Research Article

Maternal under-nutrition and anaemia factors associated with low birth weight babies in Yemen

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ABSTRACT

Background: Low birth weight is one of the main contributors to very high infant and under-five mortality rates in developing countries. The study aimed to identify the predicting risk factors for LBW in Yemen.

Methods: An institutional-based, cross-sectional study was conducted from September 2014 to March 2015 and September 2015 to January 2016. Study procedures have included completing a questionnaire, maternal measurement of mid upper arm circumference, testing for haemoglobin level in mothers and weighing all targeted neonates. Descriptive, cross tabling and binary logistic regression analyses were used.

Results: A total of 585 mother-neonate pairs were interviewed and examined for LBW and the associated risk factors. Logistic regression analysis identified three significant independent predicting factors; maternal under-nutrition (odds ratio (OR) 11.4, 95% CI 3.8 - 35.2), maternal anemia (OR 5.3, 95% CI 1.5 - 18.6) and rural residents (OR 0.2, 95% CI 0.1 - 0.7).

Conclusions: Incidence of LBW in these communities was high. Maternal under-nutrition, maternal anaemia and rural settlements were significantly associated with babies with low weight at birth. There is a need for continued focus on maternal nutrition at the time of conception and during pregnancy both for the optimum fetomaternal health and national development.

Keywords: Maternal nutrition, Maternal anaemia, Low birth weight, Children, Yemen

INTRODUCTION

Low birth weight (LBW) is a common public health problem in the world and an important cause of childhood morbidity and mortality in low resource settings.¹ It has been defined by world health organization (WHO) as weight of live born infants of less than 2,500 grams, regardless of gestational age or any other etiology.² The disease and its consequences have a strong link with the health status of under five years' children, adversely affects their growth and development and put them at risk of death or growth retardation, poor cognition and school performance, neurological sequels and complications of chronic illnesses in early and later life.^{1,3}

Globally, the burden of LBW has found to be at 15.5% of all births, with above 20 million neonates a year, the majority of them are from developing countries. It has been identified that the incidence rates in Asia; range from 5.2% to 30%, sub-Saharan Africa; range from 7% to 18%, Latin America; range from 9% to 17.9% while in North America; range from 6% to 6.9% and Europe; range from 4% to 7%.^{4,5}

Contributing risk factors are many and varied to obstetric, medical and nutritional factors. Studies from the world have reported that birth interval, maternal height, age, BMI during pregnancy, gestational age, family income, malaria, infectious disease, female infant, and history of clampsia and/or placenta previa are more likely to

associate with LBW outcomes.⁶⁻¹² In Yemen, LBW has been documented as a public health concern and one study has found that younger mothers and bleeding during pregnancies are more likely to produce LBW but however, very little are known about the association of LBW with maternal nutrition status.^{13,14} Evidences from the world have indicated significant association of maternal under-nutrition and LBW, reinforces the importance of good nutrition for mothers in reducing child and maternal illnesses and deaths.¹⁵⁻¹⁸

Among other things, Yemen is one of the poorest countries in the Arab World, has in economic development lagged seriously behind the neighbouring Gulf States. In March 2015, the poor country has expressed a civil armed conflict, spread to 21 of the 22 Yemen's Governorates, contributing to the worsening of the health and humanitarian situation, has left a total of 14.42 million on food insecure status (including 7.6 million severely food insecure), 19.33 million lack adequate access to clean water, sanitation and hygiene, nearly 320,000 children are severely malnourished, and 15.2 million people on need for basic health services, including more than 522,000 pregnant women (constituting 15%), of whom are more prone to higher risk pregnancies.¹⁹⁻²¹

UNICEF, World Food Program (WFP) and governmental and non-governmental organizations have responded to health and nutrition needs, formulated and strengthen the 2016 Country Annual Plan (CAP) with a goal of reducing child and maternal morbidity and mortality from preventable disease, including malnutrition. However, The principal interventions of the outlined goal require health and nutrition programs targeted on the basis of vulnerability, risk factors and burden. In the present study, we attempted to assess the LBW and its association to nutritional status of mothers. More specifically, we aimed to identify the incidence of LBW within these communities and to determine the risk factors for the observed babies with low weight.

