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Determinants of Low Birth Weight in Afghanistan: A cross-sectional analysis of the Demographic and Health Survey 2015

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ABSTRACT

Objectives: This study aimed to investigate the factors associated with low birth weight (LBW) in Afghanistan.

Design: Cross-sectional study.

Setting: This study used Afghanistan Demographic and Health Survey (AfDHS) 2015 data.

Participants: Facility-based data from 2,773 weighted live-born children were included in our analysis.

Primary and secondary outcome measures: The primary outcome was LBW, defined as birthweight <2.5 kilograms (kg).

Results: Out of 2,773 newborns, 15.5% (n=431) had LBW. A majority of these newborns were females (58.3%, n=251), had a mother with no formal schooling (70.5%, n=304), and lived in urban areas (63.4%, n=274) and in the Central region of Afghanistan (59.7%, n=257). In multivariable analysis, female children (adjusted odds ratio [AOR]: 1.9; 95% confidence interval [CI]: 1.3-2.9), residence in Central (AOR: 3.5; 95% CI: 1.8-6.9), Central Western (AOR: 3.0; 95% CI: 1.4-6.3) and Southern Western (AOR: 4.0; 95% CI: 1.7-9.2) regions had positive association with LBW. On the other hand, newborns with primary (AOR: 0.5; 95% CI: 0.3-0.8) and secondary/higher (AOR: 0.3; 95% CI: 0.1-0.9) maternal education, birth interval ≥48 months (AOR: 0.4; 95% CI: 0.1-0.9), belonging to the richest wealth quintile (AOR: 0.2; 95% CI: 0.1-0.6), birth order 5-6 (AOR: 0.5; 95% CI: 0.3-0.9) and rural residence (AOR: 0.3; 95% CI: 0.2-0.6) had decreased odds of LBW.

Conclusions: Multiple factors had positive association with LBW in Afghanistan. Maternal, Neonatal and Child Health (MNCH) programs should focus on enhancing maternal education, promoting birth spacing and ensuring birth preparedness by primi-gravida women to prevent LBW. To reduce the overall burden of LBW, women of the poorest wealth quintiles, those living in urban areas and residents of Central, Central Western, and Southern Western regions should also be prioritized.

Key words: Afghanistan, global health, low birth weight, birth weight, factors, and determinants.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- The survey used validated and standardized survey tools to interview survey participants.
- We used low birth weight (LBW) data which were verified through records, preventing recall bias.
- The study included only facility-based data because almost of all the home deliveries did not record birth weight, resulting in the exclusion of a significant proportion of the study sample.
- Our results lack a temporal relationship between the exposure and the outcome variables due to the cross-sectional design of the study.
- Because we included only data from women who survived childbirth, selection bias may have impacted our results.

INTRODUCTION

Globally, there has been a substantial reduction in child mortality over the past few decades; however, significant challenges remain.[1 2] For instance, although the under-five child mortality reduced by 56% between 1990 and 2016, the neonatal mortality declined by only 41% during the same period.[3] Out of the estimated 5.6 million under-five children who die annually, more than three-fourths of them die due to preventable causes. These deaths occur mostly in low and middle-income countries (LMIC).[3] Furthermore, the reduction of under-five mortality has been attributed to the prevention and control of infectious diseases among children one or more years old.[4] Therefore, infant mortality, and particularly neonatal mortality, have become the leading cause of death in children under five.[5] Neonatal deaths alone comprised about half (46%) of the under-five mortality in 2016.[3]

Low birth weight (LBW), defined as birth weight less than 2.5 kilograms (kg) irrespective of gestational age,[6] is one of the leading causes of neonatal mortality.[7 8] LBW neonates are prone to develop sepsis, another leading cause of neonatal mortality.[9] Even after this stage in life, these children may suffer long-term neurodevelopmental complications including a deficit in cognition, attention, and neuromotor functioning.[10 11] LBW is a hindrance for achieving the Sustainable Development Goals' (SDGs) targets related to neonatal and under-five mortality reduction. The SDGs aim for a reduction of neonatal mortality rate (NMR) and under-five mortality rate (U5MR) to 12 and 25 per thousand live-births by 2030, respectively.[12] Furthermore, achieving these targets could be more challenging for LMICs, as a large proportion of LBW babies are born in these countries.[13-15] Most LMICs including Afghanistan have a higher prevalence of LBW babies compared to developed countries.

Afghanistan is a landlocked country in South Asia. The total area of this country is 652,230 km^2 and the estimated population size is about 34 million.[16] Like other South Asian developing countries, Afghanistan is also experiencing a slower reduction in neonatal mortality than that of under-five mortality which may impede the country's progress to achieve the SDG targets.[3 17] Kibria et al. analyzed the Afghanistan Demographic and Health Survey 2015 (AfDHS 2015) data to investigate the determinants of early neonatal mortality in Afghanistan. The authors found that smaller than average birth size neonates had two-folds higher probability of death.[17] The updated knowledge on the determinants of LBW could help policymakers of Afghanistan to plan and design maternal, neonatal and child health (MNCH) programs to address this problem. Prior studies that investigated the determinants of LBW in other countries have found that advanced maternal age[7 8 18], being a female child[13 19], poor maternal educational achievement[7 13 19 20], poor household wealth index[13 19 20], and rural residence[7 8 11 21] as important factors impacting this occurrence. Although other studies have examined the determinants of LBW, there remains a lack of evidence about factors associated with LBW in Afghanistan. We attempted to fill existing gaps in literature to assess the determinants of LBW in Afghanistan using recent data from AfDHS 2015.

METHODS

data source

The AfDHS 2015 was the first DHS in Afghanistan. The AfDHS 2015 was a cross-sectional survey conducted from June 2015 to February 2016. This survey utilized a nationally representative sample implemented by the Central Statistics Organization (CSO) and the Ministry of Public Health (MoPH), Afghanistan.[22]

sampling design

The AfDHS 2015 used a two-stage sampling strategy to enroll participants. The target group for this survey was women of reproductive age (15-49 years). All residents in selected households were eligible to participate. A total of 25,741 households were selected for the final sample. Among them, 98% agreed for anthropometric measurement. The detailed sample selection process is shown in Supplementary File 1. The details of this survey including survey design, methodologies, questionnaires, sample size calculation, and results have been reported elsewhere.[22]

survey tools and data collection

Three standard sets of questionnaires were used by the AfDHS 2015: women's, men's, and household's questionnaires. The women's questionnaire was adapted according to the local context and pre-tested to collect the socio-demographic information (e.g., age, sex, household wealth index, place of residence). The questionnaire was then translated into local language (Dari and Pashto) and then back-translated into English to maintain the quality. Data was collected through face to face interview.[22]

study variables

The outcome variable of this study was birth weight, dichotomized into low (<2.5 kg) and normal (≥2.5 kg) birth weights. Trained data collectors asked each respondent (mother) to provide a detailed birth history for children born in the preceding five years. The survey included questions about antenatal, delivery, and postnatal complications. Birth weights were recorded in grams from birth records.[22] We included birth weight records as these were more reliable than birth weight reported by the mothers which may introduce recall bias in the study.[23] Only data from the most recent child was included. Data from mothers with stillbirth child were excluded.

128 Based on literature review and the structure of the AfDHS 2015 dataset, the following independent variables were selected: maternal age (in years), sex of the child, maternal education level, maternal occupation, preceding birth interval (in months), parity (i.e., birth order), iron pill consumption, number of visits for antenatal care (ANC), wealth status, place of residence and province of residence.[7 8 11 13 18-21] Table 1 provides a description of the study variables along with categories.

Table 1: List of study variables

Study variables	Description and categories
Outcome Variable	Weight of the child at birth (0=normal birth weight [≥2500 grams]; 1= low birth weight [<2500 grams]).
Explanatory Variables	
Maternal age	Maternal age during child-birth (0= ≤19 years; 1= 20-34 years; 2= ≥ 35 years).
Sex	Sex of the child at birth (0=male; 1= female).
Maternal education	Education level of the mother (0 = no formal education; 1 = primary; 2= secondary or above).
Maternal occupation	Working status of the mother (0= not working; 1= working).
Preceding birth interval	Interval between last pregnancy and current pregnancy (0= first birth; 1 = <24 months; 2 = 24-47 months; 3= ≥48 months).
Parity	The number of pregnancies reaching viable gestational age (including live births and stillbirths) (0 = 1-2; 1 = 3-4; 2 = 5-6; 3 = ≥ 7).
Took iron pill	Mother's intake of iron pill during pregnancy of the studied child (0 = no; 1 = yes).
Number of antenatal care visit	Number of antenatal care received by the mother during pregnancy of the studied child

	(0= no visit [0]; 1= inadequate [1-3]; 2 = adequate [≥4]).
Household wealth status	Household wealth quintile (0 = poorest; 1 = poorer; 2 = middle; 3 = richer; 4 = richest).
Place of residence	Type of the cluster (0= urban1 = rural).
Region of residence	Region of residence within the country (0 = North Eastern; 1 = North Western; 2= Central Eastern; 3 = Central; 4 = Central Western; 5 = Southern Eastern; 6 = Southern Western).

statistical analysis

Weighted descriptive statistics (frequency and percentage) were used to present the socio-demographic characteristics of the respondents. Next, simple and multivariable logistic regression analyses were conducted to investigate the association between LBW with explanatory variables. Variables which showed *p-value* < 0.20 in bivariate analyses were included in the multivariable model. The significance level of 0.20 was considered sufficient to prevent residual confounding in the final multivariable model.[25] Logistic regression analysis accounted for the cluster sampling design of the survey. Variance inflation factors (VIF) were assessed to check multi-collinearity among the variables. To assess the internal validity of the regression model, the F-adjusted mean residual goodness-of-fit test was used to measure the internal validity of the regression model. Both unadjusted and adjusted odds ratio (OR) were reported. The AfDHS 2015 used principal component analysis to stratify household wealth status into quintiles.[22] All the analyses were done using Stata 13.0 (Stata Corporation, College Station, TX, USA).[25] The authors followed Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement in writing the manuscript (Supplementary File 2).

ethical consideration

The AfDHS 2015 received ethical approval from the ICF Institutional Review Board and the Ministry of Public Health of Afghanistan. Written informed consent was taken from the participants. In cases of minor participants, assent form was signed by the respondents and written informed consent was given by the adult guardian.[23] Data were accessed from DHS program with prior approval.

patient involvement

Patients were not involved in the study.

RESULTS

Characteristics of the study sample

A total of 2,896 weighted children had birth weight measurements taken. Among them, 123 had home delivery and were excluded. The final sample size of this study was 2,773 children. Table 2 presents the weighted distribution of the respondents according to background characteristics. Of the included children, 2,342 (84.5%) had normal birth weight and 431 (15.5%) children had LBW. More than half of the surveyed children were males (53.3%, n=1,477). However, a greater proportion of female children had LBW than normal weight (58.3% [n=251] vs 44.6% [n=1,045]). Approximately three-fifths (60.7%, n=1,683) of mothers did not receive any formal education, higher among the LBW children (70.5% [n=304] versus 58.9% [n=1,378]). Less than half of the mothers (44.0%, n=1,221) received 4 or more ANC visits, but 15.2% (n=420) of them never received any ANC visit. Regarding preceding birth interval, preceding births (43.3%, n =1,202) mostly took place between 24-47 months. Around one-fifth of the surveyed children were the first birth (20.7%, n=574), and this proportion was greater among LBW children than normal birth weight children (24.3% [n=105] versus 20.0% [n=469]). Nearly half (47.5%, n=1,316) of the respondents belonged to the richest wealth quintile. Almost equal proportions of the children were from urban (51.4%, n= 1,425) and rural areas (48.6%, n=1,348).

