



# Antenatal Care Services and Incidence of Low Birth Weight: A Comparison of Demographic and Health Surveys in 4 ASEAN Countries

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**Objectives:** This study aimed to assess the effect of complete coverage and content of available antenatal care (ANC) on the incidence of low birth weight (LBW) in 4 countries belonging to the Association of Southeast Asian Nations (ASEAN).

**Methods:** Measures of complete coverage and content of ANC services included the frequency of ANC visits and the seven service components (blood pressure measurement, iron supplementation, tetanus toxoid immunization, explanations of pregnancy complications, urine sample test, blood sample test, and weight measurement). The complete coverage and content of ANC services were assessed as high if more than 4 ANC visits and all seven components were delivered. Multivariable logistic regression with complex survey designs was conducted using Demographic Health Survey data from the 4 ASEAN countries in question from 2014 to 2017.

**Results:** The proportion of LBW infants was higher in the Philippines (13.8%) than in Indonesia (6.7%), Cambodia (6.7%), or Myanmar (7.5%). Poor ANC services were associated with a 1.30 times higher incidence of LBW than a high level of complete coverage and content of ANC services (adjusted odds ratio [aOR], 1.30; 95% confidence interval [CI], 1.11 to 1.52). In addition, the risk of LBW was higher in the Philippines than in other countries (aOR, 2.25; 95% CI, 2.01 to 2.51) after adjusting for mothers' demographic/socioeconomic factors, health behaviors, and other factors.

**Conclusions:** In sum, complete coverage and content of ANC services were significantly associated with the incidence of LBW in Indonesia, Cambodia, and Myanmar. The Philippines did not show statistically significant results for this relationship, but had a higher risk of LBW with poor ANC.

**Key words:** Female, Health surveys, Infant, Low birth weight, Pregnant women, Prenatal care

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## INTRODUCTION

Low birth weight (LBW) is defined by the World Health Organization (WHO) as a birth weight of less than 2500 g (5.5 pounds) [1]. LBW can occur due to preterm birth or due to restricted intrauterine growth in a full-term infant. Babies with LBW are at risk for neonatal death; those that survive are at higher risk of growth delays, lower intelligence, and experiencing non-communicable diseases like obesity and diabetes as adults [2]. In 2015, 14.6% of the 20.5 million babies born were estimated to

have LBW, and of this number around 96.5% were born in developing countries. According to the WHO (2018), 60-80% of neonatal deaths were caused by LBW. More than half of babies with LBW came from the Asian continent, and South Asia was the largest contributor to the global incidence of LBW, followed by Southeast Asia, which accounted for 12.3% of global LBW births. The decline in the incidence of LBW from 2000 to 2015 was slow in Association of Southeast Asian Nations (ASEAN) countries, decreasing by only 1.4% (95% confidence interval [CI], 0.9 to 1.9). South Asian countries, in contrast, experienced a decrease of 5.9% (95% CI, 3.8 to 8.8) over the same period of time [2-4].

Demographic Health Survey (DHS) data showed the following prevalence rates of LBW in 4 ASEAN countries: Indonesia at 7% (2017), Cambodia at 7.9% (2014), the Philippines at 15% (2017), and Myanmar at 8.1% (2015-2016) [5-8]. Trends in the prevalence of LBW from 2000 to 2015, derived from data from the United Nations Children's Fund, showed an annual decrease in the incidence of LBW by 0.1% [2]. However, this has not been enough to reduce the impact of the risk of neonatal death in Indonesia, Cambodia, Myanmar, and the Philippines [9]. Reducing the incidence of LBW has long been a global public health priority. Countries committed to a 30% reduction in LBW between 2012 and 2025 at the 65th World Health Assembly in 2012 [3]. High-quality antenatal care (ANC) is key for reducing the incidence of LBW, as the ANC services obtained by the mother during pregnancy and the health of the newborn are correlated [10-12]. These services are related to prevention, early detection, and maintenance of good health during pregnancy. The comprehensive WHO guidelines on ANC involve a "focused ANC" package that includes the frequency and timing of ANC visits, as well as the quality of ANC. In these guidelines, at least 4 ANC visits are recommended, 1 each for the first and second trimesters, and 2 for the third. These visits can include tracing maternal disease history; examinations of blood pressure, anemia, and fetal movement; screening and tests; treatment of syphilis and bacteriuria if indicated; preventive measures such as tetanus toxoid immunization and iron and folic acid supplementation; and overall health education [13,14].

