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Annual distribution of births and deaths outcomes at Harare Maternity Hospital, Zimbabwe

SA FERESU

Abstract

Objectives: To assess socio-demographic and reproductive/obstetric risk factors for stillbirth, preterm births and low birth weight (LBW). To explore the probability of death at birth by antenatal care attendance, and by delivery with a Caesarean section.
Design: Using information available in obstetric records, we conducted a retrospective analysis of data, covering a twelve month period.
Setting: Harare Maternity Hospital, Zimbabwe
Subjects: All deliveries (17,174 births) occurring from October 1997 to September 1998
Main Outcome Measures: Stillbirth, preterm births and LBW.
Results: The annual stillbirth rate was 57 per 1,000, preterm birth 215 per 1,000 and LBW was 243 per 1,000 total births. Women delivering stillbirths, preterm births and LBW infants were less likely to attend antenatal care (adjusted relative risk [RR] = 2.56 95% confidence intervals [CI]: 2.18 to 3.00, RR = 3.02 95% CI: 2,77 to 3.29, and RR = 2.38; 95% CI: 1.58-3.60), or to be delivered by Caesarean section (RR = 0.61; 95% CI: 0.49 to 0.76, RR = 0.68; 95% CI: 0.61 to 0.76 and RR = 0.82; 95% CI: 0.75 to 0.90), but more likely to deliver a breech (RR = 3.17; 95% CI: 2.62 to 3.85, RR = 4.16; 95% CI: 3.72 to 4.64 and RR = 5.34; 95% CI: 4.88 to 5.85), respectively. Stillbirths were more likely to be a preterm birth (RR = 6.53; 95% CI: 5.65 to 7.79) or a LBW infant (RR = 6.42; 95% CI: 5.49 to 7.52).
Conclusion: The annual frequency of poor birth outcomes at Harare Maternity Hospital, which is a referral hospital, also catering for a proportion of patients coming from distant health centers and from rural areas, is high. This high prevalence of birth outcomes is associated with lack of prenatal care, and breech delivery. Infants born too early or small have an increased risk of mortality. Early prenatal care, improved obstetric care, accessibility to care, use of emergency care services, and early access to Caesarean section, could save life, and could assist in reducing the frequency of poor birth outcomes in this population.

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Introduction

Information on frequency and distribution of adverse birth outcomes is important for planning of maternal and child health care services world-wide, and knowledge of local patterns of morbidity and mortality is essential for improving antenatal and obstetric care. Perinatal mortality remains a challenge in the care of

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pregnant women worldwide, particularly in developing countries.[1-5] Stillbirths, who form the highest number of perinatal deaths, are both common and devastating, and in developed countries, about one third has been shown to be of unknown or unexplained origin.[6-7] The stillbirth rate is an important indicator of the quality of antenatal and obstetric care.[2-4, 8-10] Understanding the distribution of stillbirths helps to identify the quality of antenatal and obstetric care available to the pregnant women and to prioritize intervention strategies appropriately. Few studies from Zimbabwe[2,3,11,12] have examined frequency of perinatal mortality and how this outcome varies across important demographic subgroups.

In Zimbabwe, perinatal mortality remains unacceptably high. In Harare, the capital city, perinatal mortality declined from 83/1,000 in 1978, to 34/1,000 in1984 and is on the increase again.[13-14] In 1983, an audit of all births occurring within the Greater Harare Maternity Unit (GHMU), which comprises of Harare Maternity Hospital (HMH) and the 12 municipal clinics in Harare, estimated perinatal mortality to be 34.5/1,000 births, with immaturity the leading cause of perinatal mortality, accounting for 19.3% of perinatal deaths.[15] By 1989, perinatal mortality had risen to 47/1,000.[13-14] Iliff and Kenyon[13-14] estimated that an increase in the number of mortality from preterm births accounted for about half this increase. In the same study, stillbirth rate was estimated to be 26/1,000. More recent studies estimated the frequency of stillbirth at HMH to be 57/1,000,[2-3] which, using conservative assumptions, translates to 33/1,000 for the GHMU. Prevention of perinatal deaths is crucial, particularly for those associated with LBW and prematurity. Intuitively infants who are born early or small have increased risk of morbidity and mortality.[2-5,15]

The frequency of LBW and preterm are often used as indicators of the risk of perinatal death including stillbirths.[1-3,11,12] Previous studies in developing countries have shown that LBW frequently results from intrauterine growth restriction, whereas studies in developed countries, especially those countries with low LBW rates, have shown that LBW is primarily attributable to preterm birth.[1,16,17] Few studies in Zimbabwe have examined the frequency of stillbirths, preterm and LBW births, or evaluated the risk factors associated with these poor birth outcomes.[2-5,11,12,18] In this study, we assessed the contribution of socio-demographic and reproductive/obstetric risk factors to the frequency of stillbirth, preterm and LBW births over a one-year period at HMH, in Zimbabwe. We further explored the probability of death if mother had not attended antenatal care, by gestational age, and the probability of death for a given birth weight by delivery with a Caesarean section (C/Section).