Table 2: Distribution of study children according to background characteristics (N=2,773)

Variables	Total (n= 2,773)		Normal Birth Weight (n=2,342)		Low Birth Weight (n=431)	
	Frequency	Percentage (%) *	Frequency	Percentage (%)*	Frequency	Percentage (%)*
Maternal age (years)						
≤20	316	11.4	280	11.9	36	8.4
21-34	2,119	76.4	1,756	75.0	363	84.3
35-49	338	12.2	306	13.1	32	7.3
Sex of child						
Male	1,477	53.3	1,297	55.4	180	41.7
Female	1,296	46.7	1,045	44.6	251	58.3
Maternal education						
No Education	1,683	60.7	1,378	58.9	304	70.5
Primary	400	14.4	350	14.9	51	11.7
Secondary or above	690	24.9	613	26.2	77	17.8

Maternal occupation						
Not Working	2,493	89.9	2,097	89.6	396	91.8
Working	280	10.1	244	10.4	35	8.2
Preceding birth interval (months)						
First Birth	574	20.7	469	20.0	105	24.3
<24	518	18.7	441	18.8	77	17.9
24-47	1,202	43.3	996	42.6	205	47.6
≥ 48	479	17.3	435	18.6	44	10.2
Parity						
1-2	1,078	38.9	897	38.3	181	42.0
3-4	740	26.7	632	27.0	108	25.0
5-6	534	19.3	475	20.3	59	13.7
≥ 7	421	15.2	337	14.4	84	19.4
Took iron pill						
No	1,962	70.8	1,628	69.5	334	77.4
Yes	811	29.2	714	30.5	97	22.6
Number of ANC visit						
No (0)	420	15.2	375	16.0	45	10.4
Inadequate (1-3)	1,132	40.8	942	40.3	189	43.9
Adequate (4 or More)	1,221	44.0	1,024	43.8	197	45.7
Wealth status						
Poorest	220	7.9	173	7.4	47	10.9

Poorer	288	10.4	248	10.6	40	9.2
Middle	321	11.6	277	11.8	43	10.0
Richer	628	22.6	558	23.8	71	16.4
Richest	1,316	47.5	1,086	46.4	231	53.5
Place of residence						
Urban	1,425	51.4	1,151	49.2	274	63.4
Rural	1,348	48.6	1,190	50.8	158	36.6
Region of residence						
North Eastern	213	7.7	194	8.3	19	4.5
North Western	465	16.8	429	18.3	37	8.5
Central East	179	6.5	165	7.0	14	3.2
Central	1,274	45.9	1,017	43.4	257	59.7
Central Western	341	12.3	276	11.8	64	14.9
Southern Eastern	225	8.1	197	8.4	28	6.5
Southern Western	76	2.7	64	2.8	12	2.7

*ANC: Antenatal Care; *: column percentage*

Factors Influencing LBW

Table 3 shows the results of the logistic regression analyses. In the final model, sex of the child, maternal education, preceding birth interval, parity, wealth status, place of residence and region of residence were significant factors associated with LBW. A female child had almost two-fold higher odds (adjusted OR (AOR): 1.9; 95% confidence interval [CI]: 1.2-2.8) of being LBW compared to a male child. Mothers who received primary (AOR: 0.5; 95% CI: 0.3-0.8) or secondary/higher education (AOR: 0.3; 95% CI: 0.1-0.9) had significantly lower odds of delivering a LBW baby compared to mothers without any formal education. Children born after a birth interval of ≥48 months were less likely to have LBW (AOR: 0.4; 95% CI: 0.1-0.9) compared to the first-born child. The odds of having a LBW child decreased with higher wealth index; however, only richer (AOR: 0.3; 95% CI: 0.1-0.6) and richest (AOR: 0.2; 95% CI: 0.1-0.6) quintiles had significant associations. The odds also reduced significantly for a parity of 5-6 (AOR: 0.5; 95% CI: 0.3-0.9) compared to a parity of 1-2. Children in rural regions had 70% lower odds of LBW (AOR: 0.3; 95% CI: 0.2-0.6) than their urban counterparts. Compared to the North Eastern region, however, respondents living in Central (AOR: 3.5; 95% CI: 1.8 -6.9), Central Western (AOR: 3.0; 95% CI: 1.4- 6.3) and Southern Western (AOR: 3.9; 95% CI: 1.7-9.3) regions were more likely to have children with LBW.

Table 3: Bivariate and multivariable logistic regression to identify factors influencing low birth weight in Afghanistan

Variables	COR (95% CI)	AOR (95% CI)[2]
Maternal age (years)		
≤20	Ref.	
21-34	1.6 (0.8- 3.3)	
35-49	0.8 (0.3- 2.0)	
Sex of child		
Male	Ref.	Ref.

Female	1.7* (1.1- 2.7)	1.9** (1.2- 2.8)
Maternal education		
No Education	Ref.	Ref.
Primary	0.7[1] (0.4- 1.0)	0.5*** (0.3- 0.8)
Secondary or above	0.6 (0.2 - 1.4)	0.3* (0.1- 0.9)
Maternal occupation		
Not Working	Ref.	
Working	0.8 (0.3- 2.0)	
Preceding birth interval (months)		
First Birth	Ref.	Ref.
<24	0.8 (0.4- 1.7)	0.9 (0.4- 2.2)
24-47	0.9 (0.5- 1.6)	0.9 (0.6- 1.6)
≥ 48	0.5* (0.2- 0.9)	0.4* (0.1- 0.9)
Parity		
1-2	Ref.	Ref.
3-4	0.8 (0.5- 1.5)	1.0 (0.5-1.9)
5-6	0.6[1] (0.3- 1.2)	0.5* (0.3-0.9)
≥ 7	1.23 (0.6- 2.8)	1.1 (0.5- 2.4)
Took iron pill		
No	Ref.	Ref.
Yes	1.5[1] (0.9- 2.4)	1.3 (0.8- 2.3)
Number of ANC visit		
No visit (0)	Ref.	Ref.

Inadequate (1-3)	1.7 (0.5- 5.3)	2.3 (0.6- 8.9)
Adequate (4 or More)	1.6[1] (0.8- 3.2)	2.1 (0.8- 5.1)
Wealth status		
Poorest	Ref.	Ref.
Poorer	0.6 (0.3- 1.2)	0.5 (0.2- 1.1)
Middle	0.6 (0.3- 1.2)	0.4* (0.2- 0.9)
Richer	0.5[1] (0.2- 1.0)	0.3*** (0.1- 0.6)
Richest	0.8 (0.3- 1.9)	0.2*** (0.1- 0.6)
Place of residence		
Urban	Ref.	Ref.
Rural	0.6[1] (0.3-1.0)	0.3*** (0.2- 0.6)
Region of residence		
North Eastern	Ref.	Ref.
North Western	0.9 (0.5- 1.6)	0.9 (0.5- 1.8)
Central East	0.8 (0.4- 1.7)	0.9 (0.4- 1.9)
Central	2.5** (1.3- 5.1)	3.5*** (1.8- 6.9)
Central Western	2.3** (1.2- 4.4)	3.0*** (1.4- 6.3)
Southern Eastern	1.4[1] (0.9- 2.3)	1.8 (0.9- 3.4)
Southern Western	1.8[1] (1.0- 3.2)	3.9*** (1.7- 9.3)

*1. p < 0.2, * p < 0.05, ** p < 0.01, *** p < 0.001, ANC: Antenatal care, AOR: Adjusted odds ratio, CI: Confidence interval, COR: Crude odds ratio.*

2. Variable with p-value less than <0.2 from unadjusted model were included into multivariable analysis

DISCUSSION

In this study we investigated the determinants of LBW among hospital-born babies in Afghanistan. The following factors have significant association with LBW after adjustment: female child, lower maternal education, poor wealth index, urban residence, and residence in Central, Central Western, and Southern Western regions. To the best of our knowledge, this is the first epidemiological study to investigate determinants of LBW in Afghanistan.

We showed that female children had higher odds of having LBW than male children. This result is similar to the findings of a multi-country study that analyzed DHS data from 10 developing countries.[13] The birth weight of male children is usually higher than female children.[26] This difference starts after 28 weeks of gestation. Although the exact mechanism impacting the difference in birth weight is unknown, it might be due to androgen activities or the Y chromosome that carries genetic material for fetal growth. As a result, male children have higher intrauterine growth and birth weight than their female counterparts.[27]

Maternal poor education was also associated with LBW in our study. This finding is also consistent with the previous studies done in developing countries.[7 13 19 20 28 29] LBW of these children may be due to poor ANC, less access to health care, and less awareness. All of these factors could have an adverse effect on fetal growth and increase a mother's chances of delivering a LBW child.[30] Therefore, educational interventions for women are needed in order to reduce the prevalence of LBW in Afghanistan. Similarly, lower wealth index had a positive association with LBW, which is also consistent with the findings of other low and middle-income countries (LMICs).[13 19 20 31] A woman from a lower socio-economic background may also have poor educational attainment and knowledge, ability or awareness about maternal care, thereby increasing the risk for LBW.[19] MNCH programs in Afghanistan should target poor socioeconomic groups for the prevention of LBW.

Our results also showed that duration of preceding birth interval was associated with LBW. In our study, a preceding birth interval of ≥ 48 months had lower odds of LBW than if the child was the first-born. By contrast, other studies found that short inter-pregnancy intervals were a strong risk factor for LBW.[33-36] One explanation is that longer birth intervals allow mothers to recover physically and psychologically, and may also improve nutritional status – all of which have a positive effect on fetal growth.[37] Kibria and colleagues also showed that shorter inter-pregnancy interval was also an important risk factor for early neonatal mortality in Afghanistan.[17] Promotion of birth spacing or family planning can be a beneficial intervention to prevent LBW, and may thereby improve prevention of neonatal mortality in Afghanistan.

Maternal parity was found to be another important predictor of LBW. Grand multiparity (i.e., parity 5-6) was found to have a negative association with LBW. In different studies, the lowest birth weight was observed among the newborns of primigravida women.[37-42] The physiological conditions in nulliparity have a direct effect on birth weight.[43] Uteroplacental blood flow is lower in nulliparous women. This causes a decreased supply of oxygen & nutrients, and ultimately results in less fetal growth.[44 45] In addition, the uterine size and capacity limits the fetal growth in the first pregnancy.[46] Finally, the maternal immune environment has greater effect on first pregnancy than the subsequent ones which restrict the fetal growth. All these factors jointly predispose the first born child to have LBW.[47] With each subsequent pregnancy, the body learns to adapt to the changes that occur as the fetus grows.[48 49] More programmatic targeting should be directed towards nulliparous pregnant women to reduce LBW.

We observed that urban residents had a higher likelihood of delivering an LBW baby. This finding is discrepant with previous studies where rural residence was found to be a significant risk factor.[7 8 11 21] Further exploration is needed to determine what factors influence LBW in the urban areas of Afghanistan. Residence in Central, Central Western, South Western regions of Afghanistan also had a higher probability of LBW. The regional inequality in LBW has been noted in other studies.[50 51] These regional pockets should be given additional emphasis to reduce the geographical inequity.

Although advanced maternal age is a known risk factor for LBW,[7 8 13 18 52] no significant association was observed in this study. Perhaps if appropriate nutrition is maintained and mothers receive proper ANC, giving birth to a normal weight baby may be possible despite advanced maternal age.[53 54] We also did not find any association between number of ANC visits and LBW. In previous studies, inadequate number of ANC visits was an important risk factor of LBW.[13 55] This may be due to the inclusion of only facility births data in our study to capture birth weights. Mothers who opt for a facility birth tend to have more ANC visits.[56] This could mask the investigated association.

STRENGTHS AND LIMITATIONS

Our study has several notable strengths. First, the AfDHS 2015 used validated and standardized survey tools to interview survey participants. Second, this study used LBW data which were verified through records, removing the opportunity for recall bias. However, limitations of the present study also warrant discussion. This study included only facility-based data because almost of all the home deliveries did not record birth weight. Therefore, a significant proportion of study samples were excluded from the study. As this is a cross-sectional study, we cannot ensure a temporal relationship between the exposure and the outcome variable. Only the data of survived women was analyzed, therefore excluding determinants of the more adversely affected mothers may cause additional selection bias. We did not investigate some known risk factors for LBW including genetic [57 58] or environmental factors [59-61] due to limitations of the AfHDS 2015 dataset. As the instruments used to measure birth weight were not calibrated or validated by the survey team, this could also cause some misclassification, though this misclassification is more likely to be non-differential in nature. Lastly, we don't know the exact timing of the birth weight measurement that could also cause some additional misclassification, as it is recommended to measure birth weight immediately after birth.[62]

CONCLUSIONS

This study identified a number of determinants of LBW in Afghanistan. Female children, lower maternal education, poor wealth index, urban residence, and residing in Central, Central Western, Southern Western regions of Afghanistan were important factors associated with LBW. Significance of factors from different levels indicate that a multifaceted approach is required to address the factors that have positive association with LBW. From a program planning perspective, to reduce the overall burden of LBW as well as reduction of childhood deaths in Afghanistan, policymakers and researchers should address these factors when forming programs on a country-wide basis.

LIST OF ABBREVIATION

AfDHS: Afghanistan Demographic and Health Survey

AOR: Adjusted odds ratio

CI: Confidence interval

LBW: Low birth weight

NMR: Neonatal mortality rate

OR: Odds ratio

SDG: Sustainable Development Goals

Contributors

RDG, KS and GMAK conceptualized the study. RDG, KS, VB and GMAK designed the study and acquired the data. RDG, MRH and GMAK conducted the data analysis. RDG, KS, VB and GMAK interpreted the data. RDG, and GMAK prepared the first draft. RDG, KS, VB, MRH and GMAK participated in critical revision of the manuscript and contributed to its intellectual improvement. All authors went through the final draft and approved it for submission.

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Competing Interests

None declared.

Patient consent

None Declared

Disclaimer

The authors are alone responsible for the integrity and accuracy of data analysis and the writing the manuscript.

Ethics approval

The datasets were obtained from DHS Programme with proper procedure. The study exempt from collecting ethical approval because the AfDHS 2015 received ethical approval from the ICF Institutional Review Board and the Ministry of Public Health of Afghanistan.

Data availability statement

330 Data are available at: https://www.dhsprogram.com/data/dataset/Afghanistan_Standard-
331 DHS_2015.cfm?flag=0. Following instruction, data are available to download.

