



RESEARCH ARTICLE

REVISED Antenatal care utilization on low birth weight children among women with high-risk births [version 2; peer review: 2 approved]

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Abstract

Background

Low birth weight (LBW) is a major public health problem in Indonesia, and is a leading cause of neonatal mortality. Adequate antenatal care (ANC) utilization would help to prevent the incidence of LBW babies. This study aims to examine the association between ANC utilization and LBW children among women with high-risk birth criteria. High-risk birth criteria consisted of 4T which were too young (mother's age <20 years old), too old (mother's age >35 years old), too close (age gap between children <2 years), and too many (number of children >2 children).

Methods

This study utilized calendar data from the women's module from the 2017 Indonesia Demographic and Health Survey (IDHS), with the unit of analysis only the last birth of women of childbearing age (15–49), which numbered 16,627 women. From this number, analysis was done by separating the criteria for women with high-risk birth. Multivariate logistic regression analyses were employed to assess the impact of ANC and socio-demographic factors on LBW among women with high-risk birth criteria.

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Results

This study revealed that only among women with too many children criteria (>2 children), adequate ANC utilization was significantly associated with LBW of children, even after controlling for a range of socio-demographic factors ($p < 0.05$). In all four women criteria, preterm birth was more likely to have LBW than those infants who were born normally (above and equal to 2500 grams) ($p < 0.001$).

Conclusions

According to WHO, qualified ANC standards have not been fully implemented, including in the case of ANC visits of at least eight times, and it is hoped that ANC with health workers at health facilities can be increased. There is also a need for increased monitoring of pregnant women with a high risk of 4T to keep doing ANC visits to reduce LBW births.

Keywords

antenatal care, risky maternal, low birth weight, pregnant women

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REVISED Amendments from Version 1

For the qualified ANC, we have explained the definition in the methods, and one of the criteria for qualified ANC is visiting at least eight ANC. There were only five recommendations from WHO that allow for analysis qualified ANC in this study, namely getting iron, getting bacteria in the urine, getting tetanus toxoid (TT) injections during pregnancy, visiting at least eight ANC, and screening of smoking history.

Besides LBW, we also concerned about ANC in this article so we still analyzing NA-LBW because we can get more information in ANC. We have made several adjustments regarding your comments which are improving our article, especially in the literature and conclusion. However, the comments reviewers are really helpful. We appreciate it and already revised based on the comments.

Any further responses from the reviewers can be found at the end of the article

Introduction

One of the focuses of the National Mid-Term Development Plan (RPJMN) in 2020–2024 was reducing the maternal mortality rate (MMR) and infant mortality rate (IMR).¹ Neonatal mortality rate (NMR) and IMR are indicators of child mortality, this figure shows an improvement since 1990. NMR decreased from 20 per 1,000 live births in 2002 to 15 per 1,000 live births in 2017 and IMR from 35 per 1,000 live births in 2002 to 24 per 1,000 live births in 2017.² However, this figure still has not reached the 2024 target, where NMR is expected to decrease to 10 per 1,000 live births and IMR to 16 per 1,000 live births.¹

The main causes of neonatal death in developing countries include low birth weight (LBW) and premature birth. Data showed that LBW and premature births were 19% in 2016.³ Babies with LBW are defined by WHO as babies born less than 2,500 grams regardless of gestational age.⁴ In Indonesia, the percentage of LBW has decreased slowly, from 11.2% in 2000 to 10.2% in 2012 then to 10.0% in 2015.⁴

Babies with LBW have a higher risk of stunting, low intelligence (IQ), and death in the first 28 days of life.^{4,5} In addition, the risk of death at the age of under 1 year is 17 times greater than that of infants with normal birth weight.⁶ In adulthood, infants with LBW are at risk for obesity, heart disease, and diabetes.⁴

LBW can be caused by premature birth (<37 weeks), babies with small gestational age (SGA), or a combination of both.^{4,7} The lower the gestational age, the lower the baby's birth weight automatically because physiologically and anatomically the fetal organs have not grown and developed perfectly, and the risk of illness and death will increase.⁸

Premature births and fetuses that fail to thrive in the womb are influenced by four maternal factors, namely maternal malnutrition, maternal health problems during pregnancy, maternal characteristics, and other factors.⁴ In addition, obstetric factors such as maternal age, both too young and too old, significantly affect LBW.^{9,10}

Pregnancy in women with "4T," namely "too young (gave birth <20 years), too old (gave birth >35 years), too close (short birth gap), and too many (a large number of children)" can have a positive effect on both the mother and the fetus being born.^{8,11–15} This risk can be prevented or minimized by performing qualified antenatal care (ANC). ANC is important to prevent, detect and treat maternal and fetal health problems.^{3,8,11,12,16–18}

Since 2016, WHO has recommended pregnant women to have a minimum of eight pregnancy check-ups.¹⁹ WHO provides guidance for pregnant women to have a healthy pregnancy (positive pregnancy) through five interventions and 19 recommendations as well as several recommendations for specific cases.

Since 2020, it is agreed in Indonesia for pregnant women to make ANC visits at least six times, with at least two contacts with doctors in the first trimester to screen for risk factors/pregnancy complications; and in the third trimester for one-time delivery risk factor screening. Based on IDHS in 2017, National Family Planning stated that the coverage number of ANC visits (>4 times) in Indonesia was 90.6% and as many as 75% carried out pregnancy checks by health workers.²

The difference between this study and other similar studies is to look at the effect of ANC on women with 4T with the incidence of LBW. Therefore, this study aimed to determine the effect of ANC on women with 4T on the incidence of LBW. The hypothesis that is built is that qualified ANC in women of childbearing age with 4T reduces the risk of LBW events.

