Quality utilization of antenatal care and low birth weight: evidence from 18 demographic health surveys

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Abstract

Background: Low birthweight (LBW) is a crucial factor in child mortality and morbidity and affects almost 20% of infants worldwide, mostly in low- and middle-income countries.

Aims: To assess the relationship between access to and quality of antenatal care (ANC) and occurrence of LBW.

Methods: We analysed data from 18 demographic and health surveys, from 2005 to 2013, including 69 446 children. The main study outcome was birthweight < 2.5 kg, and access to and number of ANC visits were exposure variables. Moreover, ANC attendants and time of visit (trimester) were considered. Multiple logistic regression adjusted for sampling at primary and country level was utilized.

Results: At least 1 and ≥ 4 ANC consultations were both associated with decreased odds of LBW when compared to none and < 4 ANC consultations, respectively. Additional benefit stemmed from having skilled ANC attendants and the first ANC consultation during the first trimester.

Conclusions: Proper ANC coverage during pregnancy is beneficial for preventing LBW in low- and middle-income countries.

Keywords: antenatal care, demographic health survey, low birth weight, low-income country, middle-income country

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Introduction

In 2012, the World Health Assembly endorsed a comprehensive plan under Resolution 65.6 with specific global nutrition targets for 2025 (*1*). This policy included a 30% reduction in low birthweight (LBW) (*2*), corresponding to a reduction from 20 million to ~14 million neonates with birthweight < 2.5 kg (*3*) between 2012 and 2025. LBW affects almost one sixth of infants worldwide with > 95% of cases located in developing countries (*3*), and is recognized as 1 of the most influential factors on child mortality and morbidity. LBW increases mortality risk by 20–30 times (*4*), and contributes to 60–80% of all neonatal deaths worldwide (*5*, *6*). Surviving infants are at higher risk of pathological conditions such as infection immediately after birth and throughout the first year of life (*7*). LBW is also associated with morbidity later in life, such as psychosocial disorders (*8*), impaired cognitive function (*9*), coronary heart disease (*10*) and noninsulin dependent diabetes (*11*). Several risk factors are claimed to be associated with LBW, including maternal factors, pregnancy, multiple gestation, socioeconomic characteristics, drug treatment and body mass index (*12*–*15*).

At least 4 antenatal care (ANC) consultations, with the first preferably in the first trimester (*16*), has been a worldwide recommended policy for the last 2 decades. However, there is still inconclusive evidence on its impact on maternal and neonatal outcomes in developing countries. Some studies have shown that ANC improves birthweight (*17*,*18*), while others have shown a lack of evidence for the effectiveness of content, frequency and timing of visits in standard ANC programmes on maternal and child health (*19*).

Our research used data from demographic and health surveys (DHSs) in 18 countries and examined the association between adequate utilization of ANC and occurrence of LBW.

Methods

Study design

This was a population-based study of data from 18 DHSs between 2005 and 2013, which reported birthweight for at least 80% of births over the 5 years preceding the survey: Albania 2008/2009, Armenia 2010, Congo (Brazzaville) 2011/2012, Dominican Republic 2013, Gabon 2012, Guyana 2009, Honduras 2011/2012, Indonesia 2012, Jordan 2012, Kyrgyzstan 2012, Maldives 2009, Republic of Moldova 2005, Peru 2012, Philippines 2013, Sao Tome and Principe 2008/2009, Swaziland 2006/07, Tajikistan 2012, and Ukraine 2007. Detailed information on procedures and sampling techniques for all DHSs have been published elsewhere (*20*). Face-to-face interviews were carried out for a total of 213 752 women.

Study population

The study population consisted of all the latest singleton live births (n = 77 809) during the 5 years preceding the DHS in each country. After excluding 8363 (10.7%) individuals for whom we had missing data on BW, the final sample included 69 446 babies. Information on BW was obtained through birth certificates and maternal recall for 21 334 (30.7%) and 48 112 (69.3%) infants, respectively.