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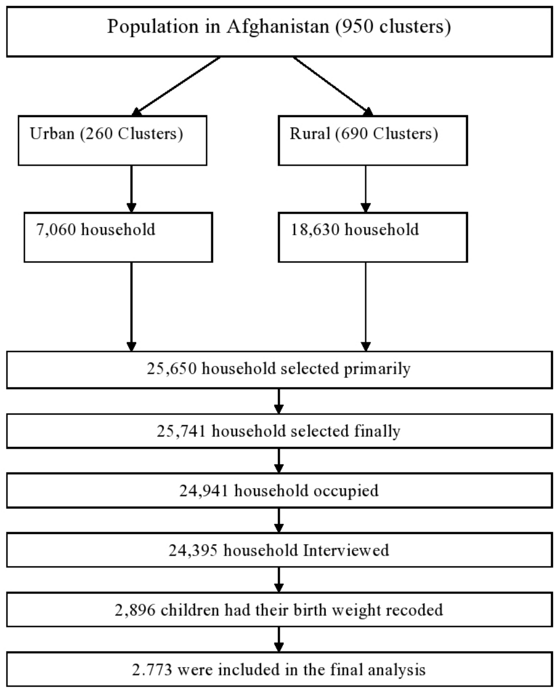
491 # Supplementary Materials:

492 **Supplementary File 1:** Flowchart showing the process of selecting the participants in the survey

493 **Supplementary File 2:** STROBE Checklist



449x582mm (72 x 72 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Title of the study: **Determinants of Low Birth Weight in Afghanistan: A cross-sectional analysis of the Demographic and Health Survey 2015**

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6-7
Objectives	3	State specific objectives, including any prespecified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	7-8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7-8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8-9
Bias	9	Describe any efforts to address potential sources of bias	9-10
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10
		(*b*) Describe any methods used to examine subgroups and interactions	Not applicable
		(*c*) Explain how missing data were addressed	Not applicable

		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Not applicable
		(*e*) Describe any sensitivity analyses	Not applicable
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11-14
		(b) Give reasons for non-participation at each stage	Not applicable
		(c) Consider use of a flow diagram	Not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11-14
		(b) Indicate number of participants with missing data for each variable of interest	Not applicable
Outcome data	15*	Report numbers of outcome events or summary measures	14-17
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	14-17
		(*b*) Report category boundaries when continuous variables were categorized	Not applicable
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Not applicable
Discussion			
Key results	18	Summarise key results with reference to study objectives	18
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	20-21
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	18-20
Generalisability	21	Discuss the generalisability (external validity) of the study results	20-21
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	22

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Title: Factors associated with Low Birth Weight in Afghanistan: A cross-sectional analysis of the Demographic and Health Survey 2015

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ABSTRACT

Objectives: This study aimed to investigate the factors associated with low birth weight (LBW) in Afghanistan.

Design: Cross-sectional study.

Setting: This study used data collected from the Afghanistan Demographic and Health Survey (AfDHS) 2015 .

Participants: Facility-based data from 2,773 weighted live-born children enrolled by a two-stage sampling strategy were included in our analysis.

Primary and secondary outcome measures: The primary outcome was LBW, defined as birthweight <2.5 kilograms (kg).

Results: Out of 2,773 newborns, 15.5% (n=431) had LBW. Most of these newborns were females (58.3%, n=251), had a mother with no formal schooling (70.5%, n=304), lived in urban areas (63.4%, n=274), or lived in the Central region of Afghanistan (59.7%, n=257). In multivariable analysis, residence in Central (adjusted odds ratio [AOR]:: 3.4; 95% confidence interval [CI]:: 1.7- 6.7), Central Western (AOR: 3.0; 95% CI: 1.5- 5.8) and Southern Western (AOR: 4.0; 95% CI: 1.7- 9.1) regions had positive association with LBW. On the other hand, male children (AOR:0.5; 95% CI: 0.4-0.8), newborns with primary maternal education (AOR: 0.5; 95% CI: 0.3-0.8) , birth interval ≥48 months (AOR: 0.4; 95% CI: 0.1-08), belonging to the richest wealth quintile (AOR: 0.2; 95% CI: 0.1-0.6), and rural residence (AOR: 0.3; 95% CI: 0.2-0.6) had decreased odds of LBW.

Conclusions: Multiple factors had association with LBW in Afghanistan. Maternal, Neonatal and Child Health (MNCH) programs should focus on enhancing maternal education and promoting birth spacing to prevent LBW. To reduce the overall burden of LBW, women of the poorest wealth quintiles, those living in urban areas and residents of Central, Central Western, and Southwestern regions should also be prioritized.

Key words: Afghanistan, global health, low birth weight, birth weight, factors, and determinants.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- The survey used validated and standardized survey tools to interview survey participants.
- We used low birth weight (LBW) data which were verified through records, preventing recall bias.
- The study included only facility-based data because almost of all the home deliveries did not record birth weight, resulting in the exclusion of a significant proportion of the study sample.
- Our results lack a temporal relationship between the exposure and the outcome variables due to the cross-sectional design of the study.
- Because we included only data from women who survived childbirth, selection bias may have impacted our results.

INTRODUCTION

Globally, there has been a substantial reduction in child mortality over the past few decades; however, significant challenges remain.[1 2] For instance, although under-five child mortality decreased by 56% between 1990 and 2016, the neonatal mortality declined by only 41% during the same period. Out of the estimated 5.6 million under-five children who die annually, more than three-fourths die due to preventable causes. These deaths occur mostly in low and middle-income countries (LMICs).[3] Furthermore, the reduction of under-five mortality has been attributed to the prevention and control of infectious diseases among children one or more years old.[4] Therefore, infant mortality, and particularly neonatal mortality, have become the leading causes of death in children under five.[5] Neonatal deaths alone comprised about half (46%) of the under-five mortality in 2016.[3]

Low birth weight (LBW), defined as birth weight less than 2.5 kilograms (kg) irrespective of gestational age,[6] is one of the leading causes of neonatal mortality.[7 8] LBW neonates are prone to developing sepsis, another leading cause of neonatal mortality.[9] Even after this stage in life, these children may suffer long-term neurodevelopmental complications including deficits in cognition, attention, and neuromotor functioning.[10 11] LBW is a hindrance for achieving the Sustainable Development Goals' (SDGs) targets related to neonatal and under-five mortality reduction. The SDGs aim for a reduction of the neonatal mortality rate (NMR) and under-five mortality rate (U5MR) to 12 and 25 per thousand live-births by 2030, respectively.[12] Furthermore, achieving these targets could be more challenging for LMICs, as a large proportion of LBW babies are born in these countries.[13-15] Most LMICs including Afghanistan have a higher prevalence of LBW babies compared to developed countries.

Afghanistan is a landlocked country in South Asia. The total area of this country is 652,230 km^2 and the estimated population size is about 34 million.[16] Like other South Asian developing countries, Afghanistan is experiencing a slower reduction in neonatal mortality than under-five mortality, which may impede the country's progress to achieve the SDG targets.[3 17] While investigating the determinants of early neonatal mortality in Afghanistan, Kibria et al. (2018) found that neonates whose birth size was smaller than average had two-folds higher probability of death compared to neonates of normal birth size.[17] Updated knowledge on the determinants of LBW could help policymakers of Afghanistan plan and design maternal, neonatal and child health (MNCH) programs to address this problem. Prior studies that investigated the determinants of LBW in other countries have found that advanced maternal age[7 8 18], maternal short stature and low body mass index[13], being a female child[13 19], poor maternal educational achievement[7 13 19 20], maternal stress[21], poor household wealth index[13 19 20], and rural residence[7 8 11 22] were important factors impacting this occurrence. Although other studies have examined the determinants of LBW, there remains a lack of evidence about factors associated with LBW in Afghanistan. We attempted to fill existing gaps in literature to assess the determinants of LBW in Afghanistan using recent data from AfDHS 2015.

METHODS

Data Source

The AfDHS 2015 was the first DHS in Afghanistan. The AfDHS 2015 was a cross-sectional survey conducted from June 2015 to February 2016. This survey utilized a nationally representative sample implemented by the Central Statistics Organization (CSO) and the Ministry of Public Health (MoPH), Afghanistan.[23]

Sampling Design

The AfDHS 2015 used a two-stage sampling strategy to enroll participants. The target group for this survey was women of reproductive age (15-49 years). All residents in selected households were eligible to participate. At the first stage, 950 clusters were randomly selected (260 in urban and 690 in rural area). A fixed number of 27 households were selected randomly from each cluster. A total of 25,741 households were selected for the final sample. Among them, 98% of the households provided consent. The detailed sample selection process is shown in Figure 1. The details of this survey including survey design, methodologies, questionnaires, sample size calculation, and results have been reported elsewhere.[23]

Figure 1: Flowchart showing the process of selecting the participants in the survey

Survey Tools and Data Collection

Three standard sets of questionnaires were used by the AfDHS 2015: women's, men's, and household's questionnaires. With the women's questionnaire, information was collected on respondents' background, reproductive health, contraception, pregnancy and postnatal care, child immunization, health and nutrition, marriage and sexual activity, fertility preferences, husband's background and women's work, HIV/AIDS, other health issues including tuberculosis and hepatitis, fistula, maternal mortality and domestic violence. This questionnaire was adapted according to the local context and pre-tested to collect the aforementioned information. The questionnaire was then translated into the local languages (Dari and Pashto) and then back-translated into English to maintain the quality. Data was collected through face-to-face interviews.[23]

Study Variables

The outcome variable of this study was birth weight, dichotomized into low (<2.5 kg) and normal (≥2.5 kg) birth weights. Trained data collectors asked each respondent (mother) to provide a detailed birth history for children born in the preceding five years. The survey included questions about antenatal, delivery, and postnatal complications. Birth weights were recorded in grams from birth records.[22] We included birth weight records as these were more reliable than birth weights reported by the mothers, thus reducing the likelihood of introducing recall bias in the study.[24] Only data from the most recent child born was included. Data from mothers with stillbirths were excluded.

Based on literature review and the structure of the AfDHS 2015 dataset, the following independent variables were selected: maternal age (in years), sex of the child, maternal education level, maternal occupation, preceding birth interval (in months), parity (i.e., birth order), iron pill consumption, number of visits for antenatal care (ANC), wealth status, place of residence and province of residence.[7 8 11 13 18-20 22] Table 1 provides a description of the study variables along with categories.

Table 1: List of study variables

Study variables	Description and categories
Outcome Variable	Weight of the child at birth (0=normal birth weight [≥2500 grams]; 1= low birth weight [<2500 grams]).

Explanatory Variables	
Maternal age	Maternal age during child-birth (0= ≤20 years; 1= 21-34 years; 2= ≥ 35 years).
Sex	Sex of the child at birth (0=female; 1= male).
Maternal education	Education level of the mother (0 = no formal education; 1 = primary; 2= secondary or above).
Maternal occupation	Working status of the mother (0= not working; 1= working).
Preceding birth interval	Interval between last pregnancy and current pregnancy (0= first birth; 1 = <24 months; 2 = 24-47 months; 3= ≥48 months).
Parity	The number of pregnancies reaching viable gestational age (including live births and stillbirths) (0 = primipara [1];; 1 = multipara [2-4]; 2 = grand multipara [≥5]).
Took iron pills	Mother's intake of iron pills during pregnancy of the studied child (0 = yes; 0 = no).
Number of antenatal care visits	Number of antenatal care visits received by the mother during pregnancy of the studied child (0= no visit [0]; 1= inadequate [1-3]; 2 = adequate [≥4]).
Household wealth status	Household wealth quintile (0 = poorest; 1 = poorer; 2 = middle; 3 = richer; 4 = richest).
Place of residence	Type of the cluster (0= urban; 1 = rural).
Region of residence	Region of residence within the country (0 = North Eastern; 1 = North Western; 2= Central Eastern; 3 = Central; 4 = Central Western; 5 = Southern Eastern; 6 = Southern Western).

Statistical Analysis

Weighted descriptive statistics (frequency and percentage) were used to present the socio-demographic characteristics of the respondents. Next, simple and multivariable logistic regression analyses were conducted to investigate the association between LBW with explanatory variables. Variables which showed *p-value* < 0.20 in bivariate analyses were included in the multivariable model. The significance level of 0.20 was considered sufficient to prevent residual confounding in the final multivariable model.[25] Logistic regression analysis accounted for the cluster sampling design of the survey. Variance inflation factors (VIF) were used to check multi-collinearity among the variables. To assess the internal validity of the regression model, the F-adjusted mean residual goodness-of-fit test was used to measure the internal validity of the regression model.[26] Both unadjusted and adjusted odds ratio (OR) were reported. Based on the presence of different household assets, the wealth index was calculated. Principal component analysis was used to create the wealth index that was supplied with the data. Then, the wealth index was divided into quintiles to calculate the wealth status of the respondents.[23] All the analyses were done using Stata 13.0 (Stata Corporation, College Station, TX, USA).[27] The authors followed the guidelines outlined in the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement in writing the manuscript (Supplementary File 1).

Ethical Consideration

The AfDHS 2015 received ethical approval from the ICF Institutional Review Board and the Ministry of Public Health of Afghanistan. Written informed consent was taken from the participants. In cases of minor participants, the assent form was signed by the respondents and written informed consent was given by the adult guardian.[24] Data were accessed from the DHS program with prior approval.

patient involvement

Patients were not involved in the study. This household-based survey collected data from women of reproductive age (15-49 years).

RESULTS

Characteristics of the Study Sample

A total of 2,896 weighted children had birth weight measurements taken. Among them, 123 had home deliveries and were excluded. The final sample size of this study was 2,773 children. Table 2 presents the weighted distribution of the respondents according to background characteristics. Of the included children, 2,342 (84.5%) had normal birth weight and 431 (15.5%) children had LBW. More than half of the surveyed children were males (53.3%, n=1,477). However, a greater proportion of female children had LBW than normal weight (58.3% [n=251] vs 44.6% [n=1,045]). Approximately three-fifths (60.7%, n=1,683) of mothers did not receive any formal education, higher among the LBW children (70.5% [n=304] versus 58.9% [n=1,378]). Less than half of the mothers (44.0%, n=1,221) received 4 or more ANC visits, but 15.2% (n=420) of them never attended any ANC visits. Preceding births (43.3%, n =1,202) mostly took place between 24-47 months. Around one-fifth of the surveyed children were the first birth (20.7%, n=574), and this proportion was greater among LBW children than normal birth weight children (24.3% [n=105] versus 20.0% [n=469]). Nearly half (47.5%, n=1,316) of the respondents belonged to the richest wealth quintile. Almost equal proportions of

196 the children were from urban (51.4%, n= 1,425) and rural areas (48.6%, n=1,348). The
197 unweighted distribution of the respondents (N=2,533) is shown in Supplementary Table 1.

