Research Article

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Environmental and maternal anthropometric determinants for low birth weight in maternity hospitals in Asmara, Eritrea

Abstract

Background: Birth weight of a neonate is a vital indicator of the newborn's chances for survival, growth, health and psychosocial development. This study was conducted to assess the environmental and maternal anthropometric factors that determine low birth weight (LBW) of a neonate.

Methods: A cross-sectional analytical study was employed using questionnaires and anthropometric measurements on 806 mother-neonate pairs.

Results: Statistically significant association was observed between maternal anthropometric factors and environmental factors with LBW.

Conclusion: This study identified various environmental and maternal anthropometric risk factors. It is therefore recommended that multifaceted and coordinated measures to address these issues are required to reduce LBW to its lowest possible level.

Keywords: Eritrea, analytical, body weight, body height, birth weight

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Abbreviations: ANC, antenatal care; AOR, adjusted odds ratios; CI, confidence interval; COR, crude odds ratios; DHS, demographic and health surveys; EIT, eritrea institute of technology; EPHS, Eritrean population and health survey; IUGR, intra- uterine growth retardation; LBW, low birth weight; LMP, last menstrual period; NBW, normal birth weight; NSO, national statistics office; SD, standard deviation; SPSS, statistical package for social sciences; UNICEF, united nations children's fund; WHO, world health organization

Introduction

Low birth weight (LBW) has been defined by the World Health Organization (WHO) as weight at birth of less than 2,500 grams.[1] Infants weighing less than 2,500g are approximately 20 times more likely to die than heavier babies.[2] LBW mainly results from preterm birth(before 37 weeks gestation) or due to Intra-Uterine Growth Restriction (IUGR)or both.[3] Neurodevelopmental handicaps, congenital anomalies and susceptibility to infections are some of the consequences of LBW which may place substantial stress on the family.[4,5]

More than 20 million infants worldwide are born with LBW, of which 95.6% are in developing countries. LBW levels in sub-Saharan Africa and Eastern Africa are around 15% and 13.5%, respectively. Among the more developed regions, North America averages 8 per cent, while Europe has the lowest regional average at 6 percent.[6]

In Eritrea almost 90% of women attended antenatal care service for the most recent birth, while the rate of assisted delivery at health facility remains at 34 percent.[7] In addition, according to the annual Ministry of Health, Eritrea, report for 2015 the health facility based LBW was 7.6%.[8] Moreover, the three Demographic and Health Surveys (DHS) conducted by National Statistics Office (NSO) in the years 1995, 2002 and 2010 revealed that the prevalence of LBW in Eritrea declined from 21 percent to 7 percent.[7,9,10] However, a report released by United Nations Children's Fund (UNICEF) puts the LBW for Eritrea for the years 2008–2012 as14 percent.[11(7, 9, 10)]

In Eritrea, the association between environmental and anthropometric effects on birth weight has not been studied. Therefore, this study is planned to include those factors and aimed to fill the gaps in the earlier related researches in Eritrea.

Material and methods

This health facility based cross-sectional quantitative study was conducted in four maternity hospitals in Asmara, capital city of Eritrea. These hospitals were Orotta National Maternity Referral Hospital, Edaga Hamus maternal and child health hospital, Biet Mekea community hospital and Sembel public-private hospital.

The study population comprised pairs of mothers and their neonates who attended the maternity care services at hospitals in Asmara. The study units were mothers and their respective newborns available during the data collection period at the selected sites. Mothers with unknown last menstrual period (LMP), twin deliveries and neonates with congenital anomalies were excluded from this study.

As suggested by Vittinghoff and McCulloch[12] at least five events per predictor variable was recommended in the analysis using multivariable logistic regression. Therefore, putting into consideration the possible number of variables that will be included in the study, data from 806 deliveries and 73 low birth weight infants were collected. Out of the 1726 deliveries conducted during the study period, 806 (46.7%) pairs of neonate-mother were included in the sample taking the consecutive births within one hour after delivery.

In addition to the maternal and neonatal anthropometric measurements taken, data on demographic information of the mother and her spouse and variables related to the household environment were included.

Eight data collectors and two supervisors with health science background were recruited. A three day training and pretesting sessions were conducted on the methods of data collection, orientation on the proposed questionnaire, interview techniques and recording of anthropometric measurements. Moreover the data collection tools were tested on five percent of the sample size on two different health facilities that provide similar health services; and based on the findings of the pretest necessary modifications were made on the data collection tools.