The upcoming results are on line with the United Nations' Sustainable Development Goals (SDG) of decreasing childhood and maternal illnesses and deaths, would help in improving our understanding of the predicting factors of LBW and in developing better intervention programs targeted these communities within Yemen.

METHODS

Study area and population

This study took place in Hadramout, Aden and Lahj Governorates, Republic of Yemen. It constitutes about a half the area of Yemen (Yemen area = 550,000 km²) and an estimated population at 3,061,320, out of 26.2 million total Yemeni population. Health services are provided by both public and private health sectors, however, maternal health and child health care indicators are poor and far

from those of other countries in Middle East. Some indicators are: under-5 mortality rate 53 per 1000 live births, maternal mortality ratio 148 maternal death per 100,000 births, and total fertility rates 4.4 children per women.¹⁹

Study design and period

This was a prospective institutional based, cross sectional study, took place in Hadramout, Aden and Lahj Governorates – Yemen between September 2014 to March 2015 and September 2015 to October 2015 among pregnant women whom all were at birth during study period. Main health facilities with a 24 hour essential obstetric services were enrolled in the study.

Sampling

The computer programme Win Episcopo 2.0 was used to calculate the sample size of this study. The estimation of our sample size based on understanding that the expected prevalence of LBW is 15% and level of confidence 95%, calculates the true prevalence ± 5 . The required sample size is 196 children on each location (Aden, Hadramout and Lahj Governorates). There are 5% were expecting to refuse or continue in the study, so, total of 617 children were sought to complete the whole study.

Inclusion criteria

Inclusion criteria are all pregnant women at term presented for normal labour and had given birth to live newborns in the health facilities. All neonates of LBW were followed for 28 days after delivery, and their outcomes have been classified as; cured, discharged with sequel, or death.

Exclusion criteria

Exclusion criteria are mothers with multiple pregnancies, still births, and critical cases need immediate intervention. LBW neonates defined as the weight of live born infants of less than 2,500 grams, regardless of gestational age or any other etiology.²

Six health facilities (hospitals), each equipped with 24 hour essential obstetric services, inpatient, outpatient services and trained staff were reached. Initially, the head of health affairs and/or hospitals were approached to seek approval of study to be conducted. Next, meetings with health staff, doctors, midwives and lab technicians were arranged in each targeted health facility. Detailed information, background, objectives, targeted population and importance of the study in addressing LBW in the country were discussed.

Simple random sample selection was applied to the study population and each eligible woman have been reached with basic concepts in LBW, definition, causes and risk factors, the magnitude of the problem and its negative impacts on the family and the community at all, the study

objectives and procedures. Thereafter, all participants were asked to provide written consent. The processes of collecting the data only start after obtaining consent. In each study location, there were two well-trained midwives have engaged in the process of data collection. Both study assistants were undergone training session by the investigator to ensure the quality of the interviews. In circumstances where the obstetric ward was loaded and/or participants have found to be ill, the study team contributed in relieving and providing essential obstetric care according to the national protocol and all for free of charge. The data for the questionnaire were on line with delivery notes and have been focused on maternal and foetal problems linked with LBW outcomes, categorized into:

- Demographic characteristics, as, age; residence; education level; and household socio-economic status.
- Reproductive behaviours and service accessibility, as, birth order; use of family planning; and time to nearest facility.
- Maternal health care and nutritional status, as, timing of first antenatal visit; haemoglobin level and maternal MUAC screening.
- Birth outcome, including, size of the baby at birth; gestational age; and sex of the baby.

