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Frequency and factors for low birth weight in northern Tanzania: A retrospective cohort study

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Abstract
Background: Low Birth Weight (LBW) is associated with both adverse perinatal outcomes and long term adverse health conditions. The information on LBW remains limited among low and middle income countries. The aim of this study is to determine the frequency and factors associated with LBW among neonates delivered at Kilimanjaro Christian Medical Center (KCMC) in northern Tanzania.
Methodology: This was a hospital-based retrospective cohort study which was conducted using maternally-linked data from KCMC medical birth registry. A total of 8,965 women who delivered singleton infants from 2013-2015 were included. Maternal complications during pregnancy and child information on gestational age, Apgar score as well as birth weight were analyzed. Data analysis was performed using SPSS version 20.0. Multivariable log-binomial regression model was performed. A P-value less than 0.05 was considered statistically significant.
Results: The frequency of LBW was 11.6%. Pre-eclampsia (RR 4.9, 95% CI 3.7-6.6), eclampsia (RR 16, 95% CI 7.2-33), maternal anemia (RR 2.4, 95% CI 1.1-5.4), induction of labor (RR 1.4, 95% CI 1.1-1.8), caesarean-section (RR 1.2, 95% CI 1.0-1.4), PROM (RR 2.0,95% CI 1.2-3.5) and maternal underweight (RR 2.0, 95% CI 1.6-3.6) were significantly associated with LBW. In addition, fetal factors such as preterm birth (RR 12.0, 95% CI 9.9-13) and Apgar score <7 at 5th min (RR 2.0, 95% CI 1.4-2.8) were also associated with increased risk of LBW.
Conclusion: The risk of LBW was extremely higher in the presence of pre-eclampsia, eclampsia and Preterm delivery complications. Screening on the conditions and danger signs during pregnancy should be reinforced to reduce risk of LBW.

Keywords: northern, Tanzania, Retrospective, both, LBW, KCMC

1. Introduction

The World Health Organization defined Low Birth Weight (LBW) as a birth weight of a live born infant of less than 2,500 grams irrespective of the gestational age [1]. Child's birth weight is an important indicator of infant and child survival. LBW is recommended to be measured within the first hour of life before significant postnatal weight loss [1]. A baby's low birth weight is either a result of preterm birth or due to intrauterine restricted fetal growth [2, 3]. The global prevalence of LBW is 16%, which accounts to about 22 million infants born each year [4]. However, there is a considerable variation in prevalence of LBW across regions and within countries [4]. The lowest prevalence of 3% has been reported in China while South-central Asia has reported the highest prevalence of 15% [5, 6]. The proportion of neonates born with LBW in Tanzania has been estimated to be 6.9% [7]. However, the prevalence of LBW in Tanzania, vary across regions ranging from 1% to 12% [7]. Low birth weight is of a significant public health concern in low and middle income countries. It has been associated with 4 to 10 times increased risks of newborn deaths as compared to babies born with normal-weight [4, 7]. LBW has been associated with adverse perinatal outcomes including perinatal asphyxia, prematurity, hypothermia, necrotizing Enterocolitis, Respiratory Distress Syndrome (RDS), neonatal jaundice, anaemia, low Apgar score at 1st and 5th Minutes and perinatal mortality [8-10]. It has also been associated with long term adverse health conditions such as coronary heart disease, stroke, hypertension, type 2 diabetes mellitus and recurrence of low birth weight in the offspring [11, 12]. Numerous factors have been associated with LBW including complications during pregnancy such as pre-eclampsia and eclampsia, chronic hypertension, maternal anemia, malaria during pregnancy, placenta abruption, Premature Rapture of Membrane (PROM), placenta Previa, maternal HIV, induced labor, delivery by caesarean section, smoking and excessive alcohol use during pregnancy, diabetes mellitus and obesity [8,13-15]. Other determinants of LBW include extremes of maternal age, residing in rural areas, poor maternal education, poor economic status as well as singleness [8, 9, 13-22]. Contrary to the high income countries, the burden of low birth weight in low and middle income countries is likely to have been underestimated [1]. The primary reason for underestimation of LBW prevalence is that in most developing countries there are prevalent home deliveries without skilled attendants and deliveries in primary health centers where babies are rarely weighed and records are poorly kept [4]. This study is aimed to determine the frequency and factors associated with low birth weight in Northern Tanzania. Findings from this study will alert clinicians, policy makers and the community to take appropriate measures towards reducing the burden of LBW.