Outcome, exposure and control variables

The main outcome was LBW, which was defined as < 2.5 kg. Characteristics of ANC were the exposure variables, which were defined as follows: "ANC", if any ANC consultation was performed; "provider", classified as skilled (doctors, nurses or other trained attendants) or unskilled attendant (traditional attendants or others); "number of ANC consultations", subdivided into < 4 or ≥ 4 ANC visits; "ANC timing", dichotomized into ANC first consultation in the first trimester or after the first trimester; and "quality of ANC", with ≥ 4 ANC consultations started in the first trimester with a skilled attendant on 1 side, and all the others on the other side. A series of socioeconomic, pregnancy and maternal characteristics were evaluated as possible confounders, including age, education, wealth, place of residence, birth interval, birth order, wanted pregnancy and child sex.

Statistical analysis

Statistical analysis was performed using STATA 13.1 SE (StataCorp, College Station, TX, USA). The "svy" command was used to adjust for clustering by primary sampling unit. Number of total livebirths and LBW by country were tabulated with relative percentages. All the study categorical confounding variables were tested against LBW using the χ^2 test. Furthermore, we used the χ^2 test to examine the association between the quality of ANC and the following socioeconomic variables: wealth status, maternal age and education, and place of residence.

The Metaprop syntax (*21*) was used in the pooled meta-analysis of all country datasets, which generated weighted subgroup and overall pooled estimates with inverse-variance weights obtained from a random-effects model. In this model, no residual heterogeneity was assumed. The final model included wealth, age, birth order, birth spacing, education, wanted pregnancy, child sex, and rural/urban residence; the factors primary sampling unit and country were added with random effect. Stepwise logistic regression analysis of LBW on the 5 ANC exposure variables was conducted adjusting for socioeconomic, maternal and pregnancy characteristics. $P < 0.05$ was considered statistically significant.

Ethical approval

This study used existing data obtained from ORC Macro (Calverton, MD, USA) through formal request mechanisms (https://dhsprogram.com). No additional ethical review for the secondary analysis was required since each country and the Institutional Review Board of ORC Macro approved the DHS data collection procedures.

Results

Overall, 6238 (9.0%) newborns with LBW were recorded, ranging from a minimum of 36 (2.8%) of 1281 in Albania to a maximum of 883 (20.8%) of 4238 newborns in the Philippines (Table 1). Data on ANC were missing for 1404 individuals, corresponding to 2% of the total study population. Most mothers had ANC (n = 66 513; 97.7%) and half of them (n = 33 038) had the first consultation during the first trimester (Table 2). Only 6517 (10%) women had < 4 consultations. Almost all pregnant women (97.2%) consulted a trained operator. Less than half of them (n = 31 372) had a good quality of ANC according to World Health Organization (WHO) criteria.

Table 3 shows a clear trend toward increasing prevalence of LBW with decreasing wealth, poorer education and shorter birth intervals, in addition to higher risk in unwanted pregnancies and female sex.

There were associations between wealth status and education and the quality of ANC. The richest and most educated women, in addition to those living in urban areas, were more likely to have ≥ 4 ANC consultations performed by skilled attendants, with the first consultation during the first trimester.

The adjusted logistic regression showed a significant benefit of having any ANC consultation when compared to no ANC (OR 1.2; 95% CI 1.0–1.4) (Table 4). Among infants of women who underwent ANC, having < 4 consultations, first consultation after the first trimester, being attended by an unskilled operator and not meeting WHO quality criteria were associated with 1.5 (95% CI 1.4–1.7), 1.1 (95% CI 1.0–1.2), 1.2 (95% CI 1.1–1.4) and 1.1 (95% CI 1.0–1.2) increased ORs of LBW, respectively.

Discussion

This secondary analysis of DHS data from 18 countries showed that the absence of ANC consultation increased the risk of LBW. All WHO criteria, separately and combined, for adequate antenatal consultations resulted in significant protection against LBW. We compared our results on the country incidence of LBW with other sources and found no substantial differences.