All participants have undergone examination for maternal and neonate anthropometric measurements. Adult MUAC tape was used as a proxy of maternal body weight and has been known as a world food programme indicator of maternal undernutrition.²³ All participants have underwent MUAC tape measurement conducted in the first hour after birth on the left mid upper arm circumference in the right – handed studied participant and right mid upper arm circumference of left-handed participants. Recorded to the nearest 0.1 cm, a MUAC less than 23 cm considered as a

cut-off point. All neonates of the targeted participants have examined for their weight within first hour of birth. Standard beam scale from CROWN, have been used to weigh the neonate, and a result of less 2.500 gm considered as a cut-off point for LBW. Meanwhile, a cut-off point less than 1500 gm has considered as a very low birth weight and that one less than 1000 gm described as extremely low birth weight. For the level of haemoglobin in pregnant women, the World Health Organization standard with Hb less 11 g/L has been used as a cut-off point for anaemia in pregnancies.²³ All participants were assigned a unique personal identification number (PIN), and used as a key in the data collection procedures. Informed consent is the only link between the PIN and personal information and kept in a locked secure room. Samples that sent to the lab for anaemia analysis were anonymised and only identified by the PIN number. All the data in questionnaire and electronic database was anonymised and protected using password protected devices.

Data analysis

Descriptive tables were used in data analysis and the general characteristics of the sample size have been calculated using the proportion and percentages from the total sample size. SPSS statistics (SPSS Inc., Chicago, USA) version 18 has been used in the study analysis and p value < 0.05 was considered statistically significant.

RESULTS

A total of 617 child bearing women aged 15-45 years were involved in the study. 32 women were not able to complete the whole process of data collection. A total of 585 child-bearing women and 585 neonates were involved in data processing and analysis. A total of 107 (18%) out of 585 infants had found to have LBW.

Table 1: Correlation of infants with low birth weight and demographic characteristics.

		LBW		Chi (2)	df*	P value
		Yes N: %	No N: %			
Residence	Urban	39: 14.3	234: 85.7	5.493 ¹	1	0.012**
	Rural	68: 21.8	244: 78.2			
Education	Illiterate	59: 20.1	235: 79.9	1.206 ²	1	0.272**
	Can read	48: 16.6	242: 83.4			
Maternal age group						
<19		40: 24.4	124: 75.6	25.387 ⁴	2	0.026**
19-30		65: 16.6	326: 83.4			
>30		2: 6.9	27: 93.1			
Socio-economic						
Good		19: 17.4	90: 82.6	6.919 ⁵	2	0.031**
Moderate		25: 13	168: 87			
Poor		63: 22.4	218: 77.6			

0 cell (0.0%) have expected count less than 5. The minimum expected count is 49.93¹; 53.13²; 35.67³; 5.31⁴ and 20.01⁵; *. df = degrees of freedom; **2 sided Fisher's exact test.

Table 2: Correlation of infants of low birth weight to maternal health care and nutritional status.

		LBW		Chi(2)	df*	P value
		Yes N: %	No N: %			
ANC	No	80: 20.5	310: 79.5	3.866 ¹	1	0.030**
	1-4	27: 13.8	168: 86.2			
Maternal anaemia	Yes	83: 21.3	307: 78.7	7.0006 ²	1	0.005**
	No	24: 12.3	171: 87.7			
Maternal undernutrition	Yes	71: 68.9	32: 31.1	214.515 ³	1	0.000**
	No	36: 7.5	446: 92.5			

0 cell (0.0%) have expected count less than 5. The minimum expected count is 35.67¹; 35.67² and 18.84³; *. df = degrees of freedom; **2 sided Fisher's Exact Test.

Demographically, the overall incidence of LBW had found to be higher and statistically significant among participants from rural areas (chi (2); 5.493, df; 1 and p=0.012. There was no significant variation in the education level to LBW incidence, indicating that LBW in the study population are distributed in both groups. The differences in age group distribution to overall LBW incidence were slightly higher among the 19-30 ages, and statistically significant among people from poor socio-economic status (Table 1).