198

199 **Table 2: Distribution of study children according to background characteristics (N=2,773)**

Variables	Total (n= 2,773)		Normal Birth Weight (n=2,342)		Low Birth Weight (n=431)	
	Frequency	Percentage (%) *	Frequency	Percentage (%)*	Frequency	Percentage (%)*
Maternal age (years)						
≤20	316	11.4	280	11.9	36	8.4
21-34	2,119	76.4	1,756	75.0	363	84.3
35-49	338	12.2	306	13.1	32	7.3
Sex of child*						
Male	1,477	53.3	1,297	55.4	180	41.7
Female	1,296	46.7	1,045	44.6	251	58.3
Maternal education						
No Education	1,683	60.7	1,378	58.9	304	70.5
Primary	400	14.4	350	14.9	51	11.7
Secondary or above	690	24.9	613	26.2	77	17.8
Maternal occupation						
Not Working	2,493	89.9	2,097	89.6	396	91.8
Working	280	10.1	244	10.4	35	8.2

Preceding birth interval (months)						
First Birth	574	20.7	469	20.0	105	24.3
<24	518	18.7	441	18.8	77	17.9
24-47	1,202	43.3	996	42.6	205	47.6
≥ 48	479	17.3	435	18.6	44	10.2
Parity						
Primipara	574	20.7	469	34.7	105	24.3
Multipara	1,244	44.8	1,060	45.3	184	42.6
Grand multipara	955	34.5	813	20.0	132	33.1
Took iron pills						
Yes	811	29.2	714	30.5	97	22.6
No	1,962	70.8	1,628	69.5	334	77.4
Number of ANC visits						
No (0)	420	15.2	375	16.0	45	10.4
Inadequate (1-3)	1,132	40.8	942	40.3	189	43.9
Adequate (4 or More)	1,221	44.0	1,024	43.8	197	45.7
Wealth status						
Poorest	220	7.9	173	7.4	47	10.9
Poorer	288	10.4	248	10.6	40	9.2
Middle	321	11.6	277	11.8	43	10.0
Richer	628	22.6	558	23.8	71	16.4
Richest	1,316	47.5	1,086	46.4	231	53.5

Place of residence						
Urban	1,425	51.4	1,151	49.2	274	63.4
Rural	1,348	48.6	1,190	50.8	158	36.6
Region of residence*						
North Eastern	213	7.7	194	8.3	19	4.5
North Western	465	16.8	429	18.3	37	8.5
Central East	179	6.5	165	7.0	14	3.2
Central	1,274	45.9	1,017	43.4	257	59.7
Central Western	341	12.3	276	11.8	64	14.9
Southern Eastern	225	8.1	197	8.4	28	6.5
Southern Western	76	2.7	64	2.8	12	2.7

** $p < 0.05$, ANC: Antenatal Care; *: column percentage*

Factors Associated with LBW

Table 3 shows the results of the logistic regression analyses. In the final model, sex of the child, maternal education, preceding birth interval, wealth status, place of residence and region of residence were significant factors associated with LBW. A male child had almost 50% lower odds (adjusted OR (AOR): 0.5; 95% confidence interval [CI]: 0.4-0.8) of having LBW compared to a female child. Mothers who received primary education (AOR: 0.5; 95% CI: 0.3-0.8) had significantly lower odds of delivering a LBW baby compared to mothers without any formal education. Children born after a birth interval of ≥48 months were less likely to have LBW (AOR: 0.3; 95% CI: 0.1-0.8) compared to the first-born child. The odds of having a LBW child decreased with higher wealth index; middle (AOR: 0.4; 95% CI: 0.2- 0.9), richer (AOR: 0.3;

95% CI: 0.1-0.6) and richest (AOR: 0.2; 95% CI: 0.1-0.6) quintiles had significant negative associations. Children in rural regions had 70% lower odds of LBW (AOR: 0.3; 95% CI: 0.2-0.6) than their urban counterparts. Compared to the North Eastern region, however, respondents living in Central (AOR: 3.4; 95% CI: 1.7- 6.7), Central Western (AOR: 3.0; 95% CI: 1.5- 5.8) and Southwestern (AOR: 4.0; 95% CI: 1.7- 9.1) regions were more likely to have children with LBW. The multivariable logistic regression without the sex variable (Supplementary Table 2) and separate analyses for male (Supplementary Table 3) and female (supplementary table 4) children yielded similar results. However, in case of female children, no intake of iron tablets by the mother during pregnancy was positively associated with LBW (AOR: 0.6; 95% CI: 0.4- 0.9) (Supplementary Table 4).

Table 3: Bivariate and multivariable logistic regression to identify factors influencing low birth weight in Afghanistan

Variables	COR (95% CI)	AOR (95% CI)[2]
Maternal age (years)		
≤20	Ref.	
21-34	1.6 (0.8- 3.3)	
35-49	0.8 (0.3- 2.0)	
Sex of child		
Male	0.6* (0.4-0.9)	0.5** (0.4-0.8)
Female	Ref.	Ref.
Maternal education		
No Education	Ref.	Ref.

Primary	0.7[1] (0.4- 1.0)	0.5*** (0.3- 0.8)
Secondary or above	0.6 (0.2 - 1.4)	0.3 (0.1- 1.0)
Maternal occupation		
Not Working	Ref.	
Working	0.8 (0.3- 2.0)	
Preceding birth interval (months)		
First Birth	Ref.	Ref.
<24	0.8 (0.4- 1.7)	0.8 (0.3- 1.8)
24-47	0.9 (0.5- 1.6)	0.8 (0.5- 1.4)
≥ 48	0.5* (0.2- 0.9)	0.3* (0.1- 0.8)
Parity		
Primipara	Ref.	
Multipara	0.8 (0.5-1.3)	
Grand multipara	0.8 (0.4-1.6)	
Took iron pills		
Yes	Ref.	Ref.
No	0.7[1] (0.4- 1.1)	0.8 (0.4- 1.3)
Number of ANC visits		
No visits (0)	Ref.	Ref.
Inadequate (1-3)	1.7 (0.5- 5.3)	2.3 (0.5- 9.6)
Adequate (4 or More)	1.6[1] (0.8- 3.2)	2.1 (0.8- 5.1)
Wealth status		
Poorest	Ref.	Ref.

Poorer	0.6 (0.3- 1.2)	0.5 (0.2- 1.1)
Middle	0.6 (0.3- 1.2)	0.4* (0.2- 0.9)
Richer	0.5[1] (0.2- 1.0)	0.3*** (0.1- 0.6)
Richest	0.8 (0.3- 1.9)	0.2*** (0.1- 0.6)
Place of residence		
Urban	Ref.	Ref.
Rural	0.6[1] (0.3-1.0)	0.3*** (0.2- 0.6)
Region of residence		
North Eastern	Ref.	Ref.
North Western	0.9 (0.5- 1.6)	0.9 (0.5- 1.7)
Central East	0.8 (0.4- 1.7)	0.9 (0.4- 1.9)
Central	2.5** (1.3- 5.1)	3.4*** (1.7- 6.7)
Central Western	2.3** (1.2- 4.4)	3.0*** (1.5- 5.8)
Southern Eastern	1.4[1] (0.9- 2.3)	1.8 (0.9- 3.5)
Southern Western	1.8[1] (1.0- 3.2)	4.0*** (1.7- 9.1)

*1. $p < 0.2$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, ANC: Antenatal care, AOR: Adjusted odds ratio, CI: Confidence interval, COR: Crude odds ratio.*

2. Variables with p-value less than <0.2 from unadjusted model were included into multivariable analysis

DISCUSSION

In this study, we investigated the factors associated with LBW among hospital-born babies in Afghanistan. The following factors had significant association with LBW after adjustment: female child, lower maternal education, poor wealth index, urban residence, and residence in Central, Central Western, and Southwestern regions. To the best of our knowledge, this is the first epidemiological study to investigate determinants of LBW in Afghanistan.

We showed that female children had higher odds of having LBW than male children. This result is similar to the findings of a multi-country study that analyzed DHS data from 10 developing countries.[13] The birth weight of male children is usually higher than female children.[28] This difference starts after 28 weeks of gestation. Although the exact mechanism impacting the difference in birth weight is unknown, it might be due to androgen activities or the Y chromosome that carries genetic material for fetal growth. As a result, male children have higher intrauterine growth and birth weight than their female counterparts.[29]

Poor maternal education was also associated with LBW in our study. This finding is also consistent with previous studies done in developing countries.[7 13 19 20 30 31] LBW of these children may be due to less access to health care, and less awareness about prenatal care. All of these factors could have an adverse effect on fetal growth and increase a mother's chances of delivering a LBW child.[31] Therefore, educational interventions for women are needed in order to reduce the prevalence of LBW in Afghanistan. Similarly, lower wealth index had a positive association with LBW, which is also consistent with findings from other low and middle-income countries (LMICs).[13 19 20 32] A woman from a lower socio-economic background may also have poor educational attainment and knowledge, ability or awareness about maternal care, thereby increasing the risk for LBW.[19] MNCH programs in Afghanistan should target poor socioeconomic groups for the prevention of LBW.

Our results also showed that duration of preceding birth interval was associated with LBW. In our study, a preceding birth interval of ≥ 48 months had lower odds of LBW than if the child was the first-born. Other studies found that short inter-pregnancy intervals were a strong risk factor for LBW.[33-36] One explanation is that longer birth intervals allow mothers to recover physically and psychologically, and may also improve nutritional status – all of which have a positive effect on fetal growth.[37] Kibria and colleagues also showed that shorter inter-pregnancy interval was also an important risk factor for early neonatal mortality in Afghanistan.[17] Promotion of birth spacing or family planning can be a beneficial intervention to prevent LBW, and may thereby improve prevention of neonatal mortality in Afghanistan.

We observed that urban residents had a higher likelihood of delivering an LBW baby. This finding is discrepant with previous studies where rural residence was found to be a significant risk factor.[7 8 11 22] Further exploration is needed to determine what factors influence LBW in the urban areas of Afghanistan. Residence in Central, Central Western, Southwestern regions of Afghanistan also had a higher probability of LBW. The regional inequality in LBW has been noted in other studies.[38 39] These regional pockets should be given additional emphasis to reduce the geographical inequity.

Although advanced maternal age is a known risk factor for LBW,[7 8 13 18 40] no significant association was observed in this study. Perhaps if appropriate nutrition is maintained and mothers receive proper ANC, giving birth to a normal weight baby may be possible despite advanced maternal age.[41 42] We also did not find any association between number of ANC visits and LBW. In previous studies, inadequate number of ANC visits was an important risk factor of

LBW.[13 43] This may be due to the inclusion of only facility births data in our study to capture birth weights. Mothers who opt for a facility birth tend to have more ANC visits.[44] This could mask the investigated association. Also, the positive association between maternal intake of iron tablets during pregnancy and LBW in the female child contradicts the existing literature[13]. This finding may be spurious, which needs further exploration.

STRENGTHS AND LIMITATIONS

Our study has several notable strengths. First, the AfDHS 2015 used validated and standardized survey tools to interview survey participants. Second, this study used LBW data which were verified through records, removing the opportunity for recall bias. However, limitations of the present study also warrant discussion. This study included only facility-based data because almost all of the home deliveries did not record birth weight. Therefore, a significant proportion of study samples were excluded from the study. As this is a cross-sectional study, we cannot ensure a temporal relationship between the exposure and the outcome variables. Only the data of survived women was analyzed, therefore excluding determinants of the more adversely affected mothers may cause additional selection bias. We did not investigate some known risk factors for LBW including genetic [45 46] or environmental factors [47-49] due to limitations of the AfHDS 2015 dataset. As the instruments used to measure birth weight were not calibrated or validated by the survey team, this could also cause some misclassification, though this misclassification is more likely to be non-differential in nature. Lastly, we do not know the exact timing of the birth weight measurement, thus adding some additional misclassification, as it is recommended to measure birth weight immediately after birth.[50]

CONCLUSIONS

This study identified several determinants of LBW in Afghanistan. Female children, lower maternal education, poor wealth index, urban residence, and residing in Central, Central Western, Southwestern regions of Afghanistan were important factors associated with LBW. Significance of factors from different levels indicate that a multifaceted approach is required to address the factors that have positive association with LBW. From a program planning perspective, to reduce the overall burden of LBW as well as reduction of childhood deaths in Afghanistan, policymakers and researchers should address these factors when forming programs on a country-wide basis. The regional pockets with high probability of having LBW (urban area and Central, Central Western, Southern Western regions of Afghanistan) should be given priority to reduce inequity. Maternal education should be promoted and women from the poorest wealth quintiles should be targeted by the Maternal, Neonatal and Child Health (MNCH) programs in order to prevent LBW.

LIST OF ABBREVIATIONS

AfDHS: Afghanistan Demographic and Health Survey

AOR: Adjusted odds ratio

CI: Confidence interval

LBW: Low birth weight

NMR: Neonatal mortality rate

OR: Odds ratio

SDG: Sustainable Development Goals

Contributors

RDG, KS and GMAK conceptualized the study. RDG, KS, VB and GMAK designed the study and acquired the data. RDG, MRH and GMAK conducted the data analysis. RDG, KS, VB and GMAK interpreted the data. RDG, and GMAK prepared the first draft. RDG, KS, VB, MRH and GMAK participated in critical revision of the manuscript and contributed to its intellectual improvement. All authors went through the final draft and approved it for submission.

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Competing Interests

None declared.

Patient consent

None Declared

Disclaimer

The authors are alone responsible for the integrity and accuracy of data analysis and the writing the manuscript.

Ethics approval

The datasets were obtained from DHS Programme with proper procedure. This study was exempt from collecting ethical approval because the AfDHS 2015 received ethical approval from the ICF Institutional Review Board and the Ministry of Public Health of Afghanistan.