Methods

Study design

This study used the 2017 Indonesian **Demographic and Health Survey** (IDHS) calendar data source, the women of childbearing age module. This study is mostly retrospective data, which requires each respondent to report their experience in ANC at the time of pregnancy and birth history. This study analyzed 49,627 women of childbearing age (15–49 years) with a total of 16,627 last births because the LBW number available in the IDHS was the last birth history.

The criteria for the unit of analysis were “4T”, among others; “too young” (gave birth <20 years) totaled 843; “too old” (gave birth >35 years) totaled 2,530; “too close” (spacing of fewer than two years) totaled 5,300; and “too many” (bearing more than two children) totaled 873.

The independent variables being analyzed were ANC quality, area of residence, education level, wealth level, work status, ANC examination place, ANC examiner staff, and access to information media. The qualified ANC indicator in the WHO guidelines is positive pregnancy.¹⁹ There were only five recommendations that allow for analysis, namely getting iron, getting bacteria in the urine, getting tetanus toxoid (TT) injections during pregnancy, visiting at least eight ANC, and screening of smoking history. The dependent variable was the incidence of LBW in women with 4T.

Data analysis

The data analysis of this study used the **IBM SPSS** application version 21. The analysis of this study was carried out descriptively and inferentially. Descriptive analysis through univariate and bivariate analysis was conducted to determine the frequency distribution of the variables studied. Inferential analysis was carried out through multivariate analysis with binary logistic regression models (crude OR and adjusted OR) to determine the effect of the independent variables on the dependent variable.

Ethics statement

According to the DHS Program, “the procedures and questionnaires for standard DHS surveys are reviewed and approved by The Institutional Review Board (IRB) of ICF International while country-specific DHS protocols are reviewed by the IRB of ICF International and typically by an IRB in the host country”. The IRB of ICF International ensures the protection of human subjects from the survey complies with the U.S. Department of Health and Human Services regulations, while the host country IRB ensures that the survey complies with the laws and norms of the nation. While downloading the data, the names and addresses of the respondents are de-identified. The data have been obtained by registering and requesting with the Demographic and Health Surveys (DHS) website (<https://dhsprogram.com>).

Results

The results of the univariate analysis presented a description of social, economic, and demographic characteristics as shown in **Table 1**. Descriptively, women in this study were relatively more middle-educated in each category (69% “too young”, 52% “too close”, 49% “too many”, and 45% “too old”). Based on the area of residence, the majority of women in

Table 1. Sociodemographic characteristics of women with 4T.

Variables	Too young (N=843) n (%)	Too old (N=2530) n (%)	Too many (N=5300) n (%)	Too close (N=873) n (%)
Education level				
Low	252 (29.9)	1.092 (43.2)	2.181 (41.1)	238 (27.3)
Middle	579 (68.7)	1.126 (44.5)	2.574 (48.6)	457 (52.3)
High	11 (1.3)	313 (12.4)	545 (10.3)	178 (20.4)
Region				
Urban	288 (34.2)	1.297 (51.2)	2.517 (47.5)	430 (49.2)
Rural	555 (65.8)	1.234 (48.8)	2.784 (52.5)	443 (50.8)
Wealth index				
Low	502 (59.6)	991 (39.2)	2.345 (44.2)	410 (46.9)
Middle	191 (22.6)	476 (18.8)	990 (18.7)	141 (16.2)
High	150 (17.8)	1.063 (42.0)	1.965 (37.1)	322 (36.9)

Table 1. *Continued*

Variables	Too young (N=843) n (%)	Too old (N=2530) n (%)	Too many (N=5300) n (%)	Too close (N=873) n (%)
Employment status				
Not working/ housewife	581 (68.9)	1.216 (48.1)	2.627 (49.6)	451 (51.6)
Working	262 (31.1)	1.309 (51.7)	2.667 (50.3)	421 (48.3)
NA		5 (0.2)	6 (0.1)	1 (0.1)
Place of ANC				
Health facility	646 (76.7)	1.999 (79.0)	4.097 (77.3)	668 (76.5)
Non-health facility	112 (13.3)	267 (10.6)	683 (12.9)	122 (14.0)
NA	85 (10.1)	264 (10.4)	520 (9.8)	83 (9.5)
ANC provider				
Non-health worker	27 (3.2)	74 (2.9)	193 (3.6)	48 (5.5)
Health worker	731 (86.60)	2.195 (86.7)	4.59 (86.6)	742 (85.0)
NA	86 (10.2)	262 (10.4)	517 (9.8)	83 (9.5)
Media exposure				
Not exposed	708 (84)	2.171 (85.8)	4.519 (85.3)	682 (78.1)
Exposed	132 (15.7)	349 (13.8)	746 (14.1)	187 (21.4)
NA	3 (0.4)	9 (0.4)	35 (0.7)	4 (0.5)
Criteria of ANC				
Non-qualified	664 (78.7)	1.928 (76.2)	4.15 (78.3)	720 (82.4)
Qualified	97 (11.5)	355 (14.0)	645 (12.2)	71 (8.2)
NA	82 (9.7)	247 (9.8)	504 (9.5)	82 (9.4)
Birth status				
Premature	52 (6.1)	111 (4.4)	189 (3.6)	39 (4.5)
Normal	791 (93.9)	2.419 (95.6)	5.111 (96.4)	834 (95.5)
Birth weight status				
Non-LBW	650 (77.1)	2.003 (79.2)	4.087 (77.1)	646 (74.0)
LBW	57 (6.8)	143 (5.6)	331 (6.3)	48 (5.5)
NA	136 (16.1)	385 (15.2)	882 (17)	179 (20.5)

Notes: (4T): "too young" (maternal age \leq 19 years at the time of last delivery), "too old" (maternal age $>$ 35 years at the time of last delivery), "too close" (birth interval between two last births $<$ 24 months) and "too many" (total births $>$ 2 children).

