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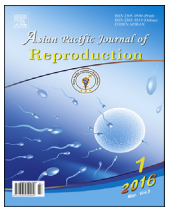

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Risk factors and adverse perinatal outcome associated with low birth weight in Northern Tanzania: a registry-based retrospective cohort study

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ABSTRACT

Objective: To determine the risk factors for low birth weight and adverse perinatal outcomes associated with low birth weight in Northern Tanzania.

Methods: A retrospective cohort study was designed using maternally linked data from Kilimanjaro Christian Medical Centre (KCMC) medical birth registry. A total of 37 799 singleton births delivered from 2000 to 2013 were analyzed. Multiple births, stillbirth and infants with birth defects were excluded. Data analysis was performed using SPSS version 16.0. *Chi*-square was used to compare difference in proportions between groups. The relative risks (*RR*) with 95% confidence interval (*CIs*) for the factors and adverse perinatal outcomes associated with LBW were estimated in a multivariate logistic regression models.

Results: The incidence of low birth weight was 10.6%. Multivariate logistic regression showed that pre-eclampsia (*RR* 3.9; 95% *CI* 3.6–4.2), eclampsia (*RR* 5.4; 95% *CI* 4.1–6.9), chronic hypertension (*RR* 2.8; 95% *CI* 2.1–3.8), maternal anemia (*RR* 1.7; 95% *CI* 1.4–2.2), HIV status (*RR* 0.8; 95% *CI* 0.7–0.8), smoking during pregnancy (*RR* 1.9; 95% *CI* 1.0–3.5), caesarean section delivery (*RR* 1.4; 95% *CI* 1.3–1.5), placental abruption (*RR* 3.7; 95% *CI* 1.3–4.7), placenta previa (*RR* 6.6; 95% *CI* 4.8–9.3), PROM (*RR* 2.5; 95% *CI* 1.9–3.3), maternal underweight (*RR* 1.3; 95% *CI* 1.2–1.6), and obesity (*RR* 1.2; 95% *CI* 1.1–1.4) and female gender of baby were significantly associated with delivery of low birth weight infants. On the other hand, LBW infants had increased risk of neonatal jaundice (*RR* 2.7; 95% *CI* 1.2–6.1), being delivered preterm (*RR* 2.0; 95% *CI* 1.8–2.3), Apgar score (<7) at fifth minute (*RR* 5.5; 95% *CI* 4.5–6.6) and early neonatal death (*RR* 3.5; 95% *CI* 2.6–4.6).

Conclusions: Low birth weight is associated with adverse perinatal outcomes. Early identification of risk factors for low birth weight through prenatal surveillance of high risk pregnant women may help to prevent these adverse perinatal outcomes.

1. Introduction

Low birth weight (LBW) is defined as birth weight of a live born infant of less than 2 500 g regardless of gestational age [1]. There is a strong relationship between preterm birth, intrauterine growth restriction and low birth weight [2]. Low birth weight is a public health problem in developing countries especially in sub Saharan Africa. It is associated with adverse perinatal outcomes such as perinatal asphyxia, prematurity, hypothermia, necrotizing enterocolitis, respiratory distress syndrome, neonatal jaundice, anemia, low Apgar score at 1st and 5th minutes and perinatal mortality [2–4]. Infants who are born with low birth weight experiences long term life consequences such as coronary heart disease, stroke, hypertension, type 2 diabetes, neurological sequel and recurrence of low birth weight in subsequent siblings [3,5,6].

Globally, the prevalence of low birth weight ranges from 3% to 15% [1]. However, the lowest prevalence of low birth weight

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of 3% has been reported in China [1]. Recent estimates show that the prevalence of low birth weight in sub-Sahara Africa is 12% [1]. The Tanzania demographic health survey reported prevalence of LBW of 16% [7].

Several factors have been associated with LBW including poor maternal nutrition before and during pregnancy, maternal diseases such as maternal anemia, chronic hypertension, renal diseases and heart diseases, alcohol, smoking, drug use during pregnancy, parity, low maternal education, maternal occupation, short stature, extreme maternal age, induced labor or elective caesarean section, physical, sexual, and emotional abuse [1–3,8–13].

Some interventions such as provision of pre-conceptual counseling and health services such as family planning services also have shown significant improvement in maternal health hence reduces prevalence of low birth weight [1].