Materials and Methods

All births which occurred between October 1997 and September 1998 were abstracted from obstetric records for women delivering at Harare Maternity Hospital, the largest referral hospital in Zimbabwe. The study methods have been described elsewhere.[2-3] Briefly, for each birth, information was abstracted on month of delivery, date of birth; residential area of the woman (rural/urban); whether the mother attended prenatal care or not; maternal age and parity; estimated gestation; birth weight; sex and vital status of the baby at birth; whether the infant was a single or multiple delivery; and the type of delivery. A woman was considered as "booked" when she had received any antenatal care during her pregnancy, and as "unbooked" otherwise. Parity was the number of previous pregnancies ending after 20 completed weeks of gestation including stillbirth (categorized as 0, 1 to 2, and more than 2 pregnancies). Type of delivery denoted whether the infant was delivered vaginally presenting as cephalic, face to pubis or breech, vaginally with instrumental assistance, or by C/Section.

Eligibility criteria for this study was based on the WHO definition of viability, that is, a birth weight of 500 or more grams and born at 20 or more weeks of gestation.[19] Births without information on vital status were excluded. A stillbirth was defined as intrauterine death of a fetus weighing at least 500 g rams after 20 completed weeks of gestation occurring before the complete expulsion or extraction from its mother.

Gestational age at birth was estimated by the number of days between the first day of the last menstrual period (LMP) and date of birth expressed in completed weeks after LMP, and assessed by obstetrician/midwife as recorded in the maternity delivery record. Preterm birth was defined as a birth occurring at or before 37 completed weeks of gestation. A post-term birth was defined as a birth occurring after 44 weeks of gestation. Birth weight was defined as the first measurement of body weight, usually in the first hour of life, measured to the nearest gram. A LBW birth was defined as the birth of an infant weighing less than 2,500 grams at birth irrespective of gestational age. We also defined three LBW subgroups; term LBW birth, preterm LBW birth and very LBW birth defined as infants weighing below 1,500 grams. A high birth weight birth, based on the upper 10^{th} percentile of our birth weight distribution, was defined as the birth of an infant weighing above 3,500 grams. The study was approved by the University of Michigan Institutional Review Board and the Medical Research Council of Zimbabwe, and permission to conduct the study was obtained from the Ministry of Health in Zimbabwe, HMH and from the Harare City Health Department.

On average between 50 to 60 deliveries occurred daily. We excluded 32 (0.2%) births below 20 weeks of gestation, 68 (0.4%) that did not have information on vital status, 78 (0.4%), that weighed below 500 grams at birth, 795 (4.4%) that had missing information on birth weight or estimated gestation, and one birth that had an estimated gestation of 48 weeks but a recorded birth weight of only 3,295 grams, leaving 17,174 births for this analysis.

Statistical Analysis.

The frequency of monthly deliveries and whether they were stillborn, preterm birth or LBW births were calculated. Distributions were also calculated by gestational age, LBW and combined birth weight and gestational age categories. To examine predictors of the risk of poor birth outcomes including preterm birth, LBW or a combination of both facets, cross-tabulations were examined using chi-square tests of homogeneity. Cross tabulations were also examined for the risk poor birth outcomes by demographic and reproductive factors. In the unadjusted analyses, relative risks (RR) and 95% confidence intervals (CI) were calculated for each demographic and reproductive risk factor using EPINFO 2000. All eligible births were included in these analyses.

Generalized linear regression models with a complimentary log-log link function were used to model each outcome, adjusting for maternal characteristics and relative risks and 95% confidence intervals were calculated. All possible interactions were evaluated individually, and significant and meaningful interactions were included as relevant. We fitted logistic regression models to calculate probability of adverse events for some of the observed interactions. Data were analyzed using Statistical Analysis Software [(SAS) Institute Inc., Cary, NC, USA] version 9.1.

Results

Of the 17, 174 births remaining in the analysis 986 (5.7%) were stillbirths, 3,338 (21.5%) were preterm births and 3,909 (24.3%) were LBW. Deliveries were evenly monthly distributed over the period of one year presented (Table 1).

Table I: Monthly distribution of deliveries at Harare Maternity Hospital by birth outcomes; October 1997 to September 1998.

	Total Births		Stillbirths		PTD[a]		LBW[b]	
	n	(%)[c]	n	(%)	n	(%)	n	(%)
January	1463	8.5	73	0.4	303	1.9	330	2.0
February	1255	7.3	58	0.3	283	1.8	280	1.7
March	1453	8.4	90	0.5	292	1.9	346	2.2
April	1333	7.8	68	0.4	261	1.7	331	2.1
May	1484	8.6	80	0.5	310	2.0	368	2.3
June	1455	8.5	84	0.5	267	1.7	330	2.0
July	1402	8.1	81	0.5	259	1.7	332	2.1
August	1404	8.2	98	0.6	283	1.8	327	2.0
September	1488	8.7	84	0.5	233	1.5	284	1.8
October	1492	8.7	90	0.5	236	1.5	304	1.9
November	1443	8.4	75	0.4	276	1.8	324	2.0
December	1502	8.8	105	0.6	335	2.2	353	2.2
Total	**17,174**	**100**	**986**	**5.7**	**3,338**	**21.5**	**3,909**	**24.3**

a PTD, is preterm delivery, born after 20 weeks, and before 37 weeks of gestation
b LBW, is low birthweight babies weighing 500 to less than 2,500grams at birth
c % denotes percentage of total births for that month.