Abbreviations: NA, not available; ANC, antenatal care; LBW, low birth weight.

the "too young" and "too many" categories are rural dwellers (66% and 53%), almost equal proportions of women in the "too close" category are urban and rural dwellers, and the majority of women in the "too old" category are urban dwellers.

Based on the wealth index, most of the women were in a low wealth index category: women who were "too young" (60%), "too many" (44%), and "too close" (47%). Based on employment status, more than half of the women were not working, namely, women who were "too young" (69%) and "too close" (52%). In addition, more than half of the women underwent pregnancy checks at health facilities, namely women with "too old" (79%), while "too young", "too much" and "too close" were 77% each. The results of the descriptive analysis also showed that four out of five women had relatively more ANC check-ups with health workers in each 4T category. **Table 1** also shows that women who perform qualified antenatal care in each 4T category have a percentage of less than 15%.

Based on the birth status of the children, almost all of them were born at term (normal) with a percentage above 90% in each 4T category. Likewise in all 4T categories, more children were born with non-LBW status (above 90%).

Qualified ANC in women of childbearing age with 4T

Table 2 shows the percentage distribution of ANC quality among women with 4T in each category according to background characteristics. Most women with a 4T have non-qualified antenatal care. Just under 20% of women with a 4T perform qualified ANC. Women with “too old” performed qualified ANC (17%) more than women with other 4T.

Among women with 4T categories, 82% have non-qualified ANC. While the higher the education of women, the more women who perform qualified ANC in each 4T category. Most of the women with qualified ANC were found in high education in the “too old” (23%) and “too close” (12%) categories. Meanwhile, in the “too many” and “too young” categories, most of the women with qualified ANC were found in secondary education, 16%, and 13% respectively.

Based on the place of residence, more women who live in urban areas perform qualified ANC for each of the “4T” categories compared to women who live in rural areas. Furthermore, based on wealth status, the higher the wealth index, the more women who perform qualified ANC in each 4T category. Based on employment status, it is seen that women who are not employed are more likely to do qualified ANC at “too young” and “too many” respectively (14%). Meanwhile, among women with “too old” (17%) and “too close” (9%), most of the women with qualified ANC were working. Less than a fifth of “4 Too” women perform qualified ANC at health facilities in each 4T category and all of them are handled by health professionals.

Women who performed qualified ANC were relatively higher among those exposed to information through the media, among women “too old” (21%), “too many” (15%), and “too close” (10%). Meanwhile, when viewed from birth status, women who gave birth to children at term/normally had relatively more qualified ANC for each 4T category compared to women with premature births of their last child. Based on the LBW category, relatively more women with non-LBW babies perform qualified ANC in each 4T category compared to women with LBW babies.

The incidence of LBW according to the ANC and characteristics of childbearing-age women with 4T

Table 3 shows the results of the logistic regression model testing between the characteristics and quality of ANC variables on the incidence of babies born with LBW in women with 4T. The effect of several variables on the incidence of LBW in each 4T risk model shows mixed results. The quality of the ANC only affects women with “too many” children on bivariate testing or together with other variables. Preterm birth status has a significant influence on the incidence of LBW in all groups of women with 4T compared to the quality of ANC and other variables. Babies born prematurely in the “too close” group of women have the greatest chance of LBW incidence compared to babies born normally in the other 4T category, as well as exposure to information through the media.

In women with “too young” status, last childbirth status, women’s exposure to media, and wealth index showed a significant effect when tested per variable or simultaneously on the incidence of LBW babies born. Women with the premature birth of their last child had a 10.48 times greater tendency to give birth to LBW babies compared to women who gave birth to a normal last child (AOR: 10.48; 99% CI; 4.74-23.16). In addition, women who were not exposed to the media had a 2.72 times greater tendency to give birth to LBW babies compared to women who were exposed to the media (AOR: 2.72; 90% CI; 0.87-8.48). Based on social characteristics, women with a middle wealth index were 0.19 times less likely to give birth to LBW babies than women with a high wealth index (AOR: 0.19; 95% CI; 0.05-0.71).

In the second model, “too old”, the status of the last child’s birth, education level, wealth index, and media exposure had a significant effect on the incidence of LBW both on the test per variable and simultaneously. The qualified ANC in the “too old” group of women did not show a significant effect on the incidence of LBW, as well as the area of residence, place of ANC examination, ANC examiner staff, and employment status. As with the previous model, women in the “too old” group with the premature birth of their last baby had a 16.63 times greater chance of giving birth to LBW babies compared to women who gave birth to a normal last child (AOR: 16.63; 99% CI; 10.42-26.53). In addition, women with low levels of education have a 2.76 times greater chance of giving birth to LBW babies than women with higher education levels (AOR: 2.76; 99% CI; 1.30-5.88). Women with a low wealth index were more likely (1.60 times) to give birth to LBW babies compared to women with a high wealth index (AOR: 1.61; 90% CI; 0.97-2.65). Not only education level and wealth index, but media exposure in this group also has a significant effect on the incidence of LBW. Interestingly, women who were not exposed to the media were 0.56 times less likely to give birth to LBW babies compared to women who were exposed to the media (AOR: 0.56; 95% CI; 0.87-8.48). In fact, the opportunity is even greater when tested simultaneously with other variables.