Despite the fact that LBW has been reported to account for perinatal morbidity and mortality, there are few studies in Tanzania which have assessed on the risk factors for low birth weight and associated perinatal morbidity and mortality. These studies have also reported contradicting findings and used cross sectional data which makes it impossible to estimate incidence of LBW and accurate ascertainment of associations between various risk factors and adverse perinatal outcomes associated with LBW. The incidence and perinatal outcomes among LBW infants have not yet been extensively explored in Tanzania. Reduction in incidence of low birth weight may lead to improvement in child survival [14]. The aim of this study was to determine incidence and risk factors for low birth weight, and associated perinatal morbidity and mortality in northern Tanzania which will in turn help to design appropriate interventions to prevent adverse perinatal outcomes associated with LBW, and help to accelerate efforts towards Millenium Development Goal 4.

2. Materials and methods

2.1. Study design and setting

A retrospective study was designed using Kilimanjaro Christian Medical Centre (KCMC) medical birth registry data for women who delivered singleton infants for the period from 2000 to 2013 at the department of Obstetrics and Gynecology. KCMC is a referral and teaching hospital. It is located in Kilimanjaro region in Northern Tanzania. It serves a population over 11 million people from the nearby communities within the region and from the nearby regions. It has an average delivery rate of 4000 births per year.

2.2. Study population

All women who delivered singleton infants at KCMC from 2000 through 2013 who had complete birth records were eligible for this study. Women with multiple gestations, stillbirths and deliveries with birth defects were excluded. Multiple gestations and those with birth defects were excluded because they have a higher risk rate of low birth weight which could lead to overestimation of studied adverse pregnancy outcomes. The final sample comprised of 37799 singleton births.

2.3. Study variables

Main outcome measures were low birth weight, early neonatal death and morbidity (jaundice, preterm birth, Apgar score and neonatal infection). Low birth weight was defined as birth weight of less than 2500 g. We included only infants born at $\geq$28 weeks of gestation. The independent variables included; maternal demographic characteristics, maternal weight during pregnancy, maternal diseases (e.g. chronic hypertension and diabetes mellitus, maternal anemia, preeclampsia and eclampsia), maternal risk behaviors (e.g. smoking and drinking alcohol during pregnancy).

2.4. Data source

This study utilized medical birth registry data from KCMC. The medical birth registry of KCMC was established in the year 1999 as a collaborative project between medical birth registry of Norway through University of Bergen in Norway and KCMC via Kilimanjaro Christian Medical University College. It has been in operation since 2000 recording all births at KCMC in a computerized database. Information recorded in the birth registry has been described in detail elsewhere [15]. In summary, information collected includes maternal and paternal sociodemographic characteristics, maternal health before pregnancy, during pregnancy, after delivery and child status.

2.5. Data collection

A trained midwife nurses conducts interviews on daily basis using a standardized questionnaire for all women who deliver at the department of Obstetrics and Gynaecology within 24 h of delivery or as soon as mothers have recovered in case of complicated deliveries. In addition, information of neonates who are admitted at neonatal care unit is also recorded in neonatal registry form. Data from medical records is also extracted from the patient's file. Verbal consents are sought from each individual mother prior the interview.

2.6. Ethical clearance

The ethical approval was obtained from the Kilimanjaro Christian Medical College University (KCMU-Co) research ethics committee prior to commencement of the study. Permission to use medical birth registry data was obtained from the KCMC hospital and medical birth registry administration. Confidentiality of information was adhered by the use of maternal unique identification number.

2.7. Statistical analysis

Data were analysed using statistical package for social science (SPSS) version 16.0, (SPSS Inc. Chicago, III). Descriptive statistics were summarized using proportions, frequency, mean, and standard deviation (for normal distribution data). Student t test was used to compare means between groups for continuous variables. We used chi-square test (χ^2) to establish the relationship between various risk factors and LBW. The relative risk (RR) with 95% confidence interval (CI) for factors associated with LBW and adverse perinatal outcomes was estimated using multivariate logistic regression model while controlling for the potential confounding. A P value of less than 0.05 (two sided) was considered to be statistically significant.

3. Results

3.1. Sociodemographic and obstetric characteristics of the study participants

The sociodemographic and obstetric characteristics of the participants are shown in Table 1. A total of 37799 singleton births were analyzed. Of these, 4007 had low birth weight (LBW) this constitutes to an incidence of 10.6%. There was no difference in mean age between women with normal birth weight and those with low birth weight infants (27.4 ± 6.0 years vs. 27.5 ± 6.3 years).Women residing in rural area had higher rate of low birth weight as compared to those who were residing in the urban area [12.3% ((1933/15764) *vs.* 9.5% (2075/21794), respectively; $P < 0.001$]. Mothers with low birth weight infants were more likely to be single as compared to those who had normal birth weight (14.7% vs. 11.5%, respectively; $P < 0.001$). In addition, mothers with low birth weight were more likely to have 4 visits as compared to mothers with normal birth weight infants (17.3% vs. 7.2%, $P < 0.001$) respectively, and were also more likely to have higher parity as compared to women in the comparison group.