Estimates from the United Nations Children's Fund and WHO global and country reports on LBW confirm the smallest percentage (3%) for Albania up to the highest (20%) in the Philippines (*22*).

Our findings on the influence of maternal education on LBW are not surprising. A study in the Islamic Republic of Iran showed that the prevalence of LBW in infants born to women with no education was 16.9%, which decreased to 5.4% in women educated to a higher level (*23*). The explanation may lie in greater access to ANC and better nutritional behaviour. Similarly, parity and birth spacing have been detected as important determinants for LBW. One study showed that mothers with very short interpregnancy intervals (IPIs; < 3 months) and high parity had a higher risk of having LBW infants when compared to those with very short IPI but low parity (*24*). The explanation for these differences may be depleted nutritional reserves in women with high parity and short IPI.

Other DHSs from single countries have reported the benefit of an early start to ANC and the importance of a sufficient number of consultations. A study from Nepal showed how women with no ANC were twice as likely to have LBW infants when compared to mothers with ≥ 4 ANC consultations (*25*). A study from Colombia reported that having the first ANC after the first trimester was associated with an increased OR for LBW when compared with first visits at the first trimester (*26*). Similar findings were reported in a study in Kenya (*27*), indicating a positive effect of ANC, which influences dietary behaviour and treatment from any illness that may have negative effects on the health of the fetus.

Although our secondary analysis had advantages, such as large sample size and use of standardized questionnaires that limited the risk of intercountry variation, it had some limitations. First, we considered only the 18 DHSs with at least 80% of data on BW, but we cannot exclude bias for all remaining women not able to report information, which may have led to underestimation of LBW. Second, two thirds of the information on BW relied on maternal recall, therefore presenting a particular type of misreporting called heaping. Heaping consists of rounding and reporting weights as multiple of 500 g, which makes interpretation difficult when infants are reported as weighing 2.5 kg, and thus likely to be misclassified as having normal weight (*28*). Third, several possible confounding variables such as genetics and maternal history of diseases were not available. Finally, we had no information on nutritional status of women to exclude maternal factors that would increase risk of LBW.

In conclusion, our study reinforces the need to encourage pregnant women to attend ANC to reduce LBW, with its short- and long-term consequences. Policies should in particular address access to and quality of ANC among disadvantaged socioeconomic groups, which are at higher risk of LBW. Uneducated mothers are less likely to understand health messages and to be

concerned about their health and nutritional status. Poorer women are less likely to afford the cost of ANC and transportation in areas where health infrastructure is distant.

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Table 1. Numbers of live births and low birthweight infants in 18 low- and middle-income countries

Country, year	Live births	Low birthweight (%)
Albania 2008/2009	1281	36 (2.8)
Armenia 2010	1139	1,438 (6.0)
Congo (Brazzaville 2011/2012)	5355	467 (8.7)
Dominican Republic 2013	2847	378 (13.3)
Gabon 2012	3485	445 (12.8)
Guyana 2009	1294	167 (12.9)
Honduras 2011/2012	7062	654 (9.3)
Indonesia 2012	13 045	840 (6.4)
Jordan 2012	6612	817 (12.4)
Kyrgyzstan 2012	3089	147 (4.8)
Maldives 2009	3206	328 (10.2)
Republic of Moldova 2005	1350	63 (4.7)
Peru 2012	7385	479 (6.5)
Philippines 2013	4238	883 (20.8)
Sao Tome and Principe 2008/2009	1159	79 (6.8)
Swaziland 2006/2007	1788	116 (6.5)
Tajikistan 2012	2955	197 (6.7)
Ukraine 2007	2156	74 (3.4)
Total	69 446	6238 (9.0)

Results are total number of newborns and number of low birthweight infants among the last births for each woman in the preceding 5 years. Results from 18 demographic health surveys.