In the third model, women with “too many”, birth status, birth rate, ANC quality, wealth index, and area of residence had a significant influence on both the tests per variable and simultaneously. Women with preterm birth had a 15.03 times greater chance of giving birth to a LBW baby compared to women who gave birth normally (not-preterm birth) (AOR:

Table 2. Sociodemographic characteristics among women with 4T according to the quality of ANC.

Variables	Too young		Too old		Too many		Too close	
	Non-qualified ANC (%)	Qualified ANC (%)	Non-qualified ANC (%)	Qualified ANC (%)	Non-qualified ANC (%)	Qualified ANC (%)	Non-qualified ANC (%)	Qualified ANC (%)
Education level								
Lower (pre and primary school)	88.3	11.7	89.9	10.1	90.3	9.7	96.0	4.0
Middle (secondary)	86.7	13.3	81.6	18.4	83.9	16.1	89.8	10.2
High (university)	90.1	9.9	76.8	23.2	84.1	15.9	87.6	12.4
Region								
Urban	85.0	15.0	79.3	20.7	82.0	18.0	88.2	11.8
Rural	88.4	11.6	89.9	10.1	90.7	9.3	93.7	6.3
Wealth index								
Low	89.5	10.5	92.8	7.2	92.2	7.8	94.8	5.2
Middle	87.7	12.3	84.9	15.1	87.7	12.3	91.2	8.8
High	78.9	21.1	76.8	23.2	79.2	20.8	86.1	13.9
Employment status								
Not working/housewife	86.5	13.5	85.7	14.3	86.3	13.7	91.3	8.7
Working	88.9	11.1	83.2	16.8	86.8	13.2	90.6	9.4
Place of ANC								
Health facility	85.6	14.4	83.1	16.9	85.3	14.7	89.6	10.4
Non-health facility	96.1	3.9	93.3	6.7	93.6	6.4	98.5	1.5
ANC provider								
Non-health worker	100.0	-	100.0	-	100.0	-	100.0	-
Health worker	86.7	13.3	83.8	16.2	85.9	14.1	90.4	9.6
Media exposure								
Not exposed	87.0	13.0	85.4	14.6	86.8	13.2	91.3	8.7
Exposed	88.3	11.7	79.4	20.6	85.1	14.9	89.6	10.4

Table 2. *Continued*

Variables	Too young		Too old		Too many		Too close	
	Non-qualified ANC (%)	Qualified ANC (%)	Non-qualified ANC (%)	Qualified ANC (%)	Non-qualified ANC (%)	Qualified ANC (%)	Non-qualified ANC (%)	Qualified ANC (%)
Birth status								
Premature	94.9	5.1	85.5	14.5	91.7	8.3	97.2	2.8
Normal	86.7	13.3	84.4	15.6	86.3	13.7	90.7	9.3
Birth weight status								
Non-LBW	86.4	13.6	83.4	16.6	85.2	14.8	90.1	9.9
LBW	86.8	13.2	85.7	14.3	90.9	9.1	92.1	7.9
Total	87.2	12.8	84.4	15.6	86.5	13.5	91.0	9.0

Notes: (4T): "too young" (maternal age ≤ 19 years at the time of last delivery), "too old" (maternal age > 35 years at the time of last delivery), "too close" (birth interval between two last births <24 months) and "too many" (total births > 2 children).

Abbreviations: ANC, antenatal care; LBW, low birth weight.

Table 3. Relationship of ANC in women of childbearing age with 4T on the incidence of LBW.