2. Methodology

2.1 Study Design and Area

This was a hospital-based retrospective cohort study which was conducted using medical birth registry data from Kilimanjaro Christian Medical Centre (KCMC) in Moshi, northern Tanzania. KCMC is a referral and teaching hospital. It serves over 15.5 million people mainly from Northern Tanzania including Tanga, Kilimanjaro, Arusha, Manyara and Singida regions. On average, the delivery rate at KCMC is 4,000 births per year. The medical birth registry at KCMC was established in 1999 and became operational since 2000. All records and information on each delivery are entered into a computerized medical birth registry database system where each birth is assigned a unique number for registration.

2.2. Study Population

All singleton deliveries that took place at Obstetrics and Gynecology Department of KCMC hospital from 2013 to 2015 with complete birth registry records were considered for analysis. The study excluded all multiple gestations because they have high rate of LBW which could overestimate our findings. The final sample was comprised of 8,965 deliveries which were analyzed.

2.3. Data collection methods and tools

A standardized questionnaire was used by trained midwives whereby all women who delivered at KCMC were interviewed within 24 hours after delivery and incase of cesarean section or any complications requiring recuperation the interview was generally performed as soon as the mother recovered. The informed consent was obtained from the mother prior the interview. The information obtained from interview was collaborated with information from antenatal cards and mother's case file. After completion of the interview, the forms with complete information were taken for data entry into a computerized database system in medical birth registry. The questionnaire had four sections to enable capturing information regarding maternal and neonatal characteristics related to pregnancy and childbirth. The information included maternal socio - demographic characteristics such as age, names, address, birth number, hospital number, date of admission, date of discharge, occupation, level of education, place of residence both childhood residence and current residence and if it was a referral or self-referral, current marital status, mother's tribe and religion. Others included obstetrics history: number of previous pregnancy, regular menstrual periods, ANC visits, Last Normal Menstrual Period (LNMP), family planning history, estimated date of delivery, Maternal health before and during pregnancy such as body weight, body height, Blood transfusions, serious disease, history of smoking, chewing tobacco history of drinking alcohol, regular medical drugs, Blood group, VDR and HIV recorded test, and disease and complications during present pregnancy such as gestation diabetes, diabetes, hypertension, preeclampsia, epilepsy and so forth.

Information concerning delivery such as complication during delivery, premature ruptures of the Membranes, Blood loss, degree of tear, placenta abruption, placenta Previa, placenta retention, ruptures of uterus, Induction of labor, Analgesia and Anesthesia. Also child information included: date of delivery, sex, birth weight, presentation, length, head circumference, status such as stillbirth, Apgar score, mode of delivery, gestation age at delivery and any other related condition.

2.4. Definition of outcome variable

The dependent variable was low birth weight. In this study, the low birth weight was defined as the weight of an infant less than 2,500g with gestational age of ≥28 weeks. The independent variables included maternal socio-demographic characteristics (age, residence, level of education, economic status, marital status as well as body mass index. Information on obstetric characteristics such as pre-eclampsia and eclampsia, anemia, maternal diabetes mellitus, caesarian section and perinatal factors (Apgar score<7 at 1^{st} and 5^{th} minute and preterm birth were also assessed.

2.5. Ethical Consideration

Ethical approval was obtained from Kilimanjaro Christian Medical University College Research Ethics Committee. Permission to use medical birth registry was obtained from KCMC administrative authority. To maintain confidentiality, maternal unique identification number was used instead of the mothers' name.