Ineffective ANC can negatively affect birth outcomes, whereas ANC interventions can improve birth outcomes [15]. Nevertheless, the prevalence of LBW varies widely between regions and countries. Ninety-seven percent of LBW occurs in low-income and middle-income countries [3], and LBW is most com-

mon among the most susceptible segments of society, such as the poor living in remote areas. In addition, poor people who live in remote areas may have difficulty accessing adequate health services. There is also a possibility that poor females often lack access to quality health services, which, along with poor nutritional quality and health conditions, increases their chances of giving birth to LBW babies.

ANC services are key to maternal health monitoring and the early detection of danger signs. Prioritizing the measurement of body weight and fetal development every month can be an effective strategy for reducing the incidence of LBW [16]. The results of a study on the effects of ANC services on the incidence of LBW, after controlling for the covariate variables (generating adjusted odds ratios [aORs]), showed that mothers who received poor-quality ANC were at a higher risk of giving birth to babies with LBW. da Fonseca et al. [12], in a study conducted in São Paulo, Brazil, reported that the odds of the incidence of LBW in mothers who received poor-quality ANC services were 4.13 times higher than those who received good-quality ANC services (aOR, 4.13; 95% CI, 1.36 to 12.51). Oulay et al. [17] in the Lao PDR and Kananura et al. [18] in Eastern Uganda reported that among pregnant females who had at least 4 ANC visits, those who made their first visit in the second trimester or later were more likely to give birth to LBW babies.

To the best of our knowledge, no research to date has examined the effects of the complete coverage and content of ANC service on the incidence of LBW in ASEAN countries. This study aimed to determine these effects by controlling for maternal variables (mother's age at pregnancy and parity), maternal health and habits (ANC provider and smoking status), infant factors (sex, birth spacing), household social characteristics (mother's education level, economic status, area of residence), and socio-familial empowerment (who makes decisions in the family) in 4 ASEAN countries.

## METHODS

### Data Source

This cross-sectional study extracted DHS data (from <https://dhsprogram.com/data/available-datasets.cfm>) for the 4 countries. DHSs have been conducted in over 90 countries worldwide; six ASEAN countries have conducted surveys, but only 4 of these have done so within the last 10 years, namely Indonesia (2017), Cambodia (2014), Myanmar (2015-2016), and the Philippines (2017). These 4 ASEAN countries were selected

**Table 1.** Study population of the Demographic and Health Surveys (2014-2017)

Country	All female	Singleton births	Babies who were weighed	Complete data
Indonesia	17 848	17 595	16 115	15 155
Cambodia	7165	7031	6299	5691
Myanmar	4815	4726	1986	1875
The Philippines	10 551	10 372	8471	7741
Total	40 379	39 724	32 871	30 462

based on the availability of complete information on the required variables, particularly ANC services and the covariates.

The DHSs were sampled in two stages according to stratified sampling methods and were nationally representative. The stratification strategy divided the population into groups. During the first stage of sampling, primary sampling units were based on census enumeration areas within each stratum, which was selected through the probability proportional to size method. In the second stage, a systematic sample of households was drawn from the list of households. All females of reproductive age (15-49 years) in the selected households were eligible for interviews, which was the focus of the survey. The female's questionnaire asked for self-reported information on pregnancy history, socioeconomic and demographic characteristics, and involvement in household decision-making [19]. Detailed information on the study design and data collection procedures of 4 ASEAN countries has been published elsewhere [5-8].