A total of 103 (17.6%) of the studied participants were found to have maternal under-nutrition. A chi-square test for independence has indicated a significant association between maternal under-nutrition and LBW infants (chi (2); 214.515, df; 1, p=0.000). Micronutrient iron deficiency was also significantly associated with LBW

infants (chi (2); 7.0006; df; 1 and p=0.005). This indicates that maternal undernutrition and maternal anaemia are more likely to produce LBW infants. Pregnant women with no antenatal care were significantly more likely to produce LBW infants (chi (2); 3.866, df; 1 and p=0.030) (Table 2).

Birth outcomes have indicates slight increases toward females but statistically was not significant (chi (2); 1.625, df; 1 and p=0.202). Meanwhile, infants with gestational age less than 37 weeks were significantly associated with LBW outcomes (chi (2); 69285, df; 1 and p=0.000) (Table 3). In relation to reproductive services and accessibilities, there was significant association between time to the nearest health facilities and LBW outcomes, indicates more likely the incidence of LBW as distances to nearest health facility increased.

Table 3: Correlation of infants with low birth weight to birth outcomes, reproductive services and accessibility.

		LBW		Chi (2)	df*	P value
		Yes N: %	No N: %			
Sex of newborn	M	33: 15.6	183: 84.3	1.625 ¹	1	0.202**
	F	73: 19.4	294: 80.1			
Gestational age	<37	36: 56.3	28: 43.8	69.285 ²	1	0.000**
	>37	71: 13.6	450: 86.4			
Family planning	Yes	57: 21.8	204: 78.2	3.970 ³	1	0.046**
	No	50: 15.4	274: 84.6			
Time to nearest HF	<1hr	30: 13	201: 87	7.185 ⁴	1	0.005**
	>1hr	77: 21.8	277: 78.2			
Gravidity	1	15: 11.9	111: 88.1	4.560 ⁵	2	0.102**
	2-4	47: 20.7	180: 79.3			
	>5	45: 19.6	185: 80.4			

0 cell (0.0%) have expected count less than 5. The minimum expected count is 39.76¹; 11.71²; 47.74³; 42.25⁴ and 23.13⁵*. df = degrees of freedom; **2 sided Fisher's Exact Test.

Direct logistic regression was performed to assess the association of a number of factors on the likelihood that pregnant women would produce LBW neonates. The model contained nine independent variables; resident

(whether rural or urban), time to nearest health facility, gestational age of the newborn, maternal undernutrition, maternal anaemia, age group, family planning, ANC and socio-economic status.

The full model containing all predictors was statistically significant; chi (2) = 238555, $p < 0.001$, indicating that the model was able to distinguish between pregnant women with LBW outcomes and pregnant women with no LBW outcomes. The model as a whole explained between 33.6% (Cox and Snell R square) and 54.7% (Nagelkerke R square) of the variance of LBW outcomes, and correctly classified 91.4% of cases. The table shown three of the independent variables made a unique statistically significant contribution to the model; maternal under-

nutrition, maternal anaemia, and rural residents. The strongest predictors of producing LBW infants were the presence of maternal under-nutrition and maternal anaemia with odds ratio of 11.48 and 5.36 respectively. This indicate that pregnant women who had under-nutrition were over 11 times and 5 times more likely to produce LBW infants than those who did not complaining of maternal under-nutrition nor maternal anaemia respectively, controlling for other factors in the model (Table 4).

Table 4: Logistic regression of contributing factors to LBW outcomes among study population.