Variables	Too young	Too old	Too many	Too close	SOR (LL-UL)	SOR (LL-UL)	SOR (LL-UL)	SOR (LL-UL)
Education level								
High	Ref							
Low	0.51 [0.9-2.97]	***2.76 [1.30-5.88]	***2.85 [1.65-4.93]	**5.25 [1.27-21.74]	***2.32 [1.26-4.30]	***2.86 [1.77-4.63]	***6.63 [1.88-23.43]	
Middle	0.35 [0.06-1.92]	1.22 [0.59-2.51]	**1.77 [1.04-3.01]	**3.64 [0.98-13.54]	1.18 [0.63-2.24]	**1.66 [1.02-2.70]	**4.20 [1.25-14.10]	
Region								
Rural	Ref							
Urban	1.05 [0.56-1.98]	1.39 [0.93-2.08]	**1.37 [1.06-1.79]	1.25 [0.61-2.55]	1.11 [0.79-1.56]	1.09 [0.87-1.37]	0.79 [0.44-1.42]	
Wealth index								
High	Ref							
Low	1.21 [0.56-2.64]	*1.61 [0.97-2.65]	**1.43 [1.05-1.95]	1.25 [0.53-2.92]	***1.57 [1.07-2.30]	***1.53 [1.19-1.96]	1.5 [0.78-2.90]	
Middle	**0.19 [0.05-0.71]	***0.18 [0.52-0.64]	0.83 [0.57-1.20]	0.76 [0.28-2.09]	1.33 [0.83-2.14]	0.99 [0.70-1.38]	1.25 [0.52-2.96]	
Employment status								
Working	Ref							
Not working/housewife	0.91 [0.481.71]	1.05 [0.72-1.52]	0.96 [0.75-1.22]	0.75 [0.39-1.45]	1.04 [0.74-1.46]	0.97 [0.77-1.21]	0.99 [0.55-1.80]	
Place of ANC								
Non-health facility	Ref							
Health facility	0.73 [0.31-1.72]	1.43 [0.70-2.91]	1.08 [0.72-1.64]	0.77 [0.26-2.25]	1.14 [0.60-2.19]	0.97 [0.66-1.41]	0.59 [0.24-1.48]	
ANC provider								
Health worker	Ref							
Non-health worker	2.05 [0.42-9.99]	2.34 [0.62-8.82]	1.56 [0.73-3.35]	1.26 [0.21-7.61]	1.60 [0.52-4.95]	*1.73 [0.92-3.27]	1.35 [0.30-6.04]	
Media exposure								
Exposed	Ref							
Not exposed	*2.72 [0.87-8.48]	**0.56 [0.32-0.96]	1.04 [0.70-1.55]	**3.96 [1.05-15.00]	0.82 [0.51-1.31]	*1.36 [0.94-1.96]	**4.40 [1.27-15.08]	
Criteria of ANC								
Qualified	Ref							
Non-qualified	0.78 [0.33-1.82]	0.94 [0.56-1.57]	*1.47 [0.98-2.20]	0.74 [0.24-2.36]	1.19 [0.74-1.93]	***1.74 [1.17-2.56]	1.2 [0.43-3.77]	
Birth status								
Normal	Ref							
Premature	***10.48 [4.74-23.16]	***16.63 [10.42-26.53]	***15.00 [10.76-21.00]	***21.72 [9.23-51.15]	***13.67 [8.79-21.25]	***14.23 [10.31-19.66]	***16.77 [7.85-35.81]	

*Significant 0.1.
 **Significant 0.05.
 ***Significant 0.01.

Notes: (4T): "too young" (maternal age ≤19 years at the time of last delivery), "too old" (maternal age >35 years at the time of last delivery), "too close" (birth interval between two last births <24 months) and "too many" (total births > 2 children).

Abbreviations: ANC, antenatal care; LBW, low birth weight; SOR, simple odds ratio; AOR, adjusted odds ratio; LL, lower level; UL, upper level.

15.03; 99% CI; 10.76-21.00). Furthermore, women with non-qualified ANC were 1.47 times more likely to give birth to LBW compared to women with qualified ANC (AOR: 1.47; 90% CI; 0.98-2.20). Interestingly, women living in urban areas were 1.37 times more likely to have LBW babies than women living in rural areas (AOR:1.37; 95% CI; 1.06-1.79). Furthermore, women with a low wealth index have a 1.43 times greater chance of giving birth to LBW than women with a high wealth index (AOR: 1.43; 95% CI; 1.05-1.95).

Education level becomes an important variable in the group of women with “too many” and “too close”. The higher the education level of women, the lower the tendency to give birth to LBW babies. Women with low and middle education levels in the group of women with “too many” were more likely to give birth to LBW babies by 2.85 times (AOR: 2.85; 99% CI; 1.65-4.93) and 1.77 times (AOR: 1.77; 95 % CI; 1.04-3.01) compared with women with higher education levels.

It was quite different because the quality of the ANC in the fourth model with “too close” did not show a significant effect on the incidence of LBW. In addition to education level, media exposure and preterm birth status were variables that consistently affect the incidence of LBW. Interestingly, preterm birth status has a nearly double chance of developing LBW in this risk group compared to other risk groups. Women with “too close,” where the distance between the last two children was less than two years and gave birth prematurely, had a 21.72 times greater chance of giving birth to LBW babies than normal births in the simultaneous test. Likewise, women who were not exposed to media in the “too close” group had a greater chance of giving birth to LBW babies than other risk groups.

Discussion

Indonesia has tried to reduce infant mortality. One of the strategies is to prevent the incidence of babies with LBW. The results of this study showed that the birth incidence of LBW babies was almost the same in each 4T category, which is around 6 to 7%. This figure is lower than other Asian country, such as India.¹⁸ Also, comparing it to African country, the LBW in Indonesia is lower.¹⁷

The results indicate that ANC quality only affects LBW births in the category of too many children. Even so, previous studies also showed a significant relationship between ANC utilization and mothers who were too old (>35 years), whereas mothers who were too old were higher in using ANC.²⁰ However, mothers who were too young had higher knowledge than mothers who were too old.²¹ A previous study showed that most adolescent births were from mothers with a low education level.²²

Women with too many children and non-qualified ANC will have a 1.47 times higher chance of giving birth to LBW babies than women with too many children and qualified ANC. This was in accordance with research conducted in Padang, mothers with less than four ANC visits were more likely to give birth to LBW babies compared to mothers with four ANC visits.²³ Similarly, studies conducted in India¹⁸ and China⁸ also stated that a comprehensive antenatal examination was associated with a reduced risk of LBW in infants. Studies conducted in Rwanda,²⁴ Ethiopia,^{12,16,17,25} and Sri Lanka¹¹ found that lack of ANC visits was associated with low infant weight. In a comprehensive ANC, including a complete number of visits, pregnant women carry out regular checkups, practice healthy living habits and obtain iron intake during pregnancy. Thus, they can detect problems, diseases, or complications during pregnancy early, including reducing the incidence of babies with LBW.^{12,13,16-18,24,25}

The results of this study showed that the age of childbirth has a significant effect on infants with LBW. Premature birth had the most significant impact on infants with low birth weight in the four 4T categories, namely “too young”, “too old”, “too many”, and “too close”. The World Health Organization (WHO) stated that premature birth is the cause of about one-third of LBW babies. Studies conducted in Yemen¹⁵ and Ethiopia²⁶ showed the same. Likewise, in Abu Dhabi, babies born prematurely have an 18 times higher risk of becoming LBW.⁷ This happens probably because fetal growth and weight gain mainly occur in the late period of pregnancy, so premature babies receive less nutrition which causes low birth weight.