2.6. Data Analysis

Data analysis was done using SPSS version 20. Descriptive statistics were used to summarize the categorical variables using frequencies and proportions while measures of central tendency and their respective measures of dispersion were used for continuous variables. Relative Risk (RR) with 95% Confidence Interval (CI) for factors associated with LBW were estimated using multivariable log-binomial regression models. A robust error variance was used to take into account the effect of repeated observations/births from the same mother. A p-value of less than 0.05 was considered statistically significant.

3. Results

3.1 Socio-Demographic and Obstetric characteristics of the study participants

A total number of 8,965 deliveries were enrolled in this study for the period 2013-2015. Out of these, 1,031 deliveries had low birth weight. This corresponds to frequency of LBW of 11.5%.The mean age of study mothers was 28 (SD=7.0) years. Majority (74.4%) were aged between 20-34 years. More than half (56.9%) of the study participants were urban dwellers. Majority (85.3%) were married while the rest were either single, divorced, widowed or cohabitating. About two-thirds (69.7%) of the women were unemployed. On average, the study subjects had a Body Mass Index (BMI) of 25.36kg/m² (Table **1**). Majority (63.2%) of the women in this study had spontaneous vaginal deliveries while 36.8% delivered by caesarean section. More than half, 4596 (51.3%) of the neonates born in this study population were males. The mean birth weight was 3115 (SD=588) grams.

Table 1: Maternal socio-demographic and obstetric characteristics (N=8965)

Characteristic	n	(%)
Age (years)		
<20	722	8.1
20-34	6649	74.4
>34	1562	17.4
Residence		
Rural	3856	43.1
Urban	5089	56.9
Religion		
Christians	7104	79.5
Muslims	1834	20.5
Marital status		
Single	1317	14.7
Married	7623	85.3
Level of education		
No formal education	170	1.9
Primary	3672	41
Secondary	3245	36.3
Tertiary	1862	20.8
Occupation		
Employed	2698	30.3
Unemployed	6214	69.7
Parity		
0-1	2012	50.6
4-Feb	1844	46.4
≥5	120	3

3.1 Socio- Demographic Characteristics and Obstetric Characteristics Associated with LBW.

Results from bivariate and multivariate analysis have been shown in Table 2. Mothers who delivered at extremes of age (<20 and >34 years) had 1.5 and 1.8 increased risk of delivering neonates with LBW respectively as compared to mothers delivering at middle age. Living in rural had 1.5-folds increased risk of delivering a LBW babies as compared to those living in urban setting. Mothers delivering LBW children were more likely to be unemployed as compared to the employed group (RR 1.4; 95% CI 1.1-1.9). The risk for delivering LBW babies decreased with increasing the level of education (Table **2**). However, this did not show any statistical significance.

Table 1: Maternal socio-demographic and obstetric characteristics (N=8965)

Birth weight					
Characteristics	Normal BW	LBW	RR (95% CI)	ARR (95% CI)	P-value
Mothers age (years)					
<20	627 (87.0)	94 (13.0)*	3.6 (0.6-1.0)	1.8 (0.9-3.7)	0.106
20-34	5921 (89.3)	710 (10.7)	1	1	
>34	1334 (85.5)	227 (14.5)***	18 (0.6-0.8)	1.5 (1.1-1.9)	0.02
Residence					
Rural	3315 (86.3)	528 (13.7)***	1.4 (1.2-1.6)	1.5 (1.2-1.8)	<0.0001
Urban	4578 (90.1)	5o4 (9.9)			
Religion					
Muslim	1590 (86.8)	241 (13.2)**	1.2 (1.0-1.4)	1.3 (1.0-1.6)	0.02
Christian	6298 (88.9)	789 (11.9)			
Marital status					
Married	6753 (88.8)	852 (11.2)**	1.2 (1.0-1.4	1.5 (1.1-2.3)	0.018
Single	1138 (86.5)	177 (13.5)			
Level of education					
Not formal	136 (80.5)	33 (19.5)***	2.7 (1.9-3.9)	1.6 (0.9-2.9)	0.119
Primary	3183 (86.9)	479 (13.1)	1.6 (1.1-2.3)	1.1 (0.8-1.7)	0.54
Secondary	2875 (88.8)	364 (11.2)	1.9 (1.3-2.8)	1.2 (0.9-1.8)	0.255
Tertiary	1705 (91.7)	154 (8.3)	1	1	
Occupation					
Unemployed	5404 (87.2)	795 (12.8)***	1.5 (1.3-1.7)	1.4 (1.1-1.9)	0.007
Employed	2465 (91.5)	228 (8.5)			
Parity					
0-1	1801 (89.6)	208 (10.4)	1 (0.4-1.5)	2.1 (1.1-4.5)	0.036
4-Feb	1623 (88.2)	217 (11.8)	1.2 (0.4-1.3)	2.1 (1.1-4.4)	0.031
≥5	109 (91.6)	10 (8.4)	1	1	