The highest percentage of deliveries was in December 1997, while the lowest percentage was in February 1998. Most stillbirths occurred in December, and least stillbirths occurred in February. Preterm births were more frequent in December, and so were LBW births. Preterm births were least frequent in April while, LBW births were least frequent in February.

Table 2 shows the risk of stillbirth by demographic and obstetric characteristics. Infants born to mothers aged below 20 years were less likely to be stillborn, while those born to mothers aged above 35 years were more likely to be stillborn in both crude and adjusted analysis. Infants born to mothers who resided in rural residence, were more likely to be stillborn, as were infants born to mothers who had not attended antenatal care clinics. Infants delivered as breech were more likely to be stillborn, while infants delivered by C/Section were less likely to be stillborn. Estimates remained significant in adjusted analysis. Mothers who were having their first baby were less likely to deliver a stillborn in crude analysis only. There was no difference in stillbirth by sex of infant, or whether it was a multiple or singleton delivery, or instrumental or face to pubis delivery.

Table II: Demographic and obstetric characteristics of risks of stillbirth for deliveries at Harare Maternity Hospital; October 1997 to September 1998.

	Total births		Stillbirths		Crude Relative Risk (95% CI[§])	Adjusted*[†] Relative risk (95% CI[§])
	n	(%)	n	(%)		
Total	17,174		986	5.7		
Mother's age						
Below 20	3,492	20.4	153	4.4	**0.75 (0.63 - 0.89)**	**0.74 (0.60 - 0.90)**
20 to 35	12,407	72.6	722	5.8	Reference	Reference
Above 35	1,187	7.0	103	8.7	**1.49 (1.22 - 1.82)**	**1.39 (1.06 - 1.83)**
Infant sex						
Male	8,595	51.7	478	5.6	1.04 (0.92 - 1.18)	1.07 (0.93 - 1.22)
Female	8,025	48.3	428	5.3	Reference	Reference
Residence						
Urban	14,666	85.9	817	5.6	Reference	Reference
Rural	2,414	14.1	167	6.9	**1.24 (1.06 - 1.46)**	**1.27 (1.05 - 1.53)**
Booking status (Antenatal care)						
Booked (At least one vi)	15,210	89.3	747	4.9	Reference	Reference
Unbooked (No ante	1,821	10.7	227	12.5	**2.54 (2.21 - 2.92)**	**2.56 (2.18 - 3.00**
Parity						
Para 0	7,646	44.7	383	5.0	**0.83 (0.73 - 0.95)**	1.00 (0.85 - 1.18)
Para 1-2	6,610	38.7	398	6.0	Reference	Reference
Para above 2	2,836	16.6	199	7.0	1.17 (0.99 - 1.37)	0.98 (0.79 -1.21)
Gestation type						
Singleton	16,115	93.8	930	5.8	Reference	Reference
Multiple	1,059	6.2	56	5.3	0.92 (0.70 - 1.19)	0.86 (0.65 - 1.14)
Delivery type						
Normal vaginal delivery	12,737	74.4	683	5.4	Reference	Reference
Breech	805	4.7	144	17.9	**3.34 (2.83 - 3.93)**	**3.17 (2.62 - 3.85)**
Caesarean section	2,993	17.5	93	3.1	**0.58 (0.47 - 0.72)**	**0.61 (0.49 - 0.76)**
Face to pubis	203	1.2	8	3.9	0.73 (0.37 - 1.46)	0.85 (0.42 - 1.70)

* *model 1 adjusted for all parameters shown except for gestation type; and model 2 for gestation type adjusted for age, sex, residence antenatal care and parity.*
† *models are significant at p=<0.00.*
§ *Abbreviations: CI = confidence intervals.*
a *% denotes percentage of total births.*
b *88 births are missing information on mother's age.*
c *554 births are missing information on sex.*
d *94 births are missing information on residence of mother.*
e *143 births are missing information on prenatal care.*
f *82 births are missing information on parity.*

Table III shows the risk of preterm birth by demographic and obstetric characteristics. Compared to mothers who resided in urban areas, mothers who resided in rural areas were more likely to deliver a preterm infant. There was an increased risk of preterm births for mothers who did not attend antenatal care compared to those who did. Multiple births had a 3-fold increase in risk of being born preterm. Infants delivered as breech were more likely to be born preterm, while infants delivered by C/section or by instrumentation were less likely to be born preterm. The estimates remained significant in adjusted analysis. Mothers who were having their first baby were less likely to deliver a preterm infant, and male infants were less likely to be preterm in crude analysis only. There was no difference in preterm birth by mother's age, and parity above two.