Data availability statement

Data are available at: https://www.dhsprogram.com/data/dataset/Afghanistan_Standard-DHS_2015.cfm?flag=0. Following instruction, data are available to download.

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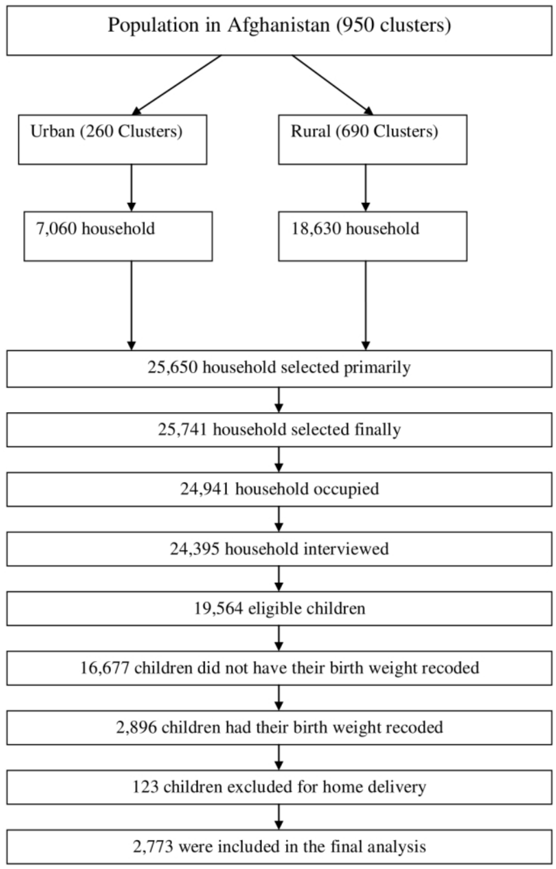
Supplementary Materials:

Supplementary File 1: STROBE Checklist

Supplementary File 2: Supplementary Tables



Flowchart showing the process of selecting the participants in the survey

143x186mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Title of the study: **Factors associated with Low Birth Weight in Afghanistan: A cross-sectional analysis of the Demographic and Health Survey 2015**

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6-7
Objectives	3	State specific objectives, including any prespecified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	7-8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7-8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8-9
Bias	9	Describe any efforts to address potential sources of bias	9-10
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10
		(*b*) Describe any methods used to examine subgroups and interactions	Not applicable

		(*c*) Explain how missing data were addressed	Not applicable
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Not applicable
		(*e*) Describe any sensitivity analyses	Not applicable
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11-14
		(b) Give reasons for non-participation at each stage	Not applicable
		(c) Consider use of a flow diagram	Not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11-14
		(b) Indicate number of participants with missing data for each variable of interest	Not applicable
Outcome data	15*	Report numbers of outcome events or summary measures	14-17
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	14-17
		(*b*) Report category boundaries when continuous variables were categorized	Not applicable
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Not applicable
Discussion			
Key results	18	Summarise key results with reference to study objectives	18
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	20-21
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	18-20
Generalisability	21	Discuss the generalisability (external validity) of the study results	20-21
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	23

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Supplementary Tables

Supplementary Table 1: Unweighted distribution of study children according to background characteristics (N=2,533)

Variables	Total (n= 2,533)		Normal Birth Weight (n=2,167)		Low Birth Weight (n=366)	
	Frequency	Percentage (%) *	Frequency	Percentage (%) *	Frequency	Percentage (%) *
Maternal age (years)						
≤20	315	12.4	276	12.7	39	10.7
21-34	1,859	73.4	1,573	72.6	286	78.1
35-49	359	14.2	318	14.7	41	11.2
Sex of child						
Male	1,388	54.8	1,213	56.0	175	47.8
Female	1,145	45.2	954	44.0	191	52.2
Maternal education						
No Education	1,740	68.7	1,473	68.0	267	73.0
Primary	307	12.1	269	12.4	38	10.4
Secondary or above	486	19.2	425	19.6	61	16.7
Maternal occupation						
Not Working	2,284	90.2	1,946	89.8	338	92.3
Working	249	9.8	221	10.2	28	7.7
Preceding birth interval (months)						
First Birth	526	20.8	453	20.9	73	19.9

<24	538	21.2	450	20.8	88	24.0
24-47	1,038	41.0	883	40.7	155	42.3
≥ 48	431	17.0	381	17.6	50	13.7
Parity						
Primipara (1)	526	20.8	453	20.9	73	19.9
Multipara (2-4)	1,090	43.0	915	42.2	175	47.8
Grand Multipara (≥5)	917	36.2	799	36.9	118	32.3
Took iron pill						
Yes	1,703	67.2	1,448	66.8	255	69.7
No	830	32.8	719	33.2	111	30.3
Number of ANC visits						
No (0)	381	15.0	327	15.1	54	14.8
Inadequate (1-3)	1,138	44.9	976	45.0	162	44.2
Adequate (4 or More)	1,014	40.0	864	39.9	150	41.0
Wealth status						
Poorest	272	10.7	206	9.5	66	18.0
Poorer	383	15.1	311	14.4	72	19.7
Middle	450	17.8	390	18.0	60	16.4
Richer	662	26.1	582	26.9	80	21.9
Richest	766	30.2	678	31.2	88	24.0
Place of residence						
Urban	996	39.3	846	39.0	150	41.0
Rural	1,537	60.7	1,321	61.0	216	59.0
Region of residence						
North Eastern	396	15.6	332	15.3	64	17.5

North Western	364	14.4	325	15.0	39	10.7
Central East	244	9.6	225	10.4	19	5.2
Central	734	29.0	612	28.2	122	33.3
Central Western	282	11.1	232	10.7	50	13.7
Southern Eastern	343	13.5	298	13.8	45	12.3
Southern Western	170	6.7	143	6.6	27	7.4

*ANC: Antenatal Care, * Column Percentage*

Supplementary Table 2: Bivariate and multivariable logistic regression (excluding the sex of the child) to identify factors influencing low birth weight in Afghanistan

Variables	COR (95% CI)	AOR (95% CI)[2]
Maternal age (years)		
≤20	Ref.	
21-34	1.6 (0.8- 3.3)	
35-49	0.8 (0.3- 2.0)	
Maternal education		
No Education	Ref.	Ref.
Primary	0.7[1] (0.4- 1.0)	0.5** (0.3-0.8)
Secondary or above	0.6 (0.2 - 1.4)	0.4 (0.1-1.0)
Maternal occupation		
Not Working	Ref.	
Working	0.8 (0.3- 2.0)	
Preceding birth interval (months)		
First Birth	Ref.	Ref.
<24	0.8 (0.4- 1.7)	0.8 (0.3-1.8)
24-47	0.9 (0.5- 1.6)	0.8 (0.5-1.4)
≥ 48	0.5* (0.2- 0.9)	0.3* (0.1-0.8)
Parity		
Primipara	Ref.	
Multipara	0.8 (0.5-1.3)	
Grand multipara	0.8 (0.4-1.6)	
Took iron pill		
Yes	Ref.	Ref.

No	0.7[1] (0.4- 1.1)	0.8 (0.5-1.3)
Number of ANC visits		
No visit (0)	Ref.	Ref.
Inadequate (1-3)	1.7 (0.5- 5.3)	2.3 (0.6-9.1)
Adequate (4 or More)	1.6[1] (0.8- 3.2)	2.0 (0.8-5.3)
Wealth status		
Poorest	Ref.	Ref.
Poorer	0.6 (0.3- 1.2)	0.5 (0.2-1.1)
Middle	0.6 (0.3- 1.2)	0.5* (0.2-0.9)
Richer	0.5[1] (0.2- 1.0)	0.3** (0.1-0.6)
Richest	0.8 (0.3- 1.9)	0.3** (0.1-0.6)
Place of residence		
Urban	Ref.	Ref.
Rural	0.6[1] (0.3-1.0)	0.3*** (0.1-0.6)
Region of residence		
North Eastern	Ref.	Ref.
North Western	0.9 (0.5- 1.6)	0.8 (0.5-1.6)
Central East	0.8 (0.4- 1.7)	0.9 (0.5-1.8)
Central	2.5** (1.3- 5.1)	3.1** (1.6-6.2)
Central Western	2.3** (1.2- 4.4)	2.7** (1.4-5.2)
Southern Eastern	1.4[1] (0.9- 2.3)	1.7 (0.9-3.1)
Southern Western	1.8[1] (1.0- 3.2)	3.9** (1.4-5.2)

*1. $p < 0.2$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, ANC: Antenatal care, AOR: Adjusted odds ratio, CI: Confidence interval, COR: Crude odds ratio.*

2. Variable with p-value less than <0.2 from unadjusted model were included into multivariable analysis

Supplementary Table 3: Bivariate and multivariable logistic regression to identify factors influencing low birth weight in Afghan male child

Variables	COR (95% CI)	AOR (95% CI)[2]
Maternal age (years)		
≤20	Ref.	
21-34	1.5 (0.6-3.5)	
35-49	0.6 (0.1-2.8)	
Maternal education		
No Education	Ref.	Ref.
Primary	2.4[1] (0.9-6.7)	0.4 (0.1-1.1)
Secondary or above	4.7** (1.5-13.1)	0.2** (0.1-0.5)
Maternal occupation		
Not Working	Ref.	
Working	0.8 (0.3-2.0)	
Preceding birth interval (months)		
First Birth	Ref.	Ref.
<24	2.1[1] (0.8-5.8)	0.7 (0.4-1.4)
24-47	1.4 (0.4-5.0)	1.1 (0.6-2.2)
≥ 48	1.3 (0.4-4.2)	0.4 (0.1-1.2)
Parity		
Primipara	Ref.	
Multipara	1.3 (0.6-2.8)	
Grand multipara	1.2 (0.5-2.8)	
Took iron pill		
Yes	Ref.	Ref.

No	1.1 (0.5-2.5)	1.1 (0.5-2.8)
Number of ANC visits		
No visit (0)	Ref.	Ref.
Inadequate (1-3)	0.6 (0.2-1.8)	0.8 (0.2-2.4)
Adequate (4 or More)	0.6[1] (0.3-1.2)	0.7 (0.3-1.9)
Wealth status		
Poorest	Ref.	Ref.
Poorer	0.9 (0.3-3.0)	0.4* (0.1-0.9)
Middle	0.6 (0.2-1.5)	0.2*** (0.0-0.4)
Richer	1.2 (0.5-2.9)	0.1*** (0.0-0.3)
Richest	2.3[1] (0.8-6.7)	0.1*** (0.0-0.3)
Place of residence		
Urban	Ref.	Ref.
Rural	0.6[1] (0.3-1.2)	0.2*** (0.1-0.4)
Region of residence		
North Eastern	Ref.	Ref.
North Western	0.6 (0.3-1.6)	0.7 (0.2-1.8)
Central East	0.7 (0.2-2.5)	1.0 (0.3-3.6)
Central	2.6* (1.1-6.4)	4.5** (1.6-12.4)
Central Western	2.6[1] (0.9-6.4)	3.6* (1.3-10.6)
Southern Eastern	2.5* (1.2-5.2)	3.9** (1.5-10.0)
Southern Western	1.7 (0.6-5.0)	3.1 (0.8-11.7)

*1. $p < 0.2$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, ANC: Antenatal care, AOR: Adjusted odds ratio, CI: Confidence interval, COR: Crude odds ratio.*

2. Variable with p-value less than <0.2 from unadjusted model were included into multivariable analysis

Supplementary Table 4: Bivariate and multivariable logistic regression to identify factors influencing low birth weight in Afghan female child

Variables	COR (95% CI)	AOR (95% CI)[2]
Maternal age (years)		
≤20	Ref.	
21-34	1.5 (0.6-4.1)	
35-49	0.9 (0.3-2.7)	
Maternal education		
No Education	Ref.	
Primary	0.8 (0.2-3.9)	
Secondary or above	1.1 (0.4-3.5)	
Maternal occupation		
Not Working	Ref.	
Working	0.8 (0.1-4.2)	
Preceding birth interval (months)		
First Birth	Ref.	Ref.
<24	2.0[1] (0.8-5.2)	0.9 (0.4-2.4)
24-47	2.2[1] (0.9-5.3)	0.7 (0.3-1.3)
≥ 48	3.4** (1.4-8.3)	0.3** (0.1-0.8)
Parity		
Primipara	Ref.	
Multipara	0.5 (0.3-1.1)	
Grand multipara	0.6 (0.2-1.4)	
Took iron pill		

Yes	Ref.	Ref.
No	0.4*** (0.3-0.6)	0.6* (0.4-0.9)
Number of ANC visits		
No visit (0)	Ref.	Ref.
Inadequate (1-3)	7.0** (2.0-24.5)	7.7* (1.6-36.0)
Adequate (4 or More)	6.7*** (2.7-16.7)	5.7** (1.9-17.1)
Wealth status		
Poorest	Ref.	Ref.
Poorer	0.5[1] (0.2-1.2)	0.6 (0.2-1.6)
Middle	0.9 (0.3-2.5)	1.0 (0.4-2.6)
Richer	0.5[1] (0.2-1.3)	0.6 (0.3-1.3)
Richest	0.4 (0.3-1.9)	0.5 (0.2-1.7)
Place of residence		
Urban	Ref.	Ref.
Rural	0.5[1] (0.3-1.1)	0.5 (0.2-1.0)
Region of residence		
North Eastern	Ref.	Ref.
North Western	1.2 (0.5-2.6)	1.1 (0.5-2.5)
Central East	1.0 (0.4-2.2)	0.8 (0.3-2.0)
Central	2.6* (1.1-6.4)	2.8** (1.2-6.2)
Central Western	2.4* (1.2-4.8)	2.8** (1.4-5.8)
Southern Eastern	0.8 (0.3-1.7)	0. (0.4-2.2)
Southern Western	1.8[1] (0.8-4.0)	4.0** (1.4-11.5)

*1. p < 0.2, * p < 0.05, ** p < 0.01, *** p < 0.001, ANC: Antenatal care, AOR: Adjusted odds ratio, CI: Confidence interval, COR: Crude odds ratio.*

2. Variable with p-value less than <0.2 from unadjusted model were included into multivariable analysis

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Title: Factors associated with Low Birth Weight in Afghanistan: A cross-sectional analysis of the Demographic and Health Survey 2015

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ABSTRACT

Objectives: This study aimed to investigate the factors associated with low birth weight (LBW) in Afghanistan.