The data collection was conducted from November15, 2017 to January 31, 2018 on the selected health facilities by the trained data collectors and supervisors.

The data collection tool was designed to have three parts that include demographic variables, environmental factors and neonatal and maternal anthropometric measurements.

After data was collected and field edited it was entered and cleaned on SPSS version 25, after which it was exported to STATA version 14 for data analysis. Descriptive analysis was utilized using frequencies, proportions, and means. Bivariate logistic regression method was applied to test the presence and strength of association between the explanatory variables and outcome variables, after which a multivariable logistic regression method was utilized.

In addition, Principal Component Analysis (PCA) was employed to determine the socio-economic position of the study subjects using the house hold wealth index as a proxy. Initially 18 variables related to availability of durable household assets, housing characteristics and type of fuel used for household cooking purposes were collected. These variables were standardized using means and standard deviations extracted from a nationally representative data from EPHS 2010. Finally, these values were multiplied by the factor weight calculated from EPHS 2010 and added together to form the socio-economic position of the household which were categorized into three levels.

After the proposal has been presented and approved by the Department of Statistics and College of Sciences, EIT, approval was sought from the Ministry of Health (MOH).The Health Research Proposal Review and Ethical Clearance Committee, and it was granted with a letter reference number 11/10/17. Permission was also secured from the Directors of the selected hospitals for the execution of the study in their respective health facilities. Verbal consent was secured from the research subjects after they were briefed on the research topic and purpose.

Results

Socio-demographic characteristics of the study participants

As indicated in Table 1, the prevalence rate for LBW and mean birth weight for the neonates in the maternity hospitals was 9.1 % (95% CI=7.1%-11.0%) and 3143.6(SD = 513.1), respectively.

Table 1 Socio-demographic distribution of the study participants by birth weight status, Asmara maternity hospitals, 2018

Variables	NBW		LBW		Total	
	n	%	n	%	n	%
Age group in years						
< 20	29	80.6	7	19.4	36	4.5
20 – 35	634	91.1	62	8.9	696	86.4
> 35	70	94.6	4	5.4	74	9.2
Address(Zoba)						
Maekel	714	91.1	70	8.9	784	97.3
Debub	12	85.7	2	14.3	14	1.7
Anseba	3	100	0	0	3	0.4
Debubawi Keih Bahri	1	50	1	50	2	0.3
Gash Barka	3	100	0	0	3	0.4
Marital Status						
Married	691	91.9	61	8.1	752	93.3
Single	42	77.8	12	22.2	54	6.7
Sex of the neonate						
Male	386	93.5	27	6.5	413	51.2
Female	347	88.3	46	11.7	393	48.8
Maternal level of education						
Junior and below	229	89.8	26	10.2	225	31.6
Secondary and above	504	91.5	47	8.5	551	68.4
Paternal level of education						
Junior and below	153	87.4	22	12.6	175	21.7
Secondary and above	580	91.9	51	8.1	631	78.3
Maternal Employment						
Housewife	580	91.8	52	8.2	632	78.4
Employed	95	87.2	14	12.8	109	13.5
Self-employed	27	90	3	10	30	3.7
Unemployed	31	88.6	4	11.4	35	4.3
Paternal Employment						
Employed	661	91.2	64	8.8	725	90
Unemployed	34	81	8	19.1	42	5.2
Others	38	91.4	1	2.6	39	4.8

Table Continued....

Variables	NBW		LBW		Total	
	n	%	n	%	n	%
Socio-economic position (SEP)						
Lower	226	86.9	34	13.1	260	32.3
Middle	248	91.5	23	8.5	271	33.6
Upper	259	94.2	16	5.8	275	34.1
Total	733	90.9	73	9.1	806	100

The mean age of participants was 27.7 years (SD = 0.19) with the majority (86.4%) being in the age range of 20– 35 years. Majority (97.3%) of the study participants came from zoba Maekel and were married (93%). The proportion of male neonates was almost equal to that of the females (males =51% vs. females=49 %).