Table III: Demographic and obstetric characteristics risks of preterm birth for deliveries at Harare Maternity Hospital; October 1997 to September 1998.

	Total births		Preterm births		Crude Relative Risk (95% CI[§])	Adjusted*[†] risk relative (95% CI[§])
	n	(%)	n	(%)		
Total	**17,174**		**3,338**	**21.5**		
Mother's age						
Below 20	3,148	20.0	696	22.1	1.04 (0.97 - 1 .12)	1.05 (0.94 - 1.16)
20 to 35	11,248	72.8	2,390	21.3	Reference	Reference
Above 35	1,060	6.8	232	21.9	1.03 (0.91 - 1.16)	0.97 (0.82 -1.14)
Infant sex						
Male	7,894	52.5	1,609	20.4	**0.93 (0.87 - 0.99)**	0.95 (0.89 - 1.03)
Female	7,131	47.5	1,565	22.0	Reference	Reference
Residence						
Urban	13,302	86.1	2,818	21.2	Reference	Reference
Rural	2,148	13.9	500	23.3	**1.10 (1.01 - 1.19)**	**1.18 (1.07 - 1.31)**
Booking status (Antenatal care)						
Booked (at least one visit)	13,777	89.4	2,518	18.3	Reference	Reference
Unbooked (no antenatal care)	1,629	10.6	780	47.9	**2.62 (2.46 - 2.79)**	**3.02 92.77 - 3.29)**
Parity						
Para 0	7,646	44.7	6,910	20.3	**0.90 (0.84 - 0.96)**	**0.90 (0.83 -0.99)**
Para 1-2	6,610	38.7	5,981	22.6	Reference	Reference
Para above 2	2,836	16.6	2,569	21.9	0.97 (0.89 - 1.06)	0.97 (0.86 - 1.09)
Gestation type						
Singleton	14,810	95.3	2,907	19.6	Reference	Reference
Multiple	725	4.7	431	59.5	**3.03 (2.83 - 3.24)**	**4.16 (3.72 - 4.64)**
Delivery type						
Normal vaginal delivery	11,571	74.7	2,462	21.3	Reference	Reference
Breech	655	4.2	381	58.2	**2.73 (2.54 - 2.94)**	**3.34 (2.97 - 3.76)**
Instrumental	375	2.3	39	10.9	**0.51 (0.38 - 0.69)**	**0.47 (0.33 - 0.66)**
Caesarean section	2,716	17.6	389	14.3	**0.67 (0.61 - 0.74)**	**0.68 (0.61 - 0.76)**
Face to pubis	184	1.2	42	22.8	1.07 (0.82 - 1.40)	1.06 (0.77 - 1.48)

* *model 1 adjusted for all parameters shown except for gestation type; and model 2 for gestation type adjusted for age, sex, residence antenatal care and parity.*
† *models are significant at p=<0.00*
§ *Abbreviations: CI = confidence intervals*

Table IV 4 presents the risk of LBW birth by demographic and obstetric characteristics. Male infants were less likely to be LBW compared to female infants. Compared to mothers who resided in urban areas, mothers who resided in rural areas were more likely deliver a LBW infant, as were mothers who did not attend antenatal care. Multiple births had a 3.3-fold increase in risk of being LBW. Infants delivered as breech were more likely to be LBW, while infants delivered by C/Section or by instrumentation were less likely to be LBW. The estimates remained significant in adjusted analysis. Mothers who were having their first baby were less likely to deliver a LBW infant in crude analysis only.

Similar to preterm birth, there was no difference in LBW birth by mother's age, and parity above two.

Table IV: Demographic obstetric characteristics risks of low birth weight for deliveries at Harare Maternity Hospital : October 1997 to September 1998.