P-value>0.05 **P-value<0.05 ***P-value<0.0001: Missing data were not included in the analysis.

3.2 Maternal Factors Associated with Low Birth Weight

Mothers who had preeclampsia had 5-times (RR 4.99; 5% CI 3.7-6.6) increased the risk of delivering an infant with LBW as compared to normotensive counterparts. Similarly, mothers who had eclampsia had 16-folds (95% CI 3.5-5.0) higher risk of delivering an infant with LBW as compared to mothers who did not have eclampsia. On the other hand, the risk of LBW was higher among mothers who had maternal anemia by 2.4-folds (95% CI 1.1-5.4). Among mothers who had induced labor, the risk of LBW was 1.4 times higher (95% CI 1.1-1.8) as compared to those who were not induced r. The risk of delivering LBW babies among mothers, who had undergone caesarean section procedure, was 1.2 times higher (95% CI 1.0-1.4) as compared to mothers who had spontaneous vaginal delivery. PROM increased women's likelihood of delivering an infant with LBW (RR 2.0; 95% CI 1.2-3.5). Chronic hypertension on the other hand, was associated with low birth weight but did not reach statistical significance (RR 1.9; 95% CI 0.4-8.7) (Table 3).

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Table 3: Obstetric factors associated with LBW (N=8965)

	Birth weight				
Maternal factor	Normal BW	LBW	RR (95% CI)	ARR (95% CI)	P-value
Preeclampsia					
Yes	274 (61.4)	172 (38.6)	1.5 (1.4-1.6)***	4.9 (3.7-6.6)	<0.0001
No	7637 (89.9)	862 (10.1)			
Eclampsia					
Yes	10 (34.5)	19 (65.5)	5.6 (4.4-7.5)***	16 (7.2-33.4)	<0.0001
No	7901 (88.9)	1015 (11.4)			
Chronic hypertension					
Yes	14 (82.4)	3 (17.6)	1.5 (0.5-4.2)*	1.9 (0.4-8.7)	0.422
No	7897 (88.5)	1031 (11.5)			
Diabetes mellitus					
Yes	21 (87.2)	3 (12.5)	1.0 (0.4-3.1)*		
No	7890 (88.4)	1031 (11.6)			
Maternal anemia					
Yes	62 (83.8)	12 (16.2)	1.7 (1.2-2.5)**	2.4 (1.1-5.4)	0.029
No	7849 (88.5)	1022 (11.5)			
Induction of labor					
Yes	5782 (87.5)	823 (12.5)	1.4 (1.2-1.6)***	1.4 (1.1-1.8)	0.005
No	2115 (91.1)	206 (8.9)			
Caesarean section					
Yes	3141 (87.1)	465 (12.9)	1.2 (1.1-1.3)**	1.2 (1.0-1.4)	0.018
No	4753 (89.3)	569 (10.7)			
Prom					
Yes	201 (79.4)	52 (20.6)	1.8 (1.4-2.3)***	2 (1.2-3.5)	0.009
No	7710 (88.7)	982 (11.3)			
BMI					
<18.5 (underweight)	182 (82.7)	38 (17.8)	1.9 (1.3-2.7)***	2 (1.6-3.6)	<0.0001
18.5-24.9 (normal)	2093 (89.6)	244 (10.4)	1	1	
25-29.9 (overweight)	1280 (90.5)	135 (9.5)	1.3 (1.0-1.6)	1.2 (0.9-1.5)	0.096
≥30 (obese)	777 (92.0)	68 (8.0)	1.0 (0.8-1.4)**	1 (0.5-1.0)	0.053

*P-value>0.05 **P-value<0.05 ***P-value<0.0001: Missing data were not included in the analysis.