Risk factor	Odds ratio (95% CI)	p-value
Residence	0.267 (0.107 - 0.666)	<0.005
Maternal age group	1.455 (0.694 - 3.049)	0.599
Socio-economic status	0.747 (0.321 - 1.737)	0.750
ANC	1.426 (0.754 - 2.695)	0.275
Maternal undernutrition	11.489 (3.754 - 35.155)	<0.001
Maternal Anaemia	5.369 (1.549 - 18.608)	<0.008
Gestational age of the newborn	1.798 (0.707 - 4.575)	0.218
Use of family planning services	0.908 (0.449 - 1.836)	0.788
Time to the nearest health facility	0.557 (0.220 - 1.413)	0.218

DISCUSSION

In this study, maternal undernutrition and maternal anaemia were identified as strongest predicting factors of low birth weight outcomes. The importance of these findings furthers evidence base that good nutrition of women at the time of conception and during pregnancy are crucial for the health of the mother, healthy fetal life and in enhancing national development at large scale.¹⁵

This study indicates that the prevalence of LBW in the fixed health facilities is 18%, slightly lower than the 22% prevalence documented in Sanaa city, the capital of Yemen.¹⁴ Both estimates are considered high, however, high prevalence in Sanaa city may attributed to a high altitudes, approximately 3500 meters above sea level, in comparison to coastal population in the recent study, making a differences between the two studies are more understood.²⁴

In the region, the study from Oman have examined 534 singleton live births for maternal and neonatal factors influencing preterm birth and LBW in Oman and found the incidence of LBW at 13.7%.⁶ Oman is a border country to Yemen, and relatively, has well established health system and better living conditions. The current study had revealed significant findings related to the following factors; rural residences ($P < 0.012$); 19-30 maternal age group ($p < 0.026$); poor socio-economic status ($p < 0.031$); no ante-natal care ($p < 0.030$); maternal anaemia ($p < 0.005$); maternal under-nutrition ($p < 0.001$); gestational age less than 37 weeks ($p < 0.001$); use of

family planning services ($p < 0.046$) and time to nearest health facility ($p < 0.005$). The three factors found to have the strongest association with LBW outcomes in this study were; rural residences; maternal under-nutrition; and maternal anaemia.

In corresponding to the demographic characteristics, the current study indicates that women from rural residence were significantly linked with LBW outcomes. The finding is consistent with research from countries with similar settings, indicating that women from rural residences are more likely to produce LBW neonates.^{11,25} This is better explained by the fact that women from rural areas have inappropriate maternal care, poor access to health services and inadequate food supply. Maternal under-nutrition with MUAC less than 23 cm was significantly correlated to LBW outcomes. The finding is consistent with the study by Makki from Yemen and is in collaborates with several studies in the world have linked maternal nutritional status with adverse birth outcomes.¹⁴

In Yemen, there has been a concern of an increasing numbers of LBW outcomes in the health facilities but, however, there has been no nationally representative assessment of LBW and its association with maternal under-nutrition. In similar low resource settings, the associations of maternal under-nutrition with LBW outcomes have been documented. Recent study by Dahlui and colleagues from Nigeria has studied the risk factors for LBW and identified maternal weight less than 70 kg as a predicting factor of LBW outcomes (aOR 1.92; 95% CI 1.32-2.78).²⁶

The study by Assefa and colleagues from Ethiopia, have conducted an observational cohort study on 1295 live birth and pregnant women to measure the incidence and determinants of LBW in a rural population; they found the incidence of LBW at 28.3% and was significantly associated with maternal MUAC less than 23 cm (OR 1.6; 95% CI 1.19-2.19).²⁷

Another study from Sudan, has examined 578 deliveries for low BMI, anaemia and poor perinatal outcome in a rural hospital in eastern Sudan and they found significant association of maternal undernutrition by low BMI with LBW (OR 1.8; 95% CI 1.0-3.2; $p=0.02$).⁹ Similarly, the current finding is consistent with reports from Asia have indicated correlation of maternal under-nutrition with LBW outcomes.^{28,29} Sen and colleagues from India have conducted a cross-sectional study on 503 mothers about the association of maternal nutritional status, body composition and socio-economic variables with LBW in west Bengal; they found 17.30% have LBW and both maternal weight and MUAC were best surrogate measures of LBW.⁸ The study by Janjua and colleagues from Pakistan has tested 540 mother-infant pairs for determinants of LBW in urban Pakistan; they concluded that poor nutritional status and inadequate antenatal care were main predictors of LBW.²⁸