Several socioeconomic and demographic characteristics such as education level, wealth index, and area of residence were significantly associated with the incidence of infants with LBW. The education variable has a significant relationship with the incidence of LBW in all four categories, except for women with births too young, which does not have a relationship with LBW incidence. In line with research conducted by Nuryani and Rahmawati, 2017 in Gorontalo Regency, there was a significant relationship between education level and the incidence of LBW ($p=0.017$).²⁷ This finding is in agreement with several studies conducted in other developing countries such as India,¹⁸ Ethiopia,²⁵ and Ghana.²⁸ Generally, women with higher education were more informed about the risks of not receiving health care during pregnancy and paid more attention to nutritional intake during pregnancy,^{18,28,29} On the other hand, women with low education generally had less access to health facilities, especially economically.²⁵ However, the research conducted by Sharma *et al.* (2015) in Nepal

and by Rahim FK and Muharry A (2018) in Kuningan showed different things, where maternal education was not associated with the incidence of LBW.^{30,31}

Regarding the wealth index in this study, among women with too old and too many, it is seen that low wealth index are more at risk for giving birth to babies with LBW compared to high wealth index. Studies in India¹⁸ and Sri Lanka¹¹ showed similar results, where the incidence of LBW decreases with an increasing wealth index.

The residence variable is seen only in the category of too many children, which has a significant effect on LBW births. Women with too many children who live in urban areas are 1.37 times more likely to give birth to LBW babies than women in rural areas. In line with research conducted by Mohammed S *et al.* (2019), the probability of giving birth to an LBW baby was significantly higher in urban residents.³² This is different from the results of the study by Kaur *et al.* (2019) that found that LBW was more common in rural areas than in urban areas (9.8% vs. 2.0%, $p=0.03$)³³ and some studies conducted in Ethiopia.^{16,17} This may be related to the education level of women who generally have low and middle education in this study.

Conclusion

Based on bivariate testing or together with other variables, qualified ANC only has a significant effect on the incidence of LBW in women with the “too many” criteria. It is known that the most influential variable on LBW in women with 4T is premature birth. Besides that, it is known that with a low level of education women who give birth too close have the highest chance of giving birth to LBW compared to the other “4 too” criteria. Likewise, women who are “too old” and “too many” with a low wealth index and women who are “too many” who live in urban areas have the highest chances of giving birth to LBW.

The findings show that the recommendations for qualified ANC according to WHO standards have not been fully implemented. In the case of qualified ANC including ANC visits of at least eight times, it is hoped that ANC with health workers at health facilities can be increased. It is also necessary to increase the monitoring of pregnant women with the risk of 4T to continue making ANC visits to reduce the risk of preterm and reduce LBW births. Moreover, increasing education and counseling related to maturing the age of marriage, reproductive health, family planning (spacing), and the dangers of 4T to reduce the risk of LBW events in women with 4T in various information media.

Data availability

The dataset of the Indonesia Demographic and Health Survey 2017 is available from the DHS Program website (<https://dhsprogram.com/data/available-datasets.cfm>). The data can be obtained after registering and requesting permission to download the dataset through the website. The authors did not have any special access privileges that others would not have.

Acknowledgments

We gratefully acknowledge the National Population and Family Planning Agency, Central Bureau of Statistics, and Ministry of Health in Indonesia which have provided the data in this study. We also acknowledge the BRIN (National Research and Innovation Agency), Universitas Airlangga, and Universitas Indonesia as the collaborative research team in this study.

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Gouranga Dasvarma 

College of Humanities, Arts and Social Sciences, Flinders University, Adelaide, SA, Australia

I have gone through the revisions. The revised manuscript may now be accepted for indexing.

Competing Interests: A few of the authors (Resti Pujihavuty, Sari Kistiana and Irma Ardiana) are my former students, but I have had no input whatsoever in the preparation of the manuscript. I confirm that this potential conflict of interest did not affect my ability to write an objective and unbiased review of the article.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 16 February 2024

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Garedew Tadege Engdaw 

Department of Environmental and Occupational Health and Safety, Institute of Public Health, College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia

I have no further comments to make for this version.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Public health and Epidemiology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Version 1

Reviewer Report 17 August 2023

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Garedew Tadege Engdaw 

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The title is very useful and interesting. The paper needs major revision - below are my recommendations and questions for the development of the paper:

1. The sentences require editing in grammar. Needs checking grammar and should be re-edited.
2. WHO recommends 4 or more ANC visits including 1st ANC in the first trimester. However, the authors focused on the effect of ANC visit on LBW and sociodemographic factors with women on high-risk birth, regardless the number of ANC visits. Some women visit a health facility for ANC just before the delivery. If the authors could compare the effect of LBW among women with no ANC visit to the women with 4 or more ANC visits, the results might be more plausible (NA).
3. For the analysis, you provided the definition of LBW to include the literature. You also need to provide the definition of ANC visits for inclusion criteria. If one or more ANC visits were your inclusion criteria, your conclusion may mislead the readers. You need to explain why you selected literatures mentioning ANC visit only, not the number of ANC visits in the limitation section.
4. **Education level:** It is the levels such as preschool, primary school, lower secondary school, upper secondary and higher education (diploma, certificate and above). Better to write the educational level of women's in a scientific way, unless you have evidence for such classification from table 1. Make words uniform across the document (like Educational level from table ...Low, Middle High, while from the prose it says secondary. It lacks consistency).
5. Your outcome of interest is to see the effect of ANC and socio demographic factors on LBW, however from Table 1 you presented the birth weight status of women's as NA (what is the

importance of presenting this result, if the status is already unknown?).