Design: Cross-sectional study.

Setting: This study used data collected from the Afghanistan Demographic and Health Survey (AfDHS) 2015 .

Participants: Facility-based data from 2,773 weighted live-born children enrolled by a two-stage sampling strategy were included in our analysis.

Primary and secondary outcome measures: The primary outcome was LBW, defined as birth weight <2.5 kilograms (kg).

Results: Out of 2,773 newborns, 15.5% (n=431) had LBW. Most of these newborns were females (58.3%, n=251), had a mother with no formal schooling (70.5%, n=304), lived in urban areas (63.4%, n=274),or lived in the Central region of Afghanistan (59.7%, n=257). In multivariable analysis, residence in Central (adjusted odds ratio [AOR]:3.4; 95% confidence interval [CI]:1.7- 6.7), Central Western (AOR: 3.0; 95% CI: 1.5- 5.8) and Southern Western (AOR: 4.0; 95% CI: 1.7- 9.1) regions had positive association with LBW. On the other hand, male children (AOR:0.5; 95% CI:0.4-0.8),newborns with primary maternal education(AOR: 0.5; 95% CI: 0.3-0.8), birth interval ≥48 months (AOR: 0.4; 95% CI: 0.1-08), belonging to the richest wealth quintile (AOR: 0.2; 95% CI: 0.1-0.6), and rural residence (AOR: 0.3; 95% CI: 0.2-0.6) had decreased odds of LBW.

Conclusions: Multiple factors had association with LBW in Afghanistan. Maternal, Neonatal and Child Health (MNCH) programs should focus on enhancing maternal education and promoting birth spacing to prevent LBW. To reduce the overall burden of LBW, women of the poorest wealth quintiles, and residents of Central, Central Western, and South Western regions should also be prioritized. Further exploration is needed to understand why urban areas are associated with higher likelihood of LBW. In addition, research using nationally representative samples are required.

Key words: Afghanistan, global health, low birth weight, birth weight, factors, and determinants.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- The survey used validated and standardized survey tools to interview survey participants.
- We used low birth weight (LBW) data which were verified through records, preventing recall bias.
- The study included only facility-based data because almost of all the home deliveries did not record birth weight, resulting in the exclusion of a significant proportion of the study sample.
- Our results lack a temporal relationship between the exposure and the outcome variables due to the cross-sectional design of the study.
- Because we included only data from women who survived childbirth, selection bias may have impacted our results.

INTRODUCTION

Globally, there has been a substantial reduction in child mortality over the past few decades; however, significant challenges remain.[1 2] For instance, although under-five child mortality decreased by 56% between 1990 and 2016, the neonatal mortality declined by only 41% during the same period. Out of the estimated 5.6 million under-five children who die annually, more than three-fourths die due to preventable causes. These deaths occur mostly in low- and middle-income countries (LMICs).[3] Furthermore, the reduction of under-five mortality has been attributed to the prevention and control of infectious diseases among children one or more years old.[4] Therefore, infant mortality, and particularly neonatal mortality, have become the leading causes of death in children under five.[5] Neonatal deaths alone comprised about half (46%) of the under-five mortality in 2016.[3]

Low birth weight (LBW), defined as birth weight less than 2.5 kilograms (kg) irrespective of gestational age,[6] is one of the leading causes of neonatal mortality.[7 8] LBW neonates are prone to developing sepsis, another leading cause of neonatal mortality.[9] Even after this stage in life, these children may suffer long-term neurodevelopmental complications including deficits in cognition, attention, and neuromotor functioning.[10 11] LBW is a hindrance for achieving the Sustainable Development Goals' (SDGs) targets related to neonatal and under-five mortality reduction. The SDGs aim for a reductionof the neonatal mortality rate (NMR) and under-five mortality rate (U5MR) to 12 and 25 per thousand live-births by 2030, respectively.[12] Furthermore, achieving these targets could be more challenging for LMICs, as a large proportion of LBW babies are born in these countries.[13-15] Most LMICs including Afghanistan have a higher prevalence of LBW babies compared to developed countries.

Afghanistan is a landlocked country in South Asia. The total area of this country is 652,230 km^2 and the estimated population size is about 34 million.[16] Like other South Asian developing countries, Afghanistan is experiencing a slower reduction in neonatal mortality than under-five mortality, which may impede the country's progress to achieve the SDG targets.[3 17] While investigating the determinants of early neonatal mortality in Afghanistan, Kibria et al. (2018) found that neonates whose birth size was smaller than average had two-folds higher probability of death compared to neonates of normal birth size.[17] Updated knowledge on the determinants of LBW could help policymakers of Afghanistan plan and design maternal, neonatal and child health (MNCH) programs to address this problem. Prior studies that investigated the determinants of LBW in other countries have found that advanced maternal age[7 8 18], maternal short stature and low body mass index[13], being a female child[13 19], poor maternal educational achievement[7 13 19 20], maternal stress[21], poor household wealth index[13 1920], and rural residence[7 8 11 22] were important factors impacting this occurrence. Although other studies have examined the determinants of LBW, there remains a lack of evidence about factors associated with LBW in Afghanistan. We attempted to fill existing gaps in literature to assess the determinants of LBW in Afghanistan using recent data from AfDHS 2015.

METHODS

Data Source

The AfDHS 2015 was the first DHS in Afghanistan. The AfDHS 2015 was a cross-sectional survey conducted from June 2015 to February 2016. This survey utilized a nationally representative sample implemented by the Central Statistics Organization (CSO) and the Ministry of Public Health (MoPH), Afghanistan.[23]

Sampling Design

The AfDHS 2015 used a two-stage sampling strategy to enroll participants. The target group for this survey was women of reproductive age (15-49 years). All residents in selected households were eligible to participate. At the first stage, 950 clusters were randomly selected (260 in urban and 690 in rural areas). A fixed number of 27 households were selected randomly from each cluster. A total of 25,741 households were selected for the final sample. Among them, 98% of the households provided consent. The detailed sample selection process is shown in Figure 1. The details of this survey including survey design, methodologies, questionnaires, sample size calculation, and results have been reported elsewhere.[23]

Figure 1: Flowchart showing the process of selecting the participants in the survey

Survey Tools and Data Collection

Three standard sets of questionnaires were used by the AfDHS 2015: women's, men's, and household's questionnaires. With the women's questionnaire, information was collected on respondents' background, reproductive health, contraception, pregnancy and postnatal care, child immunization, health and nutrition, marriage and sexual activity, fertility preferences, husband's background and women's work, HIV/AIDS, other health issues including tuberculosis and hepatitis, fistula, maternal mortality and domestic violence. This questionnaire was adapted according to the local context and pre-tested to collect the aforementioned information. The questionnaire was then translated into the local languages (Dari and Pashto) and then back-translated into English to maintain the quality. Data was collected through face-to-face interviews.[23]

Study Variables

The outcome variable of this study was birth weight, dichotomized into low (<2.5 kg) and normal (≥2.5 kg) birth weights. Trained data collectors asked each respondent (i.e., mother) to provide a detailed birth history for children born in the preceding five years. The survey included questions about antenatal, delivery, and postnatal complications. Birth weights were recorded in grams from birth records.[22] We included birth weight records as these were more reliable than birth weights reported by the mothers, thus reducing the likelihood of introducing recall bias in the study.[24] Only data from the most recent child born was included. Data from mothers with stillbirths were excluded.

Based on literature review and the structure of the AfDHS 2015 dataset, the following independent variables were selected: maternal age (in years), sex of the child, maternal education level, maternal occupation, preceding birth interval (in months), parity (i.e., birth order), iron pill consumption, number of visits for antenatal care (ANC), wealth status, place of residence and province of residence.[7 8 11 13 18-20 22] Table 1 provides a description of the study variables along with categories.

Table 1: List of study variables

Study variables	Description and categories
Outcome Variable	Weight of the child at birth (0=normal birth weight [≥2500 grams]; 1= low birth weight [<2500 grams]).
Explanatory Variables	

Maternal age	Maternal age during child-birth (0= ≤20years; 1= 21-34 years; 2= ≥ 35 years).
Sex	Sex of the child at birth (0=female; 1= male).
Maternal education	Education level of the mother (0 = no formal education; 1 = primary; 2= secondary or above).
Maternal occupation	Working status of the mother (0= not working; 1= working).
Preceding birth interval	Interval between last pregnancy and current pregnancy (0= first birth; 1 = <24 months; 2 = 24-47 months; 3= ≥48 months).
Parity	The number of pregnancies reaching viable gestational age (including live births and stillbirths) (0 = primipara [1]; 1 = multipara [2-4]; 2 = grand multipara [≥5]).
Took iron pills	Mother's intake of iron pills during pregnancy of the studied child (0 = yes; 1= no).
Number of antenatal care visits	Number of antenatal care visits received by the mother during pregnancy of the studied child (0= no visit [0]; 1= inadequate [1-3]; 2 = adequate [≥4]).
Household wealth status	Household wealth quintile (0 = poorest; 1 = poorer; 2 = middle; 3 = richer; 4 = richest).
Place of residence	Type of the cluster (0= urban; 1 = rural).
Region of residence	Region of residence within the country (0 = North Eastern; 1 = North Western; 2= Central Eastern; 3 = Central; 4 = Central Western; 5 = Southern Eastern; 6 = Southern Western).

Statistical Analysis

The observations with missing data were dropped. Weighted descriptive statistics (frequency and percentage) were used to present the socio-demographic characteristics of the respondents. Next, simple and multivariable logistic regression analyses were conducted to investigate the association between LBW with explanatory variables. Variables which showed *p-value* < 0.20 in bivariate analyses were included in the multivariable model. The significance level of 0.20 was considered sufficient to prevent residual confounding in the final multivariable model.[25] Logistic regression analysis accounted for the cluster sampling design of the survey. Variance inflation factors (VIF) were used to check multi-collinearity among the variables. To assess the internal validity of the regression model, the F-adjusted mean residual goodness-of-fit test was used to measure the internal validity of the regression model.[26] Both unadjusted and adjusted odds ratio (OR) were reported. Based on the presence of different household assets, the wealth index was calculated. Principal component analysis was used to create the wealth index that was supplied with the data. Then, the wealth index was divided into quintiles to calculate the wealth status of the respondents.[23] All the analyses were done using Stata 13.0 (Stata Corporation, College Station, TX, USA).[27] The authors followed the guidelines outlined in the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement in writing the manuscript (Supplementary File 1).

Ethical Consideration

The AfDHS 2015 received ethical approval from the ICF Institutional Review Board and the Ministry of Public Health of Afghanistan. Written informed consent was taken from the participants. In cases of minor participants, the assent form was signed by the respondents and written informed consent was given by the adult guardian.[24]Data were accessed from the DHS program with prior approval.

Patient Involvement

Patients were not involved in the study. This household-based survey collected data from women of reproductive age (15-49 years).

RESULTS

Characteristics of the Study Sample

A total of 2,896 weighted children had birth weight measurements taken. Among them, 123 had home deliveries and were excluded. The final sample size of this study was 2,773children. Table 2 presents the weighted distribution of the respondents according to background characteristics. Of the included children, 2,342 (84.5%) had normal birth weight and 431 (15.5%) children had LBW. More than half of the surveyed children were males (53.3%, n=1,477). However, a greater proportion of female children had LBW than normal weight (58.3% [n=251] vs 44.6% [n=1,045]). Approximately three-fifths (60.7%, n=1,683) of mothers did not receive any formal education, higher among the LBW children (70.5% [n=304] versus 58.9% [n=1,378]). Less than half of the mothers (44.0%, n=1,221) received 4 or more ANC visits, but 15.2% (n=420) of them never attended any ANC visits. Preceding births (43.3%, n =1,202) mostly took place between 24-47 months. Around one-fifth of the surveyed children were the first birth (20.7%, n=574), and this proportion was greater among LBW children than normal birth weight children (24.3% [n=105] versus 20.0% [n=469]). Nearly half (47.5%, n=1,316) of the respondents belonged to the richest wealth quintile. Almost equal proportions of the children were from urban (51.4%, n= 1,425) and rural areas (48.6%, n=1,348). The unweighted distribution of the respondents (N=2,533) is shown in Supplementary Table 1.