	Total births n	(%)	Low Birth Weight n	(%)	Crude Relative Risk (95% CI§)	Adjusted*† risk relative (95% CI§)
Total	**17,174**		**3,909**	**24.3**		
Mother's age						
Below 20	3,266	20.4	814	24.9	1.04 (0.97 - 1 .11)	1.03 (0.93 - 1.13)
20 to 35	11,653	72.7	2,795	24.0	Reference	Reference
Above 35	1,107	6.9	279	25.2	1.05 (0.94 - 1.17)	1.06 (0.91 - 1.23)
Infant sex						
Male	8,055	51.7	1,770	22.0	**0.84 (0.79 - 0.89)**	**0.85 (0.79 - 0.90)**
Female	7,539	48.3	1,973	26.3	Reference	Reference
Residence						
Urban	13,772	86.0	3,288	23.9	Reference	Reference
Rural	2,245	14.0	597	26.6	**1.11 (1.03 - 1.20)**	**1.20 (1.09 - 1.31)**
Booking status (Antenatal care)						
Booked (at least one visit)	14,284	89.4	3,025	21.2	Reference	Reference
Unbooked (no antenatal care)	1,690	10.6	841	49.8	**2.35 (2.22 - 2.49)**	**2.70 (2.48 - 2.93)**
Parity						
Para 0	7,193	44.9	1,683	23.4	**0.92 (0.87 - 0.98)**	0.95 (0.88 - 1.03)
Para 1-2	6,204	38.7	1.572	25.3	Reference	Reference
Para above 2	2,635	16.4	629	23.9	0.94 (0.87 - 1.02)	0.90 (0.80 - 1.00)
Gestation type						
Singleton	15,102	93.8	3,199	21.2	Reference	Reference
Multiple	1,004	6.2	710	70.7	**3.34 (3.17 - 3.51)**	**5.34 (4.88 - 5.85)**
Delivery type						
Normal vaginal delivery	11,885	74.0	2,776	23.4	Reference	Reference
Breech	765	4.8	491	64.2	**2.75 (2.54 - 2.92)**	**3.61 (3.25 - 4.01)**
Instrumental	353	2.2	35	9.9	**0.42 (0.31 - 0.58)**	**0.41 (0.29 - 0.57)**
Caesarean section	2,864	17.8	537	18.8	**0.80 (0.74 - 0.87)**	**0.82 (0.75 - 0.90)**
Face pubis	189	1.2	47	24.9	1.06 (0.83 - 1.37)	1.12 (0.84 - 1.51)

* ***model 1 adjusted for all parameters shown except for gestation type; and model 2 for gestation type adjusted for age, sex, residence antenatal care and parity.***
† ***models are significant at p=<0.00***
§ ***Abbreviations: CI = confidence intervals***

Table V8 presents the distribution of deliveries by birth outcomes. Among preterm infants, 2,160 (64.7%) were between 32 and less than 37 weeks of gestation, 691 (20.7%) were between 28 and less than 32 weeks of gestation, while 487 (14.6%) were between 20 and less than 28 weeks of gestation. Only 32 (0.2%) of all births were post term births. For births which were examined by both birth weight by gestational age, 1,607 (9.4%) were term and weighed less than 2,500 grams (term LBW); 2,303 (13.4%) were preterm weighing less than 2,500 grams (preterm LBW); 1,036 (6%) were preterm weighing more than 2,500 grams (preterm no LBW); while 1,837 (10.7%) were high birth weight births, term and weighing more than 3,500 grams. A total of 948 (5.5%) of all births were very preterm, weighing less than 1,500 grams.

Table V: Distribution of deliveries at Harare Maternity Hospital by birth outcomes: October 1997 to 1998.

Total Births	n	(%)[a]
Vital status		
Live births	16,188	94.3
Stillborn	986	5.7
Gestational age categories		
Term	13,836	78.5
All pre-term < 37 weeks	3,338	21.5
Preterm categories		
≥32 to <37 weeks	2,160	64.7
≥28 to <32 weeks	691	20.7
≥20 to <28 weeks	487	14.6
Post term >44 weeks	32	0.2
Low birth weight categories		
<2,500 grams	13,265	77.2
>2,500 grams	3,909	22.8
Birth weight categories by gestational age		
Term normal birth weight[b]	10,368	60.5
Term <2,500 grams	1,607	9.4
Term >3,500 grams	1,837	10.7
Pre-term ≥2,500 grams	1,036	6.0
Pre-term <2,500 grams	2,302	13.4
Pre-term <1,500 grams[c]	948	5.5

a *percent of total births for vital status, gestational age categories, post-term births, low birth weight births, and pre-term <1,500 grams; percent of subset for preterm categories and birth weight categories by gestational age.*
b *births 2500 to 3500 grams ,and gestation 37 to <45 weeks.*

Table VI shows the risk of being stillbirth for preterm and low birth weight deliveries. As expected, all preterm births, irrespective of gestational age were more likely to be stillborn, with the risk increasing with decreasing gestational age. Similarly, LBW births were more likely to be stillborn. The trend remained the same for births examined by both birth weight and gestational age, and also in adjusted analysis, except for high birth weight births.

Table VI: Risks by birth weight and gestational age categories for deliveries at Harare Maternity Hospital: October 1997 to September 1998.