Sixty eight percent of the mothers and 78.3% of their partners completed high school. Almost three fourth (78.4%) of the mothers were house wives, while 90% of their partners were employed. In addition, to determine the socio-economic position of the respondents, socio-economic status of the participants was categorized into three levels: Lower, Middle and Upper.

Comparison of the main maternal and neonatal variables between mothers with normal birth weight (NBW) and LBW

In order to determine the differences related to certain demographic and anthropometric measurements between the NBW and LBW neonates, independent *t-test* was performed on six variables: maternal age, birth weight of the neonate, maternal weight, maternal height, maternal Body Mass Index (BMI) and maternal Mid Upper Arm Circumference (MUAC). The differences observed between NBW and LBW neonates in all the selected variables were statistically significant (Table 2).

Table 2 Comparison of main maternal and neonatal variables between mothers with NBW and LBW, Asmara Maternity Hospitals, 2018

Variables	NBW mean (SD)	LBW mean (SD)	Total mean (SD)	t-value	p-Value
Age of the mother in years	27.8(5.43)	26.4(5.38)	27.7(5.44)	2.12	0.0341*
Birth weight of the neonate	3240.6(421.7)	2169.4(279.9)	3143.6(513.1)	21.24	0.0001**
Maternal weight in Kgs	56.1(9.20)	51.1(9.46)	55.7(9.33)	4.49	0.0001**
Maternal height in meter	1.59(0.057)	1.56(0.066)	1.59(0.058)	4.26	0.0001**
Maternal BMI	22.1(3.43)	20.9(3.60)	22.0(3.46)	2.87	0.0042**
Maternal MUAC in centimeters	23.9(2.24)	22.7(2.41)	23.8(2.28)	4.38	0.0001**

*P<0.05 ** p<0.0001

Bivariate analyses on environmental and anthropometric factors on LBW

Eight variables were selected to determine the presence and strength of the associations. These variables include type of latrine available, accessibility to a separate room for kitchen, main fuel used for cooking, exposure to hard physical work during current pregnancy, MUAC measurement, maternal body weight, maternal body height and BMI. All variables except type of available latrine were statistically significant on bivariate logistic regression analyses at 0.05 level of significance (Table 3).

Table 3 Bivariate analyses on environmental and anthropometric factors with LBW, Asmara maternity hospitals, 2018

Variables	NBW n (%)	LBW n (%)	Total n (%)	COR (95% CI)	p Value
Type of latrine					
Improved, not shared facility	246(91.8)	52(8.2)	268(33.7)	0.85(0.51-1.44)	0.55
Non-improved facility	487(90.5)	51(9.5)	538(66.3)	Ref.	
Has separate room for kitchen					
Yes	433(93.5)	30(6.5)	463(57.4)	Ref.	
No	300(87.5)	43(12.5)	343(42.6)	2.07(1.27 – 3.37)	0.004
Main fuel used for cooking					
LPG/Biogas	514(93.8)	34(6.2)	548(68.0)	Ref.	
Kerosene	128(86.5)	20(13.5)	148(18.4)	2.36(1.32 – 4.24)	0.004
Firewood/Charcoal	91(82.7)	19(17.3)	110(13.6)	3.16(1.73 – 5.77)	0.001
Exposed to hard physical work during current Pregnancy					
Yes	81(84.4)	15(15.6)	96(11.9)	2.08(1.13 – 3.84)	0.019
No	652 (91.8)	58 (8.2)	710 (88.1)	Ref.	
Current MUAC measurement in cm					
< 23	233(85.7)	39(14.3)	272(33.7)	2.46(1.51 - 3.99)	0.0001

Table Continued....

Variables	NBW	LBW	Total	COR (95% CI)	p Value
	n (%)	n (%)	n (%)		
≥ 23	500(93.6)	34(6.4)	534(66.3)	Ref.	
Current body weight in kg					
< 50	184(82.9)	38(17.1)	222(27.5)	3.24(1.99 – 5.28)	0.0001
≥ 50	549(94.0)	35(6.0)	584(72.5)	Ref.	
Body height in meter					
< 1.50	10(58.8)	7(41.2)	17(2.1)	7.67(2.83 – 20.81)	0.0001
≥ 1.50	723(91.6)	66 (8.4)	789 (97.9)	Ref.	
Current BMI					
< 18.5	103(85.1)	18(14.9)	121(15.0)	1.81 (1.01 - 3.24)	0.046
18.5 - 24.99	497(91.2)	48(8.8)	545(67.6)	Ref.	
25.0 - 29.99	116(95.9)	5(4.1)	121(15.0)	0.44(0.17 – 1.15)	0.094
≥ 30.0	17(89.5)	2(10.5)	19(2.4)	1.22(0.27 – 5.43)	0.796
Total	**733(90.9)**	**73(9.1)**	**806(100.0)**		