200 **Table 2: Distribution of study children according to background characteristics (N=2,773)**

Variables	Total (n= 2,773)		Normal Birth Weight (n=2,342)		Low Birth Weight (n=431)	
	Frequency	Percentage (%) *	Frequency	Percentage (%)*	Frequency	Percentage (%)*
Maternal age (years)						
≤20	316	11.4	280	11.9	36	8.4
21-34	2,119	76.4	1,756	75.0	363	84.3
35-49	338	12.2	306	13.1	32	7.3
Sex of child*						
Male	1,477	53.3	1,297	55.4	180	41.7
Female	1,296	46.7	1,045	44.6	251	58.3
Maternal education						
No Education	1,683	60.7	1,378	58.9	304	70.5
Primary	400	14.4	350	14.9	51	11.7
Secondary or above	690	24.9	613	26.2	77	17.8
Maternal occupation						
Not Working	2,493	89.9	2,097	89.6	396	91.8
Working	280	10.1	244	10.4	35	8.2
Preceding birth interval (months)						
First Birth	574	20.7	469	20.0	105	24.3
<24	518	18.7	441	18.8	77	17.9

24-47	1,202	43.3	996	42.6	205	47.6
≥ 48	479	17.3	435	18.6	44	10.2
Parity						
Primipara	574	20.7	469	34.7	105	24.3
Multipara	1,244	44.8	1,060	45.3	184	42.6
Grand multipara	955	34.5	813	20.0	132	33.1
Took iron pills						
No	811	29.2	714	30.5	97	22.6
Yes	1,962	70.8	1,628	69.5	334	77.4
Number of ANC visits						
No (0)	420	15.2	375	16.0	45	10.4
Inadequate (1-3)	1,132	40.8	942	40.3	189	43.9
Adequate (4 or More)	1,221	44.0	1,024	43.8	197	45.7
Wealth status						
Poorest	220	7.9	173	7.4	47	10.9
Poorer	288	10.4	248	10.6	40	9.2
Middle	321	11.6	277	11.8	43	10.0
Richer	628	22.6	558	23.8	71	16.4
Richest	1,316	47.5	1,086	46.4	231	53.5
Place of residence						
Urban	1,425	51.4	1,151	49.2	274	63.4
Rural	1,348	48.6	1,190	50.8	158	36.6
Region of residence*						

North Eastern	213	7.7	194	8.3	19	4.5
North Western	465	16.8	429	18.3	37	8.5
Central East	179	6.5	165	7.0	14	3.2
Central	1,274	45.9	1,017	43.4	257	59.7
Central Western	341	12.3	276	11.8	64	14.9
Southern Eastern	225	8.1	197	8.4	28	6.5
Southern Western	76	2.7	64	2.8	12	2.7

** $p < 0.05$, ANC: Antenatal Care; *: column percentage*

Factors Associated with LBW

Table 3 shows the results of the logistic regression analyses. In the final model, sex of the child, maternal education, preceding birth interval, wealth status, place of residence and region of residence were significant factors associated with LBW. A male child had almost 50% lower odds (adjusted OR [AOR]: 0.5; 95% confidence interval [CI]: 0.4-0.8) of having LBW compared to a female child. Mothers who received primary education (AOR: 0.5; 95% CI: 0.3-0.8) had significantly lower odds of delivering a LBW baby compared to mothers without any formal education. Children born after a birth interval of ≥48 months were less likely to have LBW (AOR: 0.3; 95% CI: 0.1-0.8) compared to the first-born child. The odds of having a LBW child decreased with higher wealth index; middle (AOR:0.4; 95% CI:0.2- 0.9), richer (AOR: 0.3; 95% CI: 0.1-0.6) and richest (AOR: 0.2; 95% CI: 0.1-0.6) quintiles had significant reductions. Children in rural regions had 70% lower odds of LBW (AOR: 0.3; 95% CI: 0.2-0.6) than their urban counterparts. Compared to the North Eastern region, however, respondents living in Central (AOR: 3.4; 95% CI: 1.7- 6.7), Central Western (AOR: 3.0; 95% CI: 1.5- 5.8) and

217 Southwestern (AOR: 4.0; 95% CI: 1.7- 9.1) regions were more likely to have children with LBW. The multivariable logistic regression without the sex variable (Supplementary Table 2) and separate analyses for male (Supplementary Table 3) and female (supplementary table 4) children yielded similar results. However, in case of female children, no intake of iron tablets by the mother during pregnancy was positively associated with LBW (AOR: 0.6; 95% CI: 0.4- 0.9). Inadequate and adequate ANC visits were also positively associated with LBW in female child (AOR: 7.7; 95% CI: 1.6-36.0 and AOR: 5.7; 95% CI: 1.9-17.1, respectively) (Supplementary Table 4).

Table 3: Bivariate and multivariable logistic regression to identify factors influencing low birth weight in Afghanistan

Variables	COR (95% CI)	AOR (95% CI)[2]
Maternal age (years)		
≤20	Ref.	
21-34	1.6 (0.8- 3.3)	
35-49	0.8 (0.3- 2.0)	
Sex of child		
Male	0.6* (0.4-0.9)	0.5** (0.4-0.8)
Female	Ref.	Ref.
Maternal education		
No Education	Ref.	Ref.
Primary	0.7[1] (0.4- 1.0)	0.5*** (0.3- 0.8)
Secondary or above	0.6 (0.2 - 1.4)	0.3 (0.1- 1.0)

Maternal occupation		
Not Working	Ref.	
Working	0.8 (0.3- 2.0)	
Preceding birth interval (months)		
First Birth	Ref.	Ref.
<24	0.8 (0.4- 1.7)	0.8 (0.3- 1.8)
24-47	0.9 (0.5- 1.6)	0.8 (0.5- 1.4)
≥ 48	0.5* (0.2- 0.9)	0.3* (0.1- 0.8)
Parity		
Primipara	Ref.	
Multipara	0.8 (0.5-1.3)	
Grand multipara	0.8 (0.4-1.6)	
Took iron pills		
Yes	Ref.	Ref.
No	0.7[1] (0.4- 1.1)	0.8 (0.4- 1.3)
Number of ANC visits		
No visits (0)	Ref.	Ref.
Inadequate (1-3)	1.7 (0.5- 5.3)	2.3 (0.5- 9.6)
Adequate (4 or More)	1.6[1] (0.8- 3.2)	2.1 (0.8- 5.1)
Wealth status		
Poorest	Ref.	Ref.
Poorer	0.6 (0.3- 1.2)	0.5 (0.2- 1.1)
Middle	0.6 (0.3- 1.2)	0.4* (0.2- 0.9)

Richer	0.5[1] (0.2- 1.0)	0.3*** (0.1- 0.6)
Richest	0.8 (0.3- 1.9)	0.2*** (0.1- 0.6)
Place of residence		
Urban	Ref.	Ref.
Rural	0.6[1] (0.3-1.0)	0.3*** (0.2- 0.6)
Region of residence		
North Eastern	Ref.	Ref.
North Western	0.9 (0.5- 1.6)	0.9 (0.5- 1.7)
Central East	0.8 (0.4- 1.7)	0.9 (0.4- 1.9)
Central	2.5** (1.3- 5.1)	3.4*** (1.7- 6.7)
Central Western	2.3** (1.2- 4.4)	3.0*** (1.5- 5.8)
Southern Eastern	1.4[1] (0.9- 2.3)	1.8 (0.9- 3.5)
Southern Western	1.8[1] (1.0- 3.2)	4.0*** (1.7- 9.1)

*1. $p < 0.2$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, ANC: Antenatal care, AOR: Adjusted odds ratio, CI: Confidence interval, COR: Crude odds ratio.*

2. Variables with p-value less than <0.2 from unadjusted model were included into multivariable analysis

DISCUSSION

In this study, we investigated the factors associated with LBW among hospital-born babies in Afghanistan. The following factors had significant association with LBW after adjustment: female child, lower maternal education, poor wealth index, urban residence, and residence in

Central, Central Western, and Southwestern regions. To the best of our knowledge, this is the first epidemiological study to investigate determinants of LBW in Afghanistan.

We showed that female children had higher odds of having LBW than male children. This result is similar to the findings of a multi-country study that analyzed DHS data from 10 developing countries.[13] The birth weight of male children is usually higher than female children.[28] This difference starts after 28 weeks of gestation. Although the exact mechanism impacting the difference in birth weight is unknown, it might be due to androgen activities or the Y chromosome that carries genetic material for fetal growth. As a result, male children could have higher intrauterine growth and birth weight than their female counterparts.[29]

Poor maternal education was also associated with LBW in our study. This finding is also consistent with previous studies done in developing countries.[7 13 19 203031] LBW of these children may be due to less access to health care, and less awareness about prenatal care. All of these factors could have an adverse effect on fetal growth and increase a mother's chances of delivering a LBW child.[31] Therefore, educational interventions for women are needed in order to reduce the prevalence of LBW in Afghanistan. Similarly, lower wealth index had a positive association with LBW, which is also consistent with findings from other low- and middle-income countries (LMICs).[13 19 20 32] A woman from a lower socio-economic background may also have poor educational attainment and knowledge, ability or awareness about maternal care, thereby increasing the risk for LBW.[19] MNCH programs in Afghanistan should target poor socioeconomic groups for the prevention of LBW.

Our results also showed that duration of preceding birth interval was associated with LBW. In our study, a preceding birth interval of ≥ 48 months had lower odds of LBW than if the child was the first-born. Other studies found that short inter-pregnancy intervals were a strong risk factor for LBW.[33-36] One explanation is that longer birth intervals allow mothers to recover physically and psychologically, and may also improve nutritional status – all of which have a positive effect on fetal growth.[37] Kibria and colleagues showed that shorter inter-pregnancy interval was also an important risk factor for early neonatal mortality in Afghanistan.[17] Promotion of birth spacing or family planning can be a beneficial intervention to prevent LBW, and may thereby improve prevention of neonatal mortality in Afghanistan.

We observed that urban residents had a higher likelihood of delivering an LBW baby. This finding is discrepant with previous studies where rural residence was found to be a significant risk factor.[7 8 11 22] Further exploration is needed to determine what factors influence LBW in the urban areas of Afghanistan. Residence in Central, Central Western, and Southwestern regions of Afghanistan also had a higher probability of LBW. The regional inequality in LBW has been noted in other studies.[38 39] These regional pockets should be given additional emphasis to reduce the geographical inequity.

Although advanced maternal age is a known risk factor for LBW,[7 8 13 18 40] no significant association was observed in this study. Perhaps if appropriate nutrition is maintained and mothers receive proper ANC, giving birth to a normal weight baby may be possible despite advanced maternal age.[41 42] We did not find any association between number of ANC visits and LBW either. In previous studies, inadequate number of ANC visits was an important risk factor of LBW.[13 43] This may be due to the inclusion of only facility births data in our study to capture birth weights. Mothers who opt for a facility birth tend to have more ANC visits.[44] This could mask the investigated association. Also, the positive association between maternal intake of iron tablets during pregnancy and LBW in the female child contradicts the existing literature[13]. Further,adequate number of ANC was positively associated with LBW in female children, which is in contrast with the literature.[13 43] These findings may be spurious, which needs further exploration.

STRENGTHS AND LIMITATIONS

Our study has several notable strengths. First, the AfDHS 2015 used validated and standardized survey tools to interview survey participants. Second, this study used LBW data which were verified through records, removing the opportunity for recall bias. However, limitations of the present study also warrant discussion. This study included only facility-based data because almost none of the home deliveries recorded birth weight. Therefore, a significant proportion of study samples were excluded from the study. As this is a cross-sectional study, we cannot ensure a temporal relationship between the exposure and the outcome variables. Only the data of survived women was analyzed, therefore excluding determinants of the more adversely affected mothers may cause additional selection bias. We did not investigate some known risk factors for LBW including genetic [45 46] or environmental factors [47-49] due to limitations of the AfHDS 2015 dataset. As the instruments used to measure birth weight were not calibrated or validated by the survey team, this could also cause some misclassification, though this misclassification is more likely to be non-differential in nature. Lastly, we do not know the exact timing of the birth weight measurement, thus adding some additional misclassification, as it is recommended to measure birth weight immediately after birth.[50]

CONCLUSIONS

This study identified several determinants of LBW in Afghanistan. Female children, lower maternal education, poor wealth index, urban residence, and residing in Central, Central Western, and South Western regions of Afghanistan were important factors associated with LBW. Significance of factors from different levels indicate that a multifaceted approach is required to address the factors that have positive association with LBW. From a program planning perspective, to reduce the overall burden of LBW as well as lowering the childhood deaths in Afghanistan, policymakers and researchers should address these factors when forming programs on a country-wide basis. The regional pockets with high probability of having LBW (urban area and Central, Central Western, Southern Western regions of Afghanistan) should be given priority to reduce inequity. Maternal education should be promoted and women from the poorest wealth quintiles should be targeted by the Maternal, Neonatal and Child Health (MNCH) programs in order to prevent LBW.

LIST OF ABBREVIATIONS

AfDHS: Afghanistan Demographic and Health Survey

AOR: Adjusted odds ratio

CI: Confidence interval

LBW: Low birth weight

NMR: Neonatal mortality rate

OR: Odds ratio

SDG: Sustainable Development Goals

Contributors

RDG, KS and GMAK conceptualized the study. RDG, KS, VB and GMAK designed the study and acquired the data. RDG, MRH and GMAK conducted the data analysis. RDG, KS, VB and GMAK interpreted the data. RDG, and GMAK prepared the first draft. RDG, KS, VB, MRH and GMAK participated in critical revision of the manuscript and contributed to its intellectual improvement. All authors went through the final draft and approved it for submission.

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Competing Interests

None declared.

Patient consent

None Declared

Disclaimer

The authors are alone responsible for the integrity and accuracy of data analysis and the writing the manuscript.

Ethics approval

The datasets were obtained from DHS Programme with proper procedure. This study was exempt from collecting ethical approval because the AfDHS 2015 received ethical approval from the ICF Institutional Review Board and the Ministry of Public Health of Afghanistan.

Data availability statement

Data are available at: https://www.dhsprogram.com/data/dataset/Afghanistan_Standard-DHS_2015.cfm?flag=0. Following instruction, data are available to download.