Further, the study of Karim and Masci-Taylor from Bangladesh on the association between birth weight, socio-demographic variables and maternal anthropometry in an urban sample from Dhaka has concluded the maternal weight at term and MUAC less than 23cm were predictors of birth outcomes.²⁹ In Brazil, an interesting unmatched case-control study on 43,944 live born infants delivered in the institution between 1986 and 2004 was performed, analysed data of factors associated with LBW and they found low maternal weight was a factor associated with LBW.³⁰ These altogether have supported the evidence of the current study and reinforce the importance of good nutritional status of mothers.

Coincides of LBW with poor maternal nutritional status indicates that mothers are not merely the affecting group but rather, it adversely affects the optimum fetal and child nutrition and development, increasing childhood morbidity and mortality, impairs cognitive function, motor and socio-emotional development, accompanied with poor school performance and learning capacities as well as lowering work capacity and productivity.

Implications for practice indicates a need of continuing both national and international efforts toward improving nutritional status of mothers and conducting MUAC screen of mothers before conception and during pregnancy for early detection and management. WFP has recommended use of adult MUAC tape with a cut-off point of less than 23 cm as an indicator of maternal nutritional status in developing countries and the tool appeared to be effective and feasible, however, some controversies about its

sensitivities and specificities in predicting LBW have been currently raised up.^{31,32}

In the current study, maternal anaemia was significantly associated with LBW (OR 5.3; 95% CI 1.5-18.6, $P<0.008$), indicating that mothers with iron deficiency anaemia are more likely to produce LBW. The finding supports Makki's study from Yemen¹⁴ and is in agreement with an excellent, recently published systematic review and meta-analysis has been carried out by Rahman and colleagues in order to estimate the pooled prevalence of anaemia, the association between maternal anaemia and pregnancy outcomes, and the population-attributable fraction (PAF) of these outcomes that are due to anaemia in low- and middle-income countries.³³

Defined anaemic group as pregnant women having hemoglobin concentration <10 g/dl or <11 g/dl, or hematocrit values $<33\%$ or $<34\%$ depending on the study, have included a total of 29 and 26 studies out of 8182 articles reviewed in the systematic review and meta-analysis respectively. The study outcome had revealed an overall, 42.7% (95% CI 37.0%-48.4%) with anaemia among studied pregnant women, and significantly associated with LBW (RR: 1.31; 95% CI 1.13-1.51), indicating that anaemia among pregnant women in low- and middle-income countries is substantial, and still a common risk of LBW. Early case detection and appropriate prevention and management will play an essential role in decreasing this morbid illness.

The strength of this study lies on its statistical analysis and an outcome which was among a limited number of studies in the country having addressed LBW and its associated risk factors. However, the study has some limitations that must be taken into consideration. Firstly, this is an institutional-based study and in case of Yemen, where majority of births took place at homes, the true burden of LBW may be underestimated.

It is possible that a community-based study would have produced an accurate estimation and even more statistically significant associations of contributing factors and LBW. Secondly, there was a concern that the participants were came from coastal areas and there was no representative sample from the internal high altitude area; so thus, the study cannot be generalized to the entire population. However, the catchment population in the current study was representative, complement existing evidence have been conducted in the internal high altitude area and all have shared similar characteristics living condition.

CONCLUSION

Incidence of LBW in these communities was high. Maternal under-nutrition, maternal anaemia and rural settlements were significantly associated with babies with low weight at birth.

There is a need for continued focus on maternal nutrition at the time of conception and during pregnancy both for the optimum fetomaternal health and national development.

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