3.2. Factors associated with low birth weight

Results from multivariate analysis have been displayed in Table 2. The common risk factors for delivering LBW infants were preeclampsia (*RR* 3.9, 95% *CI* 3.6–4.2), eclampsia (*RR* 5.4; 95% *CI* 4.1–6.9), chronic hypertension (*RR* 2.8; 95% *CI* 2.1–3.8), maternal anemia (*RR* 1.7; 95% *CI* 1.4–2.2), malaria during pregnancy (*RR* 3.5; 95% *CI* 3.3–3.6), smoking during the current pregnancy (*RR* 1.9; 95% *CI* 1.0–3.5), delivery by cesarean section (*RR* 1.4; 95% *CI* 1.3–1.5), placental abruption (*RR* 3.7; 95% *CI* 1.3–4.7), premature rupture of membrane (*RR* 2.5; 95% *CI* 1.9–3.3), placenta previa (*RR* 6.6; 95% *CI* 4.8–9.3), maternal underweight (*RR* 1.3; 95% *CI* 1.2–1.6), and obesity (*RR* 1.2; 95% *CI* 1.1–1.4). Diabetes mellitus was associated with low birth weight but this association did not reach statistical significance. Other known risk factors for LBW such as alcohol drinking and induced labor and maternal HIV were not significantly associated with LBW in this population after.

Table 1
Sociodemographic and obstetric characteristics of the study participants.

Characteristics	Birth weight		χ^2	*P* value
	Normal BW (n = 33792)	LBW (n = 4007)		
Mother's age (year)[a]	27.4 (6.0)	27.5 (6.3)		0.23
Maternal age (year)			24.7	<0.001
<20	2994 (8.9)	415 (10.4)		
20-34	26 095 (77.2)	2965 (73.9)		
≥35	4,703 (13.9)	627 (15.6)		
Area of residence			72.1	<0.001
Rural	13 831 (40.9)	1,933 (48.2)		
Urban	19 961 (59.1)	2074 (51.8)		
Occupation			26.4	<0.001
Employed	7874 (23.3)	795 (19.9)		
Unemployed	25 918 (76.7)	3212 (80.1)		
Marital status			35.8	<0.001
Married	29 663 (87.8)	3404 (85.0)		
Single	4129 (12.2)	603 (15.0)		
ANC visits			8.7	<0.001
<4	23 397 (69.2)	1814 (45.3)		
≥4	10 395 (30.8)	2193 (54.7)		
Parity			26.1	<0.001
0	17 171 (50.8)	1354 (33.8)		
1	7708 (22.8)	815 (20.3)		
2-4	8124 (24.0)	1031 (25.7)		
≥5	789 (2.3)	807 (20.1)		

[a] Mean and standard deviation: Number in brackets is percentage.

Table 2
Results of multiple logistic regression model for risk factors of low birth weight (*n* = 37799).