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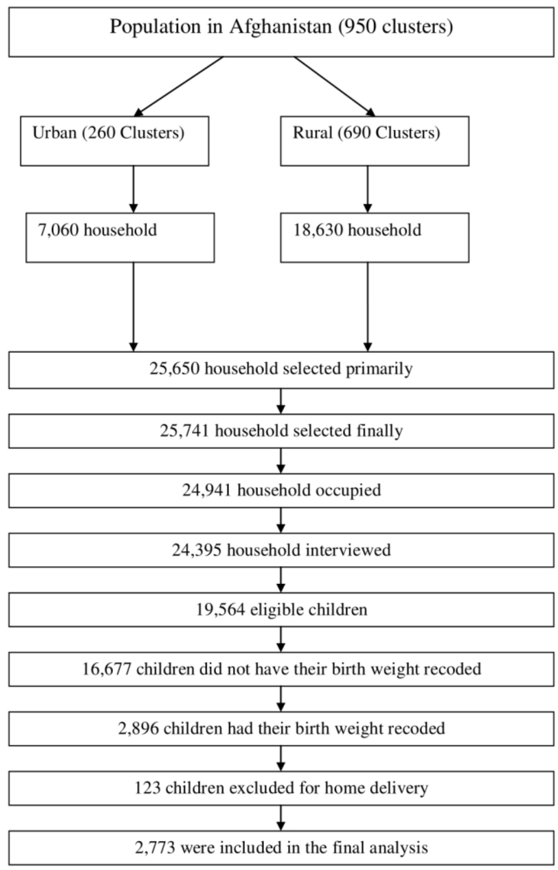
484 # Supplementary Materials:

485 **Supplementary File 1:** STROBE Checklist

486 **Supplementary File 2:**Supplementary Tables



Flowchart showing the process of selecting the participants in the survey

143x186mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Title of the study: **Factors associated with Low Birth Weight in Afghanistan: A cross-sectional analysis of the Demographic and Health Survey 2015**

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6-7
Objectives	3	State specific objectives, including any prespecified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	7-8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7-8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8-9
Bias	9	Describe any efforts to address potential sources of bias	9-10
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10
		(*b*) Describe any methods used to examine subgroups and interactions	Not applicable

		(*c*) Explain how missing data were addressed	10
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	11
		(*e*) Describe any sensitivity analyses	Not applicable
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11-14
		(b) Give reasons for non-participation at each stage	Not applicable
		(c) Consider use of a flow diagram	Not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11-14
		(b) Indicate number of participants with missing data for each variable of interest	Not applicable
Outcome data	15*	Report numbers of outcome events or summary measures	14-17
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	14-17
		(*b*) Report category boundaries when continuous variables were categorized	9-10
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Not applicable
Discussion			
Key results	18	Summarise key results with reference to study objectives	18
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	20-21
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	18-20
Generalisability	21	Discuss the generalisability (external validity) of the study results	20-21
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	23

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Supplementary Tables

Supplementary Table 1: Unweighted distribution of study children according to background characteristics (N=2,533)

Variables	Total (n= 2,533)		Normal Birth Weight (n=2,167)		Low Birth Weight (n=366)	
	Frequency	Percentage (%) *	Frequency	Percentage (%) *	Frequency	Percentage (%) *
Maternal age (years)						
≤20	315	12.4	276	12.7	39	10.7
21-34	1,859	73.4	1,573	72.6	286	78.1
35-49	359	14.2	318	14.7	41	11.2
Sex of child						
Male	1,388	54.8	1,213	56.0	175	47.8
Female	1,145	45.2	954	44.0	191	52.2
Maternal education						
No Education	1,740	68.7	1,473	68.0	267	73.0
Primary	307	12.1	269	12.4	38	10.4
Secondary or above	486	19.2	425	19.6	61	16.7
Maternal occupation						
Not Working	2,284	90.2	1,946	89.8	338	92.3
Working	249	9.8	221	10.2	28	7.7
Preceding birth interval (months)						
First Birth	526	20.8	453	20.9	73	19.9

<24	538	21.2	450	20.8	88	24.0
24-47	1,038	41.0	883	40.7	155	42.3
≥ 48	431	17.0	381	17.6	50	13.7
Parity						
Primipara (1)	526	20.8	453	20.9	73	19.9
Multipara (2-4)	1,090	43.0	915	42.2	175	47.8
Grand Multipara (≥5)	917	36.2	799	36.9	118	32.3
Took iron pill						
Yes	1,703	67.2	1,448	66.8	255	69.7
No	830	32.8	719	33.2	111	30.3
Number of ANC visits						
No (0)	381	15.0	327	15.1	54	14.8
Inadequate (1-3)	1,138	44.9	976	45.0	162	44.2
Adequate (4 or More)	1,014	40.0	864	39.9	150	41.0
Wealth status						
Poorest	272	10.7	206	9.5	66	18.0
Poorer	383	15.1	311	14.4	72	19.7
Middle	450	17.8	390	18.0	60	16.4
Richer	662	26.1	582	26.9	80	21.9
Richest	766	30.2	678	31.2	88	24.0
Place of residence						
Urban	996	39.3	846	39.0	150	41.0
Rural	1,537	60.7	1,321	61.0	216	59.0
Region of residence						
North Eastern	396	15.6	332	15.3	64	17.5

North Western	364	14.4	325	15.0	39	10.7
Central East	244	9.6	225	10.4	19	5.2
Central	734	29.0	612	28.2	122	33.3
Central Western	282	11.1	232	10.7	50	13.7
Southern Eastern	343	13.5	298	13.8	45	12.3
Southern Western	170	6.7	143	6.6	27	7.4

*ANC: Antenatal Care, * Column Percentage*

Supplementary Table 2: Bivariate and multivariable logistic regression (excluding the sex of the child) to identify factors influencing low birth weight in Afghanistan

Variables	COR (95% CI)	AOR (95% CI)[2]
Maternal age (years)		
≤20	Ref.	
21-34	1.6 (0.8- 3.3)	
35-49	0.8 (0.3- 2.0)	
Maternal education		
No Education	Ref.	Ref.
Primary	0.7[1] (0.4- 1.0)	0.5** (0.3-0.8)
Secondary or above	0.6 (0.2 - 1.4)	0.4 (0.1-1.0)
Maternal occupation		
Not Working	Ref.	
Working	0.8 (0.3- 2.0)	
Preceding birth interval (months)		
First Birth	Ref.	Ref.
<24	0.8 (0.4- 1.7)	0.8 (0.3-1.8)
24-47	0.9 (0.5- 1.6)	0.8 (0.5-1.4)
≥ 48	0.5* (0.2- 0.9)	0.3* (0.1-0.8)
Parity		
Primipara	Ref.	
Multipara	0.8 (0.5-1.3)	
Grand multipara	0.8 (0.4-1.6)	
Took iron pill		
Yes	Ref.	Ref.

No	0.7[1] (0.4- 1.1)	0.8 (0.5-1.3)
Number of ANC visits		
No visit (0)	Ref.	Ref.
Inadequate (1-3)	1.7 (0.5- 5.3)	2.3 (0.6-9.1)
Adequate (4 or More)	1.6[1] (0.8- 3.2)	2.0 (0.8-5.3)
Wealth status		
Poorest	Ref.	Ref.
Poorer	0.6 (0.3- 1.2)	0.5 (0.2-1.1)
Middle	0.6 (0.3- 1.2)	0.5* (0.2-0.9)
Richer	0.5[1] (0.2- 1.0)	0.3** (0.1-0.6)
Richest	0.8 (0.3- 1.9)	0.3** (0.1-0.6)
Place of residence		
Urban	Ref.	Ref.
Rural	0.6[1] (0.3-1.0)	0.3*** (0.1-0.6)
Region of residence		
North Eastern	Ref.	Ref.
North Western	0.9 (0.5- 1.6)	0.8 (0.5-1.6)
Central East	0.8 (0.4- 1.7)	0.9 (0.5-1.8)
Central	2.5** (1.3- 5.1)	3.1** (1.6-6.2)
Central Western	2.3** (1.2- 4.4)	2.7** (1.4-5.2)
Southern Eastern	1.4[1] (0.9- 2.3)	1.7 (0.9-3.1)
Southern Western	1.8[1] (1.0- 3.2)	3.9** (1.4-5.2)

*1. $p < 0.2$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, ANC: Antenatal care, AOR: Adjusted odds ratio, CI: Confidence interval, COR: Crude odds ratio.*

2. Variable with p-value less than <0.2 from unadjusted model were included into multivariable analysis

Supplementary Table 3: Bivariate and multivariable logistic regression to identify factors influencing low birth weight in Afghan male child

Variables	COR (95% CI)	AOR (95% CI)[2]
Maternal age (years)		
≤20	Ref.	
21-34	1.5 (0.6-3.5)	
35-49	0.6 (0.1-2.8)	
Maternal education		
No Education	Ref.	Ref.
Primary	2.4[1] (0.9-6.7)	0.4 (0.1-1.1)
Secondary or above	4.7** (1.5-13.1)	0.2** (0.1-0.5)
Maternal occupation		
Not Working	Ref.	
Working	0.8 (0.3-2.0)	
Preceding birth interval (months)		
First Birth	Ref.	Ref.
<24	2.1[1] (0.8-5.8)	0.7 (0.4-1.4)
24-47	1.4 (0.4-5.0)	1.1 (0.6-2.2)
≥ 48	1.3 (0.4-4.2)	0.4 (0.1-1.2)
Parity		
Primipara	Ref.	
Multipara	1.3 (0.6-2.8)	
Grand multipara	1.2 (0.5-2.8)	
Took iron pill		
Yes	Ref.	Ref.

No	1.1 (0.5-2.5)	1.1 (0.5-2.8)
Number of ANC visits		
No visit (0)	Ref.	Ref.
Inadequate (1-3)	0.6 (0.2-1.8)	0.8 (0.2-2.4)
Adequate (4 or More)	0.6[1] (0.3-1.2)	0.7 (0.3-1.9)
Wealth status		
Poorest	Ref.	Ref.
Poorer	0.9 (0.3-3.0)	0.4* (0.1-0.9)
Middle	0.6 (0.2-1.5)	0.2*** (0.0-0.4)
Richer	1.2 (0.5-2.9)	0.1*** (0.0-0.3)
Richest	2.3[1] (0.8-6.7)	0.1*** (0.0-0.3)
Place of residence		
Urban	Ref.	Ref.
Rural	0.6[1] (0.3-1.2)	0.2*** (0.1-0.4)
Region of residence		
North Eastern	Ref.	Ref.
North Western	0.6 (0.3-1.6)	0.7 (0.2-1.8)
Central East	0.7 (0.2-2.5)	1.0 (0.3-3.6)
Central	2.6* (1.1-6.4)	4.5** (1.6-12.4)
Central Western	2.6[1] (0.9-6.4)	3.6* (1.3-10.6)
Southern Eastern	2.5* (1.2-5.2)	3.9** (1.5-10.0)
Southern Western	1.7 (0.6-5.0)	3.1 (0.8-11.7)

*1. $p < 0.2$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, ANC: Antenatal care, AOR: Adjusted odds ratio, CI: Confidence interval, COR: Crude odds ratio.*

2. Variable with p-value less than <0.2 from unadjusted model were included into multivariable analysis

Supplementary Table 4: Bivariate and multivariable logistic regression to identify factors influencing low birth weight in Afghan female child

Variables	COR (95% CI)	AOR (95% CI)[2]
Maternal age (years)		
≤20	Ref.	
21-34	1.5 (0.6-4.1)	
35-49	0.9 (0.3-2.7)	
Maternal education		
No Education	Ref.	
Primary	0.8 (0.2-3.9)	
Secondary or above	1.1 (0.4-3.5)	
Maternal occupation		
Not Working	Ref.	
Working	0.8 (0.1-4.2)	
Preceding birth interval (months)		
First Birth	Ref.	Ref.
<24	2.0[1] (0.8-5.2)	0.9 (0.4-2.4)
24-47	2.2[1] (0.9-5.3)	0.7 (0.3-1.3)
≥ 48	3.4** (1.4-8.3)	0.3** (0.1-0.8)
Parity		
Primipara	Ref.	
Multipara	0.5 (0.3-1.1)	
Grand multipara	0.6 (0.2-1.4)	
Took iron pill		

Yes	Ref.	Ref.
No	0.4*** (0.3-0.6)	0.6* (0.4-0.9)
Number of ANC visits		
No visit (0)	Ref.	Ref.
Inadequate (1-3)	7.0** (2.0-24.5)	7.7* (1.6-36.0)
Adequate (4 or More)	6.7*** (2.7-16.7)	5.7** (1.9-17.1)
Wealth status		
Poorest	Ref.	Ref.
Poorer	0.5[1] (0.2-1.2)	0.6 (0.2-1.6)
Middle	0.9 (0.3-2.5)	1.0 (0.4-2.6)
Richer	0.5[1] (0.2-1.3)	0.6 (0.3-1.3)
Richest	0.4 (0.3-1.9)	0.5 (0.2-1.7)
Place of residence		
Urban	Ref.	Ref.
Rural	0.5[1] (0.3-1.1)	0.5 (0.2-1.0)
Region of residence		
North Eastern	Ref.	Ref.
North Western	1.2 (0.5-2.6)	1.1 (0.5-2.5)
Central East	1.0 (0.4-2.2)	0.8 (0.3-2.0)
Central	2.6* (1.1-6.4)	2.8** (1.2-6.2)
Central Western	2.4* (1.2-4.8)	2.8** (1.4-5.8)
Southern Eastern	0.8 (0.3-1.7)	0. (0.4-2.2)
Southern Western	1.8[1] (0.8-4.0)	4.0** (1.4-11.5)

*1. p < 0.2, * p < 0.05, ** p < 0.01, *** p < 0.001, ANC: Antenatal care, AOR: Adjusted odds ratio, CI: Confidence interval, COR: Crude odds ratio.*

2. Variable with p-value less than <0.2 from unadjusted model were included into multivariable analysis