6. Operationalize the word **Qualified ANC** and **Non-Qualified ANC, Non-health worker in ANC provider** women of childbearing age.

Discussion:

1. From the first paragraph you wrote as "This figure is lower than other Asian **countries**, such as India.¹⁸ While comparing it to African **countries**, the LBW in Indonesia is lower". Make a correction for this paragraph as in "Asian country" and "African country" - you had only one literature for this evidence. Works for the whole document.

You think the two sentences had difference? This figure is **lower than** other Asian countries, such as India.¹⁸ While comparing it to African countries, the LBW in Indonesia is **lower**" (the figure is "**lower than both in Asian country and Indonesia**"...)

1. Write the possible reason for the discrepancy (in your study and other studies) including the factors for the discussion.
2. From the last paragraph of the discussion you wrote as "**several** studies conducted in Ethiopia.¹⁶⁻¹⁷ This may be related to the education level of women who generally have low and middle education in this study". You had only two evidences. Generally speaking, 'several' is used to refer to quantities above two or so but not so much that it's a lot or many. Perhaps the most common interpretation or intended sense of several is around three to five, but this can vary greatly depending on the context. Change it to 'some studies'.

Conclusion:

1. In the case of ANC visits of at least **eight times**, *it is hoped that ANC with health workers at health facilities can be increased*. Better to conclude your findings based on your discussion (the number of ANC visit is not related with your study/objective).
2. It is necessary to review the coverage of ANC in the National Health Insurance (NHI) mechanism, which is only four times, especially for the poor and with low education. Not related with your objective.

How is reviewing the National Health Insurance (NHI) related with LBW and related with ANC? It may be showing only the ANC attendants, number of ANC, the service provided during each ANC...not the low birth weight risks of the mothers on ANC follow up (**remove the above two sentences**).

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Public health and Epidemiology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 25 May 2023

<https://doi.org/10.5256/f1000research.139258.r170911>

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Gouranga Dasvarma 

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General comments:

1. This is a useful study of the determinants of low birth weight babies in Indonesia based on data collected at a recent national survey, namely The Indonesia Demographic Health Survey 2017.
2. The authors have approached the problem of low birth weight babies (LBW) by sensibly selecting the groups of women who are at the highest risk of giving birth to babies with less than the recommended weight of 2,500 grams. Such groups of women comprise those with the following characteristics at the birth of their children, namely women (i) who are too young (less than 20 years of age), (ii) too old (more than 35 years of age), (iii) have too many children (3 or more) and too close (birth interval less than 2 years).
3. The aim of the study is to examine the effects of antenatal care (ANC) on the prevalence of LBW in each of the high-risk groups of women mentioned above, with the hypothesis that qualified ANC reduces the risk of LBW babies in the high-risk women.
4. The justification of the study appears to be that, by assumption the prevalence of LBW is high in the high-risk groups of women and that it can be reduced by good ANC. However, the prevalence of LBW is 7.1% as at the 2017 Indonesia Demographic and Health Survey, and it seems that Indonesia may be on track to achieving a 30% reduction in LBW between

2015 and 2030 as one of the Sustainable Development Goals of the United Nations. Therefore, further justification is needed for the present study.

5. Moreover, a similar study, based on data from the 2017 Indonesia Demographic and Health Survey exists (see Safitri *et al.*, 2022¹), which identifies ANC as a determinant of LBW in Indonesia, although the present manuscript focuses on low birthweight among high-risk groups of women. But reference should be made to the Safitri *et al.* study.
6. The manuscript needs a major revision, particularly a revision of Table 2 and rewriting the discussion of Table 2 findings.
7. The manuscript also requires a thorough editing for English.
8. Several other, specific comments are made in the body of the text, which is returned for revision - please also find two attachments of the manuscript with my comments linked here ([Attachment 1](#) and [Attachment 2](#)).

Specific comments:

1. Title. A similar study based on data from the 2017 Indonesia Demographic and Health Survey exists (see Safitri *et al.*, 2022¹), which identifies ANC as a determinant of LBW in Indonesia. Acknowledgement and appropriate references should be made of the Safitri *et al.* study.

What new information does your study provide to the field of knowledge? Is it the analysis of low birthweight among high-risk groups of women?

1. Abstract. Background, Line 2. Rewrite as "and is a leading cause of neonatal mortality".
2. Abstract. Methods, Line 3. "unit of analysis".
3. Abstract. Methods, Line 3. pre-term birth is not included in the four criteria (4Ts) mentioned above.
4. Abstract. Conclusions, Lines 1-2. The sentence reads as if WHO has found that qualified ANC standards have not been fully implemented (in Indonesia). But it is a finding of your analysis, is it not?
5. Methods. Lines 11-12. How was quality of ANC (qualified ANC) determined? There are no data in the 2017 IDHS about the quality of ANC.
6. Methods. Line 12. Do you mean "positive pregnancy experience"?
7. Methods. Line 12. Do you mean to say, "Data were collected at IDHS 2017 only for five WHO recommendations"?
8. Methods. Line 14. All four Ts together?
9. Results. Line 3. The "too many" and "too old" categories of women (as well as the "too close" category) also have high proportions in the High education category. This is notable.