Maternal factors	Birth weight		ARR (95% CI)[a]
	Normal BW (*n* = 33792)	LBW (*n* = 4007)	
Preeclampsia			3.9 (3.6–4.2)
Yes	886 (2.6)	529 (13.2)	
No	32906 (97.4)	3478 (86.8)	
Eclampsia			5.4 (4.1–6.9)
Yes	18 (0.1)	7 (0.2)	
No	33774 (99.9)	4000 (99.8)	
Chronic hypertension			2.8 (2.1–3.8)
Yes	69 (0.2)	30 (0.7)	
No	33723 (99.8)	3977 (99.3)	
Diabetes mellitus			1.4 (0.8–2.3)
Yes	65 (0.2)	11 (0.3)	
No	33727 (99.8)	3996 (99.7)	
Maternal anemia			1.7 (1.4–2.2)
Yes	564 (1.7)	122 (3.0)	
No	33228 (98.3)	3885 (97.0)	
Maternal HIV status			0.8 (0.7–0.8)
Positive	10109 (29.9)	1374 (34.3)	
Negative	23683 (70.1)	2633 (65.7)	
Malaria during pregnancy			3.5 (3.3–3.6)
Yes	5630 (16.7)	648 (16.2)	
No	28162 (83.3)	3359 (83.8)	
Smoking during pregnancy			1.9 (1.01–3.5)
Yes	32 (0.1)	8 (0.2)	
No	33760 (99.9)	3999 (99.8)	
Alcohol use during pregnancy			0.7 (0.7–0.8)
Yes	10946 (32.4)	1051 (26.2)	
No	22846 (67.6)	2956 (73.8)	
Body mass index (BMI)			
18.5–24.5 (Normal)	13389 (39.6)	1528 (38.1)	1.0
25–29.5 (over weight)	7648 (22.6)	697 (17.4)	0.2 (0.1–0.6)
<18.5 (Under weight)	1389 (4.1)	229 (5.7)	1.3 (1.2–1.6)
≥30 (Obese)	11366 (33.6)	1553 (38.8)	1.2 (1.1–1.4)
Induction of labor			0.7 (0.6–0.8)
Yes	7324 (21.7)	692 (17.3)	
No	26468 (78.3)	3315 (82.7)	
Cesarean section			1.4 (1.3–1.5)
Yes	10486 (31.0)	1568 (39.1)	
No	23306 (69.0)	2439 (60.9)	
Placental abruption			3.7 (1.3–4.7)
Yes	53 (0.2)	56 (1.4)	
No	33739 (99.8)	3951 (98.6)	
Placenta previa			6.6 (4.8–9.3)
Yes	34 (0.1)	45 (1.1)	
No	33758 (99.9)	3962 (98.9)	
PROM			2.5 (1.9–3.3)
Yes	607 (1.8)	170 (4.2)	
No	33185 (98.2)	3837 (95.8)	

[a] Adjusted for maternal age, gestational age, area of residence, occupation, marital status, use of ANC and parity. Number in brackets is percentage.

Table 3
Adverse perinatal outcomes associated with low birth weight.

Outcomes	LBW (% (n/N)	ARR*	95%CI	*P*-value
Neonatal infection		1.0	0.9–1.2	0.6
Yes	11.8 (1334/11 287)			
No	10.1 (2673/26 512)			
Neonatal jaundice		3.0	0.8–11.3	0.3
Yes	40.0 (4/10)			
No	10.6 (4003/37 789)			
Preterm birth		2.0	1.8–2.3	<0.001
Yes	14.8 (546/3700)			
No	10.1 (3461/34 099)			
Apgar score (<7 at 1 min)		1.9	1.5–4.3	<0.001
Yes	17.2 (736/4281)			
No	9.8 (3271/33 518)			
Apgar score (<7 at 5 min)		1.3	1.2–3.3	<0.001
Yes	14.1 (234/1659)			
No	10.4 (3773/36 140)			
Early neonatal death		3.5	2.6–4.6	<0.001
Yes	44.6 (87/195)			
No	10.7 (3920/37 604)			

* Adjusted for maternal age, parity, area of residence, preeclampsia, eclampsia, gestational diabetes and hypertension.

3.3. Perinatal morbidity and mortality associated with low birth weight

Table 3 summarizes results from multivariate logistic analysis for adverse perintal outcomes associated with LBW. We found that LBW infants had increased risks of low Apgar score of <7 at 1 min (RR 1.9; 95% CI 1.5–4.3 and at 5 min (RR 1.3; 95% CI 1.2–3.3) respectively, being born preterm (RR 2.0; 95% CI 1.8–2.3), early neonatal death (RR 3.5; 95% CI 2.6–4.6). Neonatal jaundice was associated with low birth weight but this association did not reach statistical significance (RR 3.0; 95% CI 0.8–11.3). Other known perinatal morbidity associated with LBW such as neonatal infection, was not associated with low birth weight in this population.

4. Discussion

In this study, we investigated incidence of low birth, risk factors, and perinatal morbidity and mortality among babies born with low birth weight using medical birth registry data from KCMC. We found that the incidence of LBW was 10.6%. Preeclampsia, eclampsia, chronic hypertension, diabetes mellitus, maternal anemia, induced labor and delivery by cesarean section were important risk factors for low birth weight. In addition, infants born with low birth weight had greater risk being born preterm, jaundiced and having a low Apgar score at first and fifth minutes as compared with infants who were born with normal weight.

The incidence of low birth weight in our study corresponds with previous study [12], it also falls within the estimate of 3%–15%, reported by World Health Organization [1]. It is however lower than the 14.6% reported by Coutinho [4]. The difference in incidence could be explained by size of study population, diagnostic criteria, nature of population and difference in prevalence of risk factors for low birth weight.