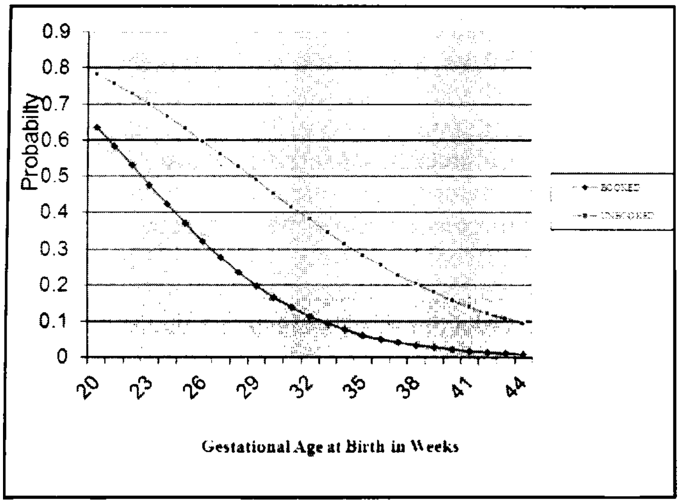
	Total births		Stillbirths		Crude relative* risk (95% CI§)	Adjusted*† relative risk (95% CI§)
	n	%	n	%		
All births	17,174		986	5.7		
Gestational age categories						
Term	12,197	78.5	3,338	2.4	Reference	Reference
All pre-term <37 weeks	3,338	21.5	2,160	17.2	**7.16 (6.25 - 8.20)**	**6.53 (5.65 - 7.79)**
≥32 to <37 weeks	2,160	15.0	211	9.8	**4.11 (3.46 - 4.88)**	**3.75 (3.07 - 4.58)**
≥28 to <32 weeks	691	5.4	172	24.9	**10.47 (8.81 - 12.44)**	**11.03 (8.80 - 13.81)**
≥20 to <28 weeks	487	3.8	185	38.0	**15.98 (13.16 - 18.76)**	**20.32 (15.91 - 25.95)**
Post term >44 weeks	32	0.3	1	3.1	1.31 (0.19 - 9.08)	1.75 (0.25 - 12.52)
Birth weight categories						
All births ≥2500 grams	12,197	75.7	290	2.4	Reference	Reference
All births <2500 grams	3,909	24.3	628	16.1	**6.76 (5.91 - 7.73)**	**6.42 (5.49 - 7.52)**
Birth weight categories by gestational age						
Term normal birth weight	10,368	60.4	10,125	2.3	Reference	Reference
Term <2500 grams	1,607	13.4	127	7.9	**3.37 (2.74 - 4.15)**	**3.34 (2.65 - 4.22)**
Term >3500 grams	1,837	15.1	48	2.6	1.11 (0.82 - 1.51)	0.93 (0.65 - 1.33)
Pre-term ≥2500 grams	1,036	9.1	67	6.5	**2.76 (2.12 - 3.59)**	**2.43 (1.79 - 3.28)**
Pre-term <2500 grams	2,302	18.2	501	21.8	**9.29 (8.02 - 10.75)**	**8.95 (7.50 - 10.67)**

* ***adjusted for maternal age, sex, residence, booking status, parity and type of delivery in all models.***
† ***models are significant at p=<0.00.***
§ ***Abbreviations: CI = confidence intervals.***
a ***Reference group for gestational age comparisons includes births gestation 37 to <45 weeks and birth weight 2500 grams.***
b ***Reference group includes term births, gestation 37 to <45 weeks.***
c ***Reference group for birth weight categories comparisons includes births 2500 to 3500 grams, and gestation 37 to <45 weeks.***

Probability of stillbirth by prenatal care, mode of delivery and birth weight.

Two clinically significant interactions for the risk of stillbirth were present. One interaction was between booking status and gestational age. We explored this interaction further in a model where gestational age was treated as a continuous variable. Fig.1 depicts the probability of stillbirth by gestational age for booked and unbooked mothers. Each week of increase in gestational age decreased the log odds of stillbirth by 0.095 such that the probability of delivering a stillborn infant at 28 weeks was 23%, at 32 weeks 11%, at 36 weeks 5%, and at 40 weeks was 2%. Overall, unbooked mothers had a higher probability than booked mothers of stillbirth at all gestational ages, but the difference in risk for unbooked mothers was much higher in pre-term than in term births.

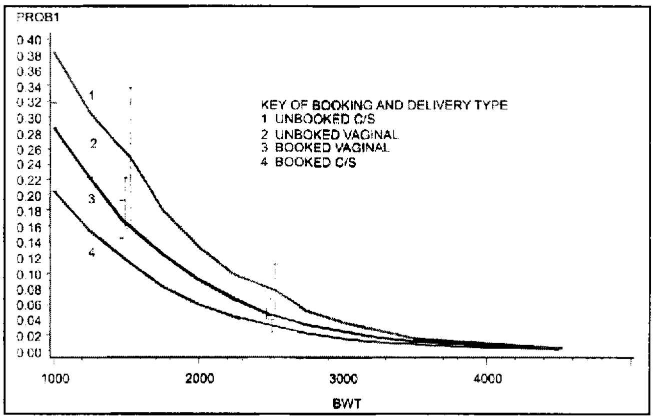
Figure I: Probability os stillbirth by gestational age and booking status, for deliveries at Harare Maternity Hospital: October 1997 to September 1998.



Probability of stillbirth by prenatal care, mode of delivery and birth weight.