Ref. = Reference

Mothers who were exposed to hard physical work during their current pregnancy were 2 times more likely to deliver LBW neonate than unexposed group (OR=2.08;95% CI=1.13–3.84;p=0.019). In addition, there was statistically significant association between availability of a separate kitchen and risk of LBW(OR=2.07; 95% CI = 1.27–3.37;p=0.003). Moreover, mothers who use kerosene and firewood/charcoal for household cooking purposes were prone to deliver LBW babies 2.4 (OR=2.36; 95% CI=1.32–4.24; p=0.004) and 3.2 (OR=3.16;95% CI=1.73–5.77;p=0.03) times, as compared to LPG/natural gas users, respectively. However, no statistically significant association was observed between type of latrine and LBW (OR =0.85; 95% CI = 0.51-1.44; p = 0.550).

Post-partum MUAC, body weight and body height measurements were taken and categorized into groups. Mothers with MUAC measurement of less than 23 cm were found to be on a higher risk of delivering LBW neonates relative to women with MUAC measurement ≥ 23cm (OR=2.46; 95% CI=1.51-3.99;p=0.0001). Body height and weight measurements were grouped into two categories and significant association were found between mothers body weight and LBW (OR=3.24; 95% CI=1.99–5.28; p=0.0001) and as well as body height and LBW (OR=7.67; 95% CI=2.83–20.81; p=0.0001).

Body mass index (BMI) was calculated by dividing weight in kg by squared value of height in meter, after which it was classified into four groups. Relative to normal range of BMI, 18.5-24.49, mothers classified into underweight group (<18.5), overweight group (25.0-29.99) and obese group (≥30) were compared and tested for any significant association with LBW. It was found that women in underweight group were 1.8(95% CI=1.01-3.24; p=0.046) times at risk of delivering a LBW neonate relative to normal body weight. But the associations between women in the obese and overweight group with birth weight were not statistically significant (Table 3).

Multivariable logistic regression analysis on environmental and anthropometric factors on LBW

Originally there were eight variables related to environmental and maternal anthropometric measurements on conducting the bivariate analyses; all except two variable entered into multiple logistic regression model. Out of these variables BMI measurement was not included in the final model due to the violation of the assumption of multi-collinearity, where the collinearity level was beyond the acceptable limit; tolerance (0.007) and VIF (140.61). Type of latrine utilized was not also included in the final model (p>0.05). Finally, six variables were included in the multivariable model; exposure to hard physical work during current pregnancy, availability of separate kitchen, main fuel used for cooking, current body weight, body height and current MUAC (Table 4).

Table 4 Multivariable analysis on environmental and anthropometric factors with LBW, Asmara maternity hospitals, 2018

Variables	NBW	LBW	Total	AOR (95% CI)	p value
	n (%)	n (%)	n (%)		
Has separate room for kitchen					
Yes	433(93.5)	30(6.5)	463(57.4)	Ref.	
No	300(87.5)	43(12.5)	343(42.6)	1.64(0.96-2.8)	0.069
Main fuel used for cooking					
LPG/Biogas	514(93.8)	34(6.2)	548(68.0)	Ref.	
Kerosene	128(86.5)	20(13.5)	148(18.4)	1.51(0.79-2.87)	0.21
Firewood/Charcoal	91(82.7)	19(17.3)	110(13.6)	2.22(1.17-4.21)	0.014
Exposed to hard work during current pregnancy					
Yes	81(84.4)	15(15.6)	96(11.9)	1.70(0.88-3.28)	0.113
No	652 (91.8)	58 (8.2)	710 (88.1)	Ref.	
Current body weight(Kg)					
< 50	184(82.9)	38(17.1)	222(27.5)	2.26(1.25-4.10)	0.007
≥ 50	549(94.0)	35(6.0)	584(72.5)	Ref.	

Table Continued....

