starting to gain momentum and is being used to combat preterm births occurring in this country. Focus groups have been conducted with pregnant women, fathers, other women who have gone through type of care, community leaders and health workers about their attitudes regarding the use Kangaroo Mother Care. The initial results showed that individuals in the focus previously

had negative perceptions about preterm birth and KMC. However, after being educated on the program through counseling, peer discussions, and success stories, their attitudes changed. These results are significant because it shows that with education and cultural sensitivity, social norms can be changed. Because of cultural similarity, this program can be implemented in Tanzania with similar success[52, 55].

**Helping Babies Breathe**

The top neonatal complication associated with hypertensive disorder in pregnancy is birth asphyxia. There have been some attempts to solve the ever-increasing rate of perinatal mortality in Tanzania. *Helping Babies Breathe* (HBB) is a low cost, global initiative created in 2009 that seeks to reduce deaths due to birth asphyxia and other respiratory complications that could occur at birth [56]. These life-saving techniques include infant stimulation, suction of the nose and mouth when appropriate, and the use of a bag-valve-mask to improve breathing and to circulate oxygen [57, 58]. The *Maternal Reproductive Health in Tanzania* program along with the U.S. Centers for Disease Control and Prevention (CDC) have been closely monitoring HBB implementation in the Kigoma region of Tanzania. Kigoma is a resource limited region where maternal and neonatal deaths have been higher than other regions in the country.

Although the HBB technique itself can be very effective, the manner in which the training is conducted is key to its effectiveness. Studies have shown that a single session of HBB training makes little or no difference to the care provided or to the rate of infant death [4]. This finding is commensurate with implementation science, which has demonstrated consistently that workshops alone do not result in much behavioral change.

To see an impact on reduction of deaths during the birthing process, community members must be trained and exposed to the material repeatedly over long periods of time. This approach is called the *High-Frequency Low Dose (HFLD)* method. Through this method, delivery care providers are mentored by facility-based champions through an initial one-day training, followed by daily practice sessions at their health care facilities. Additionally, the trainees receive refresher workshops and are frequently retested on their skills. The first pilot of HFLD HBB in Tanzania showed a 47 percent reduction of neonatal deaths and a 24 percent reduction in fresh stillbirths after its implementation in 2009. After implementation of the HFLD HBB method in participating hospitals and health care facilities in Kigoma Region, CDC documented, a 17 percent reduction in perinatal deaths before discharge compared with the pre-implementation period. HFLD HBB in Tanzania has proven effective for reduction of perinatal deaths in Tanzania. This initiative improves survival for babies and trains members of the community in the hopes of preventing deaths from birth asphyxia complications [4, 56, 57].

### Massawe et al. Pilot Study: A Low-Cost Care Bundle Reduces Preterm Infant Mortality in Tanzania

A solution to preterm infant mortality attributed to birth asphyxia, prematurity, and sepsis was developed from a low-cost care bundle. This bundle includes antenatal corticosteroids and maternal antibiotics[59]. Moreover, *Helping Babies Breathe* resuscitation techniques and hypothermia prevention were emphasized. This study sought to analyze how these care packages would affect preterm mortality in Tanzania. Along with Helping Babies Breathe resuscitation techniques and hypothermia prevention

were emphasized. In addition, antenatal corticosteroids and antibiotics were given to women during pregnancy. The pilot study was conducted in September 2014 which saw a 26% reduction in one-week neonatal mortality and an unanticipated 33% reduction in fresh stillbirth rates in preterm infants[59]. These care packages can be of great assistant in areas of Tanzania where there is limited primary/prenatal care and can provide the necessary tools to prevent these types of perinatal deaths.

**Limitations**

There were several limitations with this study. The first limitation is the use of surveillance/ cross sectional data. A prospective study or quasi-experimental study would be ideal to follow the mother and neonates into the future. This would ensure follow up of any morbidities later in the first year among those neonates born to mothers with a documented maternal hypertensive disorder.

Additionally, this surveillance data does not contain any information about quality of prenatal care. As a result, assumptions in terms of the association between prenatal care quality and maternal hypertensive is disorder in this instance cannot be made. Providing information about prenatal care is essential to understand if the mother even attempted to receive prenatal care, if they had an early diagnosis of maternal hypertensive disorder, if they were properly monitored, and if they received proper treatment/medication to manage these disorders before turning deadly.

Furthermore, with this type of surveillance data there may be data entry errors . The information/data is handwritten manually on hard copies of labor and delivery register sheets. Pictures are taken of each hard labor and delivery register and the data is then extracted manually into an excel worksheet. Many of the data entry errors occur by misinterpretation of handwriting. However, there are other data entry errors that occur from omission of information from healthcare providers back in Tanzania. This is usually a result of understaffing and high patient demand. In addition to data entry errors, there is also an underreporting of certain conditions, especially mortality numbers.

There also may be inconsistencies as to what constitutes certain maternal hypertensive disorders. As a result, many women may be misclassified as the wrong type of maternal hypertensive disorder. In consistencies in definitions of pregnancy-induced hypertension, preeclampsia, eclampsia, and unspecified hypertension were bound to affect the results documented in this paper. The actual blood pressure of the patient was not recorded in the labor and delivery register/surveillance data, so the study has based the maternal hypertensive disorder status solely on provider diagnosis. Within this data set, hypertensive disorders in pregnancy are a rare event and so the sample size for mothers with this complication compared to mothers with no complication is miniscule.

Another limitation to this study is that home births are often vastly underreported in this dataset. This is likely due to the absence of traditional birth attendants who are mandated to report home births. If the traditional birth attendant or midwife is not present, the death will more than likely not be reported to the appropriate health authority.

Lastly, because of the data entry errors and underreporting, there are a plethora of missing and unknown values. This is especially troublesome in accurately depicting mortality rates and prevalence of both maternal and baby complications.

## CONCLUSION

Although the percentage of maternal hypertensive disorders in Kigoma Region, Tanzania are found to be rare, when they do occur there can be devastating effects. Any reduction in perinatal mortality associated with these disorders will be a positive step for public health. The impact for reduction of perinatal mortality and morbidities has great implications for public health and for Tanzanian society.

Further recommendations based on the above results would be to focus on early detection, careful monitoring, and treatment of perinatal morbidities/complications that arise from maternal hypertensive disorders postpartum. As mentioned previously, *Helping Babies Breathe* seeks to recognize and treat babies that develop birth asphyxia during the birthing process. This is especially important as birth asphyxia is a major perinatal complication from maternal hypertensive disorders. A continuation of this program throughout Tanzania will continue to provide better health outcomes for these neonates.

There are some gaps in the current literature in that there is very little information on hypertensive disorders in pregnancy and specifically how they are associated with perinatal mortality in Tanzania. This literature is well developed higher resources countries, such as the United States where these types of disorders are more prevalent. More research is warranted in sub-Saharan African to capture contextual information about social determinants and barriers specific to this population.

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