Table 2. Distribution of ANC variables among 69 446 low birthweight and normal weight livebirths in 18 low- and middle-income countries in 2005–2013

		Low birthweight		Normal weight		*P*
<tabletxt1>ANC variables		n	(%)	n	(%)	χ^2
<tabletxt>ANC	No	177	(11.6)	1,352	(88.4)	< 0.001
	Yes	5948	(8.9)	60 565	(91.1)	
Time of first ANC consultation	First trimester	2795	(8.5)	30 243	(91.5)	< 0.001
	After first trimester	3248	(9.4)	31 406	(90.6)	
No. of ANC consultations	≥ 4	5108	(8.5)	54 888	(91.5)	< 0.001
	< 4	840	(12.9)	5677	(87.1)	
ANC attendant	Skilled	5908	(8.9)	60 291	(91.1)	< 0.001
	Unskilled	217	(11.8)	1626	(88.2)	
ANC highest quality	Yes	2628	(8.4)	28 744	(91.6)	< 0.001
	No	3610	(9.5)	34 464	(90.5)	

ANC = antenatal care.

Table 3. Characteristics of mothers of 69 446 low birthweight and normal weight infants in 18 low- and middle-income countries in 2005–2013

		Low birthweight		Normal weight		*P*
Maternal characteristics		n	(%)	n	(%)	χ^2
Maternal age (years)	15–19	568	(13.2)	3745	(86.8)	< 0.001
	20–24	1541	(9.7)	14 305	(90.3)	
	25–29	1538	(8.1)	17 383	(91.9)	
	30–34	1155	(7.7)	13 756	(92.2)	
	35–39	838	(8.5)	8996	(91.5)	
	40–44	479	(10.4)	4127	(89.6)	
	45–49	119	(11.7)	896	(88.3)	
Birth order	1	2,227	(10.6)	19 920	(89.9)	< 0.001
	> 1	4,011	(8.5)	43 288	(91.5)	
Preceding birth interval (months)	< 18	397	(12.1)	2871	(87.8)	< 0.001
	18–23	438	(9.2)	4337	(90.8)	
	24–35	863	(8.4)	9347	(91.5)	
	> 35	2313	(8.0)	26 733	(92.0)	
Place of residence	Urban	2936	(8.7)	30 829	(91.3)	0.01
	Rural	3302	(9.2)	32 379	(90.7)	
Education	No education	248	(11.7)	1869	(88.3)	< 0.001
	Primary	1901	(10.1)	16 897	(89.9)	
	Secondary	3094	(8.7)	32 338	(91.3)	
	Higher	992	(7.6)	12 063	(92.4)	
Wealth index	Poorest	1882	(11.3)	14 780	(88.7)	< 0.001
	Poorer	1540	(9.4)	14 748	(90.5)	
	Middle	1202	(8.5)	13 009	(91.5)	
	Richer	960	(7.8)	11 378	(92.2)	
	Richest	654	(6.6)	9293	(93.4)	
Wanted pregnancy	Wanted	4077	(8.5)	44 109	(91.5)	< 0.001

	Not wanted	2156	(10.2)	19 057	(89.8)	
Child sex	Male	2964	(8.2)	33 031	(91.8)	< 0.001
	Female	3274	(9.8)	30 177	(90.2)	

Table 4. Odds ratios for low birthweight in 69 446 singleton births

ANC	OR (95% CI) unadjusted	OR (95% CI) adjusted[a]
No ANC visit	1.3 (1.1–1.6)	1.2 (1.0–1.4)
< 4 ANC visits	1.6 (1.5–1.7)	1.5 (1.4–1.7)
ANC visit after first trimester	1.1 (1.0–1.2)	1.1 (1.0–1.2)
No Skilled ANC	1.4 (1.2–1.6)	1.2 (1.1–1.4)
No Quality ANC	1.1 (1.0–1.2)	1.1 (1.0–1.2)

[a]Adjusted for wealth, age, birth order, birth spacing, education, wanted pregnancy, child sex, and rural/urban residence.

ANC = antenatal care; CI = confidence interval; OR = odds ratio.