Variables	NBW n (%)	LBW n (%)	Total n (%)	AOR (95% CI)	p value
Body height(Mt)					
< 1.50	10(58.8)	7(41.2)	17(2.1)	4.30(1.51-12.27)	0.006
≥ 1.50	723(91.6)	66 (8.4)	789 (97.9)	Ref.	
Current MUAC(Cm)					
< 23	233(85.7)	39(14.3)	272(33.7)	1.27(0.70 -2.30)	0.433
≥ 23	500(93.6)	34(6.4)	534(66.3)	Ref.	

Ref. = Reference

As it is shown in Table 4, mothers who used firewood/charcoal as their main source of energy for cooking were 2.2 times as likely to deliver LBW neonates as compared to those mothers who used LPG/Natural gas(OR=2.22; 95% CI=1.17-4.21; p = 0.014).

Mothers with body weight of less than 50 kg and body height of less than 1.5 meters were having almost 2 times (OR=2.26;95% CI=1.25-4.10;p=0.007) and almost 4 times (OR=4.30;95% CI=1.51-12.27;p=0.006) risks of delivering LBW neonates, respectively. However, the association between the MUAC measurement and LBW delivery was not significant (OR=1.27; 95% CI=0.70 -2.30; p=0.433).

Having no separate room for kitchen, exposure to hard physical work during their current pregnancy and utilizing kerosene as a main fuel for household cooking were not statistically significant on multivariable analysis (p > 0.05).

Discussion

This cross-sectional study was conducted from November 16, 2017 up to January 31, 2018 at four maternity hospitals in Asmara. So far, to the best knowledge of the researchers, in Eritrea, no study on environmental and anthropometric determinants of LBW has been conducted. Therefore, this study is expected to serve as a baseline for future similar or related studies.

In this study an attempt was made to determine the environmental and anthropometric determinants of LBW for the hospital deliveries using bivariate and multivariable logistic regression analyses. Initially eight variables were included in the bivariate logistic regression analysis, except BMI and type of latrine utilized, all others were also retained for multivariable logistic regression analysis. These variables were: availability of a separate room for kitchen, main fuel used for cooking, exposure to hard work during current pregnancy, current body weight, body height, current MUAC.

It has been discussed by Ferraz et al.,[13] and Bashar et al.,[14] that post-partum body weight may be considered as an estimation for pre-pregnancy body weight. In this study, the association between maternal post-partum body weight and delivering LBW was found to be statistically significant. This finding is supported by similar studies in Brazil,[13] Eastern Nepal[14] and Pakistan.[15] The LBW attributed to post-partum body weight of the mother might have been occurred as a result of maternal nutritional deficiency that have occurred since their infancy.

In contrast to findings in studies conducted in Pakistan[16] Northern Ethiopia[17] and Nepal,[18] maternal height was observed to have a significant association with LBW. This finding was consistent with previous studies conducted in Southern Ethiopia,[19] Eastern Nepal,[14] Karachi[15] and Sudan.[20]

On multivariable analysis, women who used Firewood and/or Charcoal were at risk for delivering a LBW neonate. In addition, on bivariate analysis, women who used kerosene for cooking purposes were found to have a higher risk of delivering LBW neonates. A study conducted in India, found that infants born in households using kerosene, coal and biomass had higher odds of LBW as compared to infants born in households using natural gas for cooking purposes.[21] Studies that were done by Boy et al.,[22] and Demelash et al.,[19] were in agreement with the findings of this study. As discussed by Fernandes et al.,[23] and Sehgal et al.,[24] the exposure to biomass smoke, which contains carbon monoxide and other toxic materials, leads to diseases related to respiratory system which in turn affects birth weight negatively.

This study selected a relatively larger sample size and the data collection and supervision activities was conducted by experienced health personnel, which could be considered as a strength of this study. However, being a health facility based study, lack of generalizability to the entire community can be considered as its limitation. Despite its limitation, we believe that this study made a significant contribution in the determination of environmental and anthropometric factors on LBW in Asmara, Eritrea.

Conclusion

This hospital based-study revealed that three variables were independently associated with LBW in the multivariable analysis. These were current body weight, body height and main fuel used for cooking, which are modifiable nutritional and environmental factors that can be improved through short, medium and long term health, educational and socio-economic interventions.

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Conflicts of interest

All authors declare that they have no conflict of interest.

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