The second interaction was between booking status, delivery by C/section and birth weight. Fig. 2 depicts the probability of stillbirth at each birth weight for C/section and vaginal births by booking status. Unbooked mothers who delivered by C/section had the highest probability of stillbirth, while booked mothers who delivered by C/section had the lowest probability of stillbirth. The difference in risk was most extreme among LBW births. At both 1500 and 2500 grams, the risk for booked patients delivered by C/section was significantly lower than the risk for all other groups of women. Conversely, for mothers who had a normal vaginal delivery, the difference in risk of stillbirth between booked and unbooked was minimal.

Figure II: Probability of stillbirth by gestational age and booking status, for deliveries at Harare Maternity Hospital: October 1997 to September 1998.



Discussion

This paper describes the distribution of poor birth outcomes including stillbirth, preterm birth and LBW among mothers giving birth at the largest hospital serving Harare, Zimbabwe. Our results suggest that a considerable number of infants were stillborn, born preterm, and were LBW, suggesting a need for early detection of risk factors of these conditions in a timely manner and a need for improved obstetric care and availability of emergency services during the delivery period. Lack of prenatal care was associated with increased risk of stillbirth, with the risk for unbooked mothers particularly high for preterm births and LBW infants. Stillbirths, preterm births and LBW infants were more likely to be delivered breech, but less likely to be delivered by C/Section. Earlier access to C/Section appears to protect against stillbirth in this population. Rural residence and breech delivery also increased the risk of having these poor birth outcomes.

The incidence of stillbirth was high, 57 per 1,000 total births. Because HMH is a referral hospital, this estimate is higher than the 26 per 1,000 total births reported by Iliff and colleagues using 1989 data from HMH and 9 Harare city municipal clinics,[13,14] and higher than the 45 per 1,000 live births at Mpilo Maternity Hospital.[15] Our findings differ from previous Zimbabwean studies because frequency and risk estimates from HMH the largest referral center in this country, are expected to be higher than that for the general population. When we recalculate our rates based on the number of deliveries in the GHMU, 57% of which occur at HMH,[2,3,20] and assuming no stillbirths occurred in the clinics, we estimate a population based stillbirth rate of 33 per 1,000 total births, a figure comparable to that reported by Iliff and colleagues. The similarities in stillbirth rates over time, raises questions whether there has been improvements in stillbirth rates in the last 10 to 20 years.

The annual frequency of preterm births at this institution was 215 per 1,000 total births, and LBW was 243 per 1,000 total births. The LBW is higher than that reported by Illif *et.al*[13,14] calculated as 181 per 1,000 total births, because the study also included 3 municipal clinics which are part of the 9 maternity clinics served by HMH, so did not only reflect referral hospital estimates. Our LBW rates estimates are similar to other African countries rates, 212 per 1,000 for Mali, 124 per 1,000 for Togo and 116 per 1,000 for Nigeria.[20,21] Although the problem of preterm births is gaining recognition in developed countries, [22,23] the focus in developing countries remains almost exclusively on LBW. LBW is often used as a proxy for preterm births in these nations. [1,24-26] LBW is considered to be one of the leading causes of stillbirths and perinatal mortality.[23-27] The relative contribution of preterm births has not been clearly defined. Besides our group work, [2,3] little has been done in Zimbabwe on frequency of preterm births and its association with stillbirth. The importance of gestational age as a risk factor for stillbirths has been suggested by a few other studies in Zimbabwe[1-3, 13, 14, 25] and in other developing countries.[9,26-28]

In this study, gestational age and birth weight are independent but correlated risk factors of stillbirth. It is conceivable that infants who are born too early or too small have increased risk of mortality, and the risk increases as gestational age and birth weight decrease.[2-5,25] It has been argued that stillbirth increases with increasing gestational age.[1,3,6,29] Paradoxically, gestational age may be overestimated for macerated stillbirth, as the time of death is not usually precisely identifiable[1,3,6,29] and may be underestimated for LBW birth as the fetus may have lost weight after death.[6,29] In this paper we did not distinguish fresh and fresh macerated stillbirths, thus the birth weight could be influenced by the maceration process. Arguably, it is difficult to establish a causal pathway between prematurity and stillbirth, as death of an infant may precede preterm birth.[2,3] However, the proposition that prematurity is independently associated with stillbirth is conceivable but needs further exploration. These data therefore confirm the adverse relationship between prematurity, LBW, and high perinatal mortality, consistent with other studies.[2-4,26-28]

As would be expected, lack of prenatal care was consistently and strongly associated with each of the birth outcomes we examined, similar to what has been reported by other studies.[9,30-34] Of critical relevance for Maternal and Child Health programs is the finding that the risk of stillbirth associated with prematurity was higher among unbooked than among booked mothers, even after adjustment for gestational age. These data suggest that prenatal care may help ensure that interventions occur in a timely manner. A caviar to this finding has to do with timing of prenatal care which is typically 28 weeks,[35] and women may tend to present at natal services because they are in preterm labour, otherwise they might have not or would have later in their pregnancy, thus late booking is a big issue for this population. Also, stillbirth or preterm delivery may occur before anticipated birth date of first date of first ANC attendance. Of the booked mothers, 53 of the mothers delivering an infant who was neither preterm, low birthweight nor stillborn booked after 38 weeks of gestation. Although the association between lack of prenatal care and adverse birth outcomes has been established,[2-318,30-32] we however do not have a full universe of women delivering at hospital and home to solidify the lack of prenatal care evidence.