3.3. Neonatal Factors Associated with Low Birth Weight

Female sex of the neonate had 1.3 times increased risk of LBW as compared to their male counterparts (RR 1.3; 95% CI 1.1-1.5). The risk of low birth weight among preterm birth was 12 times (95% CI 9.9-13) higher compared with term birth. The Apgar score <7 at the 1st minute increased the risk of LBW by 2.7 folds. Similarly, Apgar score <7 at 5th min had 2.0-folds (1.4-2.8) higher than Apgar score >7 (Table **4**).

Table 4: Neonatal factors associated with LBW (N=8965)

	Birth weight				
Neonatal factor	Total	LBW n (%)	RR (95% CI)	ARR(95% CI)	P-value
Sex					
Female	4326	536(12.4)	1.1 (1.0-1.3)*	1.3 (1.1-1.5)	0.001
Male	4596	495 (10.8)			
Preterm birth					
Yes	1581	660 (41.7)	8.1(7.2-9.1)**	12 (9.9-13)	<0.0001
No	7256	373 (5.1)			
Apgar score <7 at 1stmin					
Yes	841	309 (36.7)	4.1 (3.7-4.6)**	2.7 (2.0-3.6)	<0.0001

No	8076	721 (8.9)			
Apgar score <7 at 5th min					
Yes	490	192 (39.2)	4.1 (3.6-4.7)**	2.0 (1.4-2.8)	<0.0001
No	8342	789 (9.5)			

*P-value<0.005 **P-value<0.0001: Missing data were not included in the analysis.

4. Discussion

In this study, the incidence and factors associated with LBW among singleton neonates delivered at Kilimanjaro Christian Medical Center (KCMC), were identified using Medical Birth Registry data from 2013-2015. The incidence of LBW was found to be 11.5%. The following socio-demographic characteristics were found to be important predictors for LBW. These include extremes of maternal age, living in rural areas, low level of education, maternal unemployment as well as parity of 2-4. Other maternal factors such as preeclampsia, eclampsia, maternal anemia during pregnancy, maternal underweight and obesity, induction of labor, caesarean section as well as premature rupture of membrane were also associated with high risk of LBW delivery. Neonatal factors which were significantly associated with LBW include female sex, preterm birth, and Apgar score <7 at the 1st and 5th minute. The incidence of LBW found in this study is similar to that of the previous study done at KCMC [15]. It is also similar to other studies elsewhere [23-25]. However, the incidence is lower than that reported in other studies elsewhere [1, 8, 13]. The unchanged rate of LBW at KCMC could be explained by unchanged risk factors and practices and the fact that the hospital receives many complicated referral cases from all over the Northern zone of Tanzania. Difference in sample size, methodology and general health practices between populations, may explain the difference in incidence between studies. Similar to other studies [15, 18, 26]. extremes of maternal age have been significantly associated with LBW. However, this is contrary to other studies [13] where the recommended reproductive age is responsible for higher rate of LBW. This can be due to the difference in reproductive characteristics between populations. In this study, as it is in many other similar studies elsewhere [13, 15, 27, 28]. living in rural areas increases women's likelihood of delivering a low birth weight baby. The reason for this is likely due lack of access to improved medical services especially during pregnancy. High prevalence of malnutrition in rural areas which is among of the factors for LBW, can also explain for the increased risk of LBW among women in the rural settings [29]. Increase in the level of education of the mother from primary to tertiary level, offers protective effect of delivering a low birth weight baby. This finding corresponds to other studies [13, 15, 23]. This can be due to the fact that, increase in the level of education goes hand in hand with improved quality of life hence improved health outcomes including birth weight. Mothers who were unemployed were more vulnerable to give birth to babies weighting less than 2,500g than employed mothers. This finding matches the finding by [15]. The possible explanation could perhaps be due to poor financial income which limits these women's access to improved health practices and medical services hence poor health outcomes. Mothers who had preeclampsia and eclampsia had 5 and 16-folds increased likelihood of delivering LBW babies, respectively. This association is in consistence with some other studies [8, 13, 15]. The mechanism is proposed to be fetal impaired perfusion intrauterine due to high blood pressure which hinders growth of the fetus hence LBW [30]. Mothers who had anemia during pregnancy had more than 2-fold increased risk of LBW as compared with mothers without anemia. This finding has been observed elsewhere [2, 15, 17, 18, 22]. Anemia during pregnancy causes hypoxia to the fetus eventually leading to restricted fetal growth [30]. In this study, induction of labor was associated with an increased risk of LBW. This corresponds to the previous study by [15]. Also delivery by caesarean section was significantly associated with LBW. The associated complications during pregnancy and during labor explain the predisposition of both the induction of labor and delivery by caesarean section to LBW. Preterm birth was a strong determinant of LBW, whereby babies born before 37 weeks of gestation had 12-folds increased risk of LBW. Similar findings have been reported elsewhere [9, 15, 21, 31]. The neonatal factors of Apgar score <7 at the 1st and 5th minutes showed a positive association with LBW as reported previously by [9, 15]. This also may be due to associated complications either during pregnancy, during labor or during delivery.