This study's participants were all females aged 15-49 years in Indonesia, Cambodia, Myanmar, and the Philippines who had live births during the last 5 years before the survey was conducted. The inclusion criteria were singleton births and access to information on the birth weight of the baby, either through a written card or mother's recall. We limited our analysis to singletons because multiple births are closely related to premature births, which are also likely to be LBW. The exclusion criteria were incomplete data on any of the identified research variables. Details about the research sample are presented in Table 1.

## Variables and Measurements

### Outcome variable

The outcome variable was the incidence of LBW (birth weight less than 2500 g) as defined by the WHO and normal weight (i.e., weight equal to or more than 2500 g), measured via a written card or by mother's recall.

### The explanatory variables

The explanatory variables were as follows: The timing of the first ANC visit was measured according to whether females initiated ANC with a healthcare professional (a doctor, midwife, village midwife [Indonesia], or nurse) or a community volunteer (barangay health worker in the Philippines, village health volunteer in Cambodia, or an auxiliary midwife in Myanmar) whether in the first, second, third trimester, or no ANC visit at all. The timing of the first ANC visit (months) of participants was recoded as first trimester (0-12 weeks), second and third trimesters (> 13 weeks), and none (or no ANC visit at all).

The completeness of coverage and content of ANC services was measured by the number of visits (with the ideal being at least 4 antenatal consultations) and receiving 7 aspects of ANC services. The components of ANC service consisted of (1) measurement of blood pressure, (2) iron supplementation, (3) tetanus toxoid immunization, (4) explanations of potential pregnancy complications, (5) a urine sample test, (6) a blood sample test, and (7) measurement of weight. The complete coverage and content of ANC services of participants were recorded as follows: "good (frequency of visits  $\geq$  4 times and 7 complete components)," "less (frequency of visits < 4 times and 7 complete components)," "less (frequency of visits  $\geq$  4 times and 7 components were incomplete)," and "poor (frequency of visits < 4 times and 7 components were incomplete)."

The covariates to be controlled included maternal characteristics (mother's age at pregnancy, parity), maternal health and habits (provider of ANC, smoking status), infant factors (baby's sex, birth spacing), household social characteristics (mother's education level, wealth index, area of residence), and socio-familial empowerment (who makes the decisions in the family). Detailed definitions of the covariates can be found in the Supplemental Material 1.

### Statistical Analysis

Data analysis was conducted using the complex survey design, which considers weighted, strata, and clusters; this was carried out following the DHS sample design, which uses a 2-stage probability sampling technique. Multivariable logistic regression was used to determine the effect of complete coverage and content of ANC services on the incidence of LBW. The final model contained all variables that were substantially correlated to the incidence of LBW. The confounding variables were assessed by excluding covariates with a  $p$ -value > 0.05 and assessing changes in the OR. If the OR changed by over

10%, then the covariate variable was kept in the model [20]. In Myanmar's DHS (2015-2016 MDHS), there were no weight measurements; instead, its analysis focused on 6 components of ANC services, whereas the data analyzed for Indonesia, the Philippines, and Cambodia contained 7 components.

### Ethics Statement

This study was based on a secondary data analysis of DHS. The authors' permission to use and download the data was given by ICF Internasional. The ethical approval was granted by an ethical committee from the Faculty of Public Health, Universitas Indonesia with approval No. Ket- 30/UN2.F10.D11/PPM.00.02/2021.