Stillbirths were less likely to be delivered by C/Section, and earlier access to C/Section appeared to protect against stillbirth. Infants of unbooked mothers who were delivered by C/Section were more likely than infants of booked mothers to be stillborn, particularly among preterm births. This finding suggests that either emergency C/Section is occurring too late to save the infant of unbooked women or that the unbooked women may have sought care because they could not feel fetal movements.[2, 3] The finding that preterm and LBW births were less likely to be delivered by C/Section or by instrumentation is conceivable, as the baby may be too small, to warrant such interventions, particularly if the baby died in utero.

Stillbirths, preterm and LBW births were likely to be delivered breech. This finding may be more related to preterm infants and would be consistent with the clinical observation that the infants turn to optimal birth presentation at about 34 weeks of gestation. Intuitively, infants that are at risk because of their small size and immaturity are likely to face the additional risk of breech presentation. As expected, multiple pregnancies were likely to be delivered as preterm and LBW infants.[2,3,18,36,37] Younger mothers were less likely to, while older mothers were more likely to deliver stillbirths, consistent with other studies[38-42] and suggesting the possibility of the role played by maternal chronic disease conditions in later years of life. Rural residence was associated with all the poor birth outcomes in this study. This finding may suggest poor access to antenatal care, about 11% of unbooked mothers resided in rural areas, and a substantial risk was linked to birth outcomes (RR = 2.37; 95% CI: 1.64 to 3.42 for stillbirth, RR = 1.94; 95% CI: 1.60 to 2.36 for preterm births and RR = 1.87; 95% CI: 1.57 to 2.22 for LBW infants). Harare Central Hospital being the major referral hospital in Zimbabwe, therefore, mothers with other obstetric and medical complications are referred because they need complex care, which may also be contributory to higher frequency of poor birth outcomes in this group, about 806 mothers were rural based patient referred to Harare Maternity Hospital.

Several constraints and potential biases of this study must be considered. Because this study was a retrospective analysis of data obtained from delivery logs, we were unable to examine other risk factors such as chronic and comorbid conditions, congenital malformations, obstetric complications and infections. Arguably, focusing solely on births within Harare Maternity Unit raises concerns about selection bias, our findings overestimate the rate of adverse birth outcomes in the general population. However when we adjust the rate to the GHMU, our rates are comparable to those previously reported.[2,3,13-15,18,20,24] More population based studies are needed to give more accurate distributions in urban Harare. Information on gestational age based on last menstrual period was limited to that recorded in the obstetric log which was clinicians' estimation, thus some error in the classification of pre-term births is likely.[43-45] Thus, these results are a rough estimate of the delivery experience at Harare maternity Hospital, and overestimates rates in the general population. Nonetheless, this study reports the joint distributions of adverse birth outcomes by maternal demographic characteristics, and reports the probability of stillbirth by gestational age and birth weight in this urban population. The results are of critical importance to public health practice and will help to gain insights of the nature of the poor birth outcomes problem in Zimbabwe. The results will be useful for generating hypotheses for future studies in this field, as well as guiding policy in training of health personnel and planning for health care services at health institutions.

Conclusions

Our findings suggest that a considerable number of adverse birth outcomes could be substantially avoided if women attend antenatal care in the first or early second trimester. Zimbabwean women enter prenatal care late in pregnancy, booking at 28 weeks or later.[2,3,18,35] Increased focus on health education programs which emphasize the benefits of booking in the first trimester at 20 weeks of pregnancy or earlier are needed. Earlier booking would enable screening for medical and obstetric complications, and allow for early interventions and treatment of infections in pregnancy. In addition, earlier booking for antenatal care creates a critical linkage between the woman and the health care system, which may increase the probability that she will seek emergency care in a timely manner. More comprehensive antenatal care coverage is likely to reduce perinatal mortality. In addition, a better understanding of the determinants of pre-term births is needed as are improved antenatal and obstetric strategies for this particular subset of high risk births. The present study indicates that stillbirth in urban Zimbabwe is largely correlated with pre-term births, and suggests the need to evaluate risk factors beyond the traditional concern of poor nutrition. Other risk factors of poor birth outcomes that may warrant further investigation include chronic co-morbid conditions such as pre-eclampsia/ eclampsia,[46,47] infections including malaria,[48-50] and urinary tract infections,[50,51] syphilis,[9-10,52] chlamydia[54] and HIV infection[51] and(unpublished data Feresu et al.). Further studies should incorporate information from women served by the entire GHMU and given the common inaccuracy in reporting of LMP, should use alternative methods for assessing gestational age, such as the modified Dubowitz or Ballard methods.[41-45] Therefore careful assessment and management of adverse birth outcomes would improve infant mortality and morbidity in Zimbabwe.

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