10. Results. Lines 3-4. This is not correct. Please rewrite this part as ""the majority of women in the "too young" and "too many" categories are rural dwellers, almost equal proportions of women in the "too close" category are urban and rural dwellers, and the majority of women in the "too old" category are urban dwellers."
11. Results. Line 6. This is true only for the "too young" women. Please re-write correctly.
12. Results. Lines 10-11. Where is it shown that "four out of five women had relatively more ANC check-ups"?
13. Results. Lines 11-12. How is this true? The table shows that 85% or more of the women each category had a Health worker as their ANC provider. Do you mean to say that most of the Health workers are not qualified?
14. Results. Lines 13-14. This result contradicts your hypothesis that women in the 4T categories run the risk of giving birth to babies with pre-maturity and low birth weight.
15. Table 1. Usually, the dependent variable (in this case women in each criterion group) should be shown on the horizontal axis and the independent variables on the vertical axis. This can be done by formatting the layout of the table as landscape. Also, try to put the entire table on one page (i.e. do not split a table between pages. Reduce the font size if needed).
16. Table 2. Line 1. "ANC quality" or qualified and unqualified ANC? The two terms are different.
17. Results. First paragraph after Table 1. **Table 2, as presented here shows the distribution of each socio-economic characteristic (independent variable) according to qualified ANC and unqualified ANC for each of the 4T categories of women. But in actual fact, you should show the distribution of qualified ANC and unqualified ANC according to each socio-economic characteristic. In other words, show the column percentages instead of row percentages. Therefore, please re-do Table 2 and re-write its description. Please also show the association (chi-square) between each of the socio-economic characteristics and unqualified and qualified ANC for each of the 4T categories.**
18. Table 3. It appears that you have not used any information derived from Table 2 in performing your analysis in Table 3. Please re-calculate Table 2 as suggested and use the relevant information from that (revised Table 2) to select the pertinent variables for logistic regression (Table 3).
19. Results. Table 3, Lines 2-3. The "mixed" results may be due to the effects of confounding factors. For example, take any one category, such as "Too old" - While this group excludes women who are "Too young", the "Too old" women may have children who are too closely spaced or may have too many children. Similarly, the women who have "Too many" children may be "too old" themselves or may have children that are "too closely" spaced, or the women who are in the "Too close" category may have too many children or may be too old themselves. Only the "Too young" women would not be subjected to confounding factors like too many or too old, but they may still have too closely spaced children. It is for these

reasons that you should also analyse the group of women who are Too old AND Too Close AND Too Many. The "Too young" group may be analysed separately, because "too young" women would have very little chances of having too many children or too closely spaced children.

20. Results. Table 3, Line 3. "Quality of ANC". Which variable(s) indicate the quality of ANC?
21. Results. Table 3, Line 15 and Line 28. Why do you refer to the groups as "Model"? Just call them what they are i.e., "Too old" or "Too many". A model may have the connotation of a separate logistic regression.
22. Discussion. Line 1. LBW. Is LBW a major cause of infant death in Indonesia?
23. Discussion. Line 1. Indonesia has already reduced its IMR by much, but it is pursuing further declines in IMR.
24. Discussion. Lines 4-5. If the prevalence of LBW is already so low in Indonesia (6-7%), then why study it? You should cite the target of LBW in Indonesia or cite the prevalence of LBW in countries which is lower than that in Indonesia and then justify your study.
25. Discussion Line 5. So, the results show that your hypothesis (that ANC quality affects the prevalence of LBW) is not true in three out of four categories of women. How do you explain this?
26. Discussion. Line 8. What kind of knowledge?
27. Conclusion. Lines 1-2. Assuming that the headings of your Table 1 are correct, according to the numbers of women in each category, women with too many children number 5,300. Thus, qualified ANC affects 55.5% of the women at risk (the number of women with all the Ts is equal to 9,546).
28. Conclusion. Line 8. Re ANC visit of at least eight times. The recommendation of eight ANC visits from the WHO came out in 2016 and probably implemented in Indonesia after the 2017 IDHS was conducted. Therefore, in most cases, at the time of IDHS 2017 the recommendation was to have at least 4 ANC visits. Table 9.2 of the 2017 IDHS Final report shows 90.6% of the women giving birth in the last five years had 4+ ANC visits.

Recommendation:

The authors should address the comments, provide further justification of this study and submit a revised manuscript.

References

1. Safitri HO, Fauziningtyas R, Indarwati R, Efendi F, et al.: Determinant factors of low birth weight in Indonesia: Findings from the 2017 Indonesian demographic and health survey. *J Pediatr Nurs.* 2022; **63**: e102-e106 [PubMed Abstract](#) | [Publisher Full Text](#)

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

Partly

If applicable, is the statistical analysis and its interpretation appropriate?

Partly

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: A few of the authors (Resti Pujihavuty, Sari Kistiana and Irma Ardiana) are my former students, but I have had no input whatsoever in the preparation of the manuscript. I confirm that this potential conflict of interest did not affect my ability to write an objective and unbiased review of the article.

Reviewer Expertise: Demography, including infant and child mortality, maternal mortality, fertility, population and development, population and environment

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

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