A previous study has reported an association between pre-eclampsia/eclampsia with low birth weight [16]. Similar to our study women with preeclampsia and eclampsia had increased risk to deliver low birth weight infants (5.8 and 8.4 folds respectively) compared to women without preeclampsia and eclampsia. Abnormal implanted placenta which predisposes a woman to preeclampsia is thought to result in poor uterine and placental perfusion yielding a state of hypoxia which affects growth of an infant which leads to low birth weight. Maternal hypertension has been reported to be associated with LBW in several studies [12,17]. Similar to our study, women with chronic hypertension had more than threefold increase in delivering LBW infants compared to non-chronic hypertensive women [3,18].

A previous study done in India demonstrated the association between maternal diabetes with increased newborn weight [19]. In contrast with our study, mothers with diabetes mellitus were three times more likely to deliver LBW infants as compared to non-diabetic mellitus mothers. Our data showed that induced labor and delivery by cesarean section were significantly associated with increased risk of LBW. Similar findings have been reported elsewhere [3]. One possible explanation for the observed association could be due to other co-morbidities which necessitated the option induced labor or cesarean section delivery to save the mother or fetus, such as hypertension, bleeding and diabetes mellitus.

Smoking and alcohol use during pregnancy were associated with low birth weight in other studies [18], but this was not the case in our study. This can be explained by smoking and alcohol taking being an uncommon practice among women in Tanzania.

Extreme maternal age has been significantly associated with low birth weight [9,17]. In consistence, we found that both young and older women were more likely to deliver LBW infants, similar to the Watson-Jones study though they found association only in younger age. The younger women are likely to deliver LBW infants due to immaturity of their reproductive organs to support development of infant in uterus resulting in growth restriction.

Previous studies have shown that marital status particularly being single, occupation and area of residence, particularly rural, have association with LBW [12,13,20]. Similar observations were found in our study. Occupation particularly unemployed women are prone to poor nutrition due to lack of financial support. Residence, particularly rural, is a risk to LBW due to insufficient health services and education on maternal issues.

Other studies have shown there is association between neonatal infection and LBW [9,17] in contrast to our study. This could be due to poor recording of specific incidents of infection in our neonates. In the present study jaundice was a significant perinatal morbidity associated with LBW, as it was reported in another study [21]. In our study LBW infant were 3 fold more likely to develop jaundiced compared to infant with normal weight.

Countinho and colleagues found an association between low birth weight and a low Apgar score in the first and fifth minutes [4]. Similar to our study, infants born with low birth weight had 4 and 6-fold increased risk of Apgar score in the first and fifth minutes respectively. Perinatal mortality among low birth weight infants was reported in our study to be similar to other studies [5,17,18,21]. Where by LBW infants have 3-fold increased risk to early neonatal death compared to normal weight infants.

The use of maternally linked data has several advantages. To begin with, the data contained maternal demographic and infant

medical information which enabled us to assess association of maternal characteristics and fetal outcome. Second, our link data gave us large sample size which helps to increase accuracy of data presentation. Third, we used data which were collected using standardized questionnaire which enabled us to obtain data that is complete and accurate.

In addition to the strengths of our study, the following limitation should be considered while interpreting the results. The largest limitation is selection bias, since this is hospital based study; there is chance that women who delivered in our setting might be a high risk group as it is a tertiary health facility, so this could have led to overestimation. Secondly, the chance of underreporting of perinatal mortality rate and morbidity due to limited follow up of mothers with their infants due to limited resources since the study data recorded only mothers who stayed in hospital within one week after delivery, also attributed to high rate of delivery in Tanzania. Third, the failure to take into account factors which are not recorded in birth registry example neurological development which is important outcome of low birth weight.

The incidence and risk factors of LBW in our study corresponds to other studies in region and population based studies in high income countries. Preeclampsia, eclampsia, chronic hypertension, diabetes mellitus, maternal anemia, induced labor and delivery by cesarean section were the significant risk factors for LBW. Low birth weight is associated with adverse perinatal mortality and morbidity. Our results provide clinicians and mothers with important information which will be considered during caring and counseling pregnant women with risk factors for LBW, also mothers with LBW infants to prevent adverse perinatal morbidity and mortality. We recommend more research to be done on causes and prevention of risk factors associated with LBW.

Conflict of interest statement

The authors declare that they have no competing interest.

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