## RESULTS

The incidence of LBW and the characteristics of the respondents varied widely across the 4 ASEAN countries included in the study (Table 2). The proportions in the Philippines, Myanmar, Indonesia, and Cambodia were 13.8%, 7.5%, 6.7%, and 6.7%, respectively. In addition, the risk of LBW was higher in the Philippines than in other countries (aOR, 2.25; 95% CI, 2.01 to 2.51). Table 3 presents an overview of ANC in the 4 countries. The highest rate of good ANC (more than 4 visits and 7 completed components) was in Myanmar at 45.5%, while the highest rate of poor ANC (fewer than 4 visits and 7 completed components) was in Cambodia at 23.3%. There were minimal differences in terms of the rates of 4 or more ANC visits; the high-

**Table 2.** Incidence of LBW and characteristics of respondents in Indonesia, Cambodia, Myanmar, and the Philippines

Variables	Indonesia 2017 (n= 15 155)	Cambodia 2014 (n=5691)	Myanmar 2015-2016 (n= 1875)	The Philippines 2017 (n=7741)
LBW				
Yes	1019 (6.7)	383 (6.7)	140 (7.5)	1071 (13.8)
No	14 136 (93.3)	5308 (93.3)	1735 (92.5)	6670 (86.2)
Baby's sex				
Female	7356 (48.5)	2787 (49.0)	854 (45.5)	3667 (47.4)
Male	7799 (51.5)	2904 (51.0)	1021 (54.5)	4074 (52.5)
Mother's age at pregnancy (y)				
20-35	11 253 (74.3)	4586 (80.6)	1396 (74.5)	5642 (72.9)
<20 or >35	3902 (25.7)	1105 (19.4)	479 (25.5)	2099 (27.1)
Mother's education				
Secondary or higher	7525 (49.6)	480 (8.4)	340 (18.1)	5056 (65.3)
Primary	6604 (43.6)	2278 (40.0)	1015 (54.1)	2006 (25.9)
None	1026 (6.8)	2933 (51.6)	520 (27.8)	679 (8.8)
Wealth index <sup>1</sup>				
Richest	3570 (23.5)	1518 (26.6)	458 (24.4)	834 (10.8)
Richer	3056 (20.2)	1067 (18.8)	480 (25.6)	1163 (15.0)
Middle	2956 (19.5)	951 (16.7)	345 (18.4)	1492 (19.3)
Poorer	2853 (18.8)	1033 (18.2)	329 (17.6)	1946 (25.1)
Poorest	2720 (18.0)	1122 (19.7)	263 (14.0)	2306 (29.8)
Area of residence				
Urban	7820 (51.6)	1662 (29.2)	694 (37.0)	2667 (34.5)
Rural	7335 (48.4)	4029 (70.8)	1181 (63.0)	5074 (65.5)
Socio-familial empowerment <sup>2</sup>				
Discussion	7911 (52.2)	2340 (41.1)	729 (38.9)	5789 (74.8)
No discussion	7244 (47.8)	3351 (58.9)	1146 (61.1)	1952 (25.2)

Values are presented as number (%).

LBW, low birth weight.

<sup>1</sup>A composite indicator dividing the households into 5 categories using principal component analysis based on information from housing characteristics and ownership of household durable goods.

<sup>2</sup>Female's power balance within social networks and their freedom of mobility; As well as representing woman's familial and marital roles, the model also shows the household status in conflict situations and negotiation.

est was 84.7% in Indonesia, while the lowest was 73% in Cambodia and Myanmar. The highest proportion of the 7 completed ANC components was in Myanmar (52.2%), while the lowest was in Indonesia (14.3%). The types of ANC services received also varied across the countries. In Indonesia, the most common type was blood pressure measurement (90.5%), and the least common type was urine sample tests (34.0%). In Cambodia, the most common was iron supplementation (90.4%), while the least common was urine sample tests (45.8%). In Myanmar, the most common type was iron supplementation (91.3%), and the least common type was urine sample tests (68.6%). In

the Philippines, the most common type was blood pressure measurement (83.6%), and the least common was type blood sample tests (61.2%).