5. Strengths and Limitations

This was a hospital-based study which used KCMC Medical Birth Registry data which were collected using standardized questionnaire which make our data more reliable. With this data base, a large sample size was obtained and it contains many variables to enhance study power, and was possible to control for the potential confounders. Lastly, because the data-base contains both maternal and neonatal information, it gave us an opportunity to study their independent and joint effect on LBW. Despite the strengths of this study, there some limitations which need to be taken into account while interpreting our findings. We could not use some of the variables because they were either improperly recorded (maternal HIV status) or not available (malaria during pregnancy). Thus, the effect of these variables on our estimates was not quantified.

6. Conclusions

This study has shown similar frequency of LBW from the previous study. The factors for LBW such as preeclampsia and eclampsia, maternal anemia, PROM, maternal underweight, induction of labor and others remains to be significant determinants of LBW. Therefore, to reduce the burden of low birth weight, there is a need to emphasize screening for hypertensive conditions during pregnancy since preeclampsia and eclampsia which have been shown to be strong determinants of LBW. Maternal nutritional status should also be assessed, and mother needs to be counseled accordingly since maternal underweight shows strong association with LBW.

7. Acknowledgements

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9. Financial Disclosure
The authors have no financial relationships relevant to this article to disclose.

10. Conflict of Interest
The authors declared that they have no conflicts of interest to disclose.

11. Table of Contents Summary
LBW is still a leading cause of adverse neonatal outcomes among newborns in Tanzania. Intervention to reduce LBW and care of LBW infants is warranted.

12. What's known on this Subject
Existing information indicates that LBW is high among regions with poor socio-economic status. However, the results have been inconsistent with time and places. Neonatal mortality rate in Tanzania is estimated to be 25% with LBW being among the leading causes.

13. What This Study Adds
Our study provides the updated information on LBW in Northern Tanzania. It can be used to compare the situation of LBW with other regions. This study highlights the need to design strategies to reduce the burden of LBW.

14. Contributors' Statements
Osward Mwalukasa: Mr. Mwalukasa, designed the study, performed the statistical analysis, drafted initial manuscript and approved the final manuscript as submitted.
Michael J. Mahande: Dr. Mahande, contributed in designing of the study, performed initial statistical analyses, critically reviewed and revised the manuscript.
Elizabeth K. Danstan: Ms. Danstan, contributed in interpretation of data, drafting the manuscript and approved the final manuscript.
Clifford S. Tarimo: Mr. Tarimo, statistical analyses, interpretation of data and reviewed the final manuscript.
Blandina T. Mmbaga: Prof. Mmbaga, participated in interpretation data, reviewed and revised the manuscript for important intellectual contents.
All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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