Lastly, the odds of pregnant female who received poor ANC services (in terms of complete coverage and content) for experiencing LBW was 1.30 times higher than those who received good ANC services (aOR, 1.30; 95% CI, 1.11 to 1.52) (Table 4). A first-trimester ANC visit was not significantly associated with the incidence of LBW in any of the 4 countries (Table 5). The results of this analysis also showed that the completeness of coverage and content of ANC services was significantly associ-

**Table 3.** Overview of ANC services in Indonesia, Cambodia, Myanmar and the Philippines

Variables	Indonesia 2017 (n=15 155)	Cambodia 2014 (n=5691)	Myanmar 2015-2016 (n=1875) <sup>1</sup>	The Philippines 2017 (n=7741)
Timing of the first ANC visit				
First trimester	11 292 (74.5)	4336 (76.2)	856 (45.6)	4603 (59.5)
Second/third trimester	2379 (15.7)	830 (14.6)	873 (46.6)	1923 (24.8)
None	1484 (9.8)	525 (9.2)	146 (7.8)	1215 (15.7)
Completeness of the coverage and content of ANC services				
Good (frequency of visits ≥ 4 times and 7 complete components)	2234 (14.7)	1603 (28.2)	854 (45.5)	3425 (44.2)
Less (frequency of visits < 4 times and 7 complete components)	50 (0.3)	212 (3.7)	125 (6.7)	220 (2.8)
Less (frequency of visits ≥ 4 times and 7 components were incomplete)	10 601 (70.0)	2551 (44.8)	517 (27.6)	2477 (32.0)
Poor (frequency of visits < 4 times and 7 components were incomplete)	2270 (15.0)	1325 (23.3)	379 (20.2)	1619 (21.0)
ANC frequency				
≥ 4 visits	12 835 (84.7)	4154 (73.0)	1371 (73.1)	5902 (76.2)
< 4 visits	2320 (15.3)	1537 (27.0)	504 (26.9)	1839 (23.8)
Completeness of ANC components				
Complete (7 components)	2168 (14.3)	1806 (31.7)	979 (52.2)	2846 (36.8)
Incomplete (< 7 components)	12 897 (85.7)	3885 (68.3)	896 (47.8)	4895 (63.2)
Received ANC services				
Blood pressure measurement	13 712 (90.5)	4985 (87.6)	1684 (89.8)	6475 (83.6)
Iron supplementation	12 374 (81.6)	5147 (90.4)	1712 (91.3)	6253 (80.8)
Tetanus toxoid immunization	9926 (65.5)	4399 (77.3)	1661 (88.6)	5784 (76.9)
Counseling about pregnancy complications	8718 (57.5)	4361 (76.6)	1456 (77.7)	5764 (74.5)
Urine sample examination	5569 (34.0)	2607 (45.8)	1287 (68.6)	5131 (66.3)
Blood sample examination	6728 (44.4)	3962 (69.6)	1325 (70.7)	4738 (61.2)
Weight measurement	13 604 (89.8)	4979 (87.5)	-	5842 (75.5)
Provider of ANC				
Health workers	13 186 (87.0)	5149 (90.5)	1676 (89.4)	6406 (82.7)
Non-health workers	485 (3.2)	17 (0.3)	53 (2.8)	120 (1.6)
No visits	1484 (9.8)	525 (9.2)	146 (7.8)	1215 (15.7)

Values are presented as number (%).

ANC, antenatal care.

<sup>1</sup>Myanmar was the only country for which data were available on 6 components of the complete coverage and content of ANC services.

ated with the incidence of LBW in Indonesia, Cambodia, and Myanmar. Although the results of the Philippines were not statistically significant, the Philippines showed a potential risk of

**Table 4.** Relationships of the timing of the first ANC visit and the complete coverage and content of ANC services with the incidence of LBW (multivariable logistic regression)

Variables	Incidence of LBW <sup>1</sup>	p-value <sup>2</sup>
Timing of the first ANC visit		
First trimester	1.00 (reference)	
Second/third trimester	0.98 (0.89, 1.10)	0.781
None	0.84 (0.61, 1.17)	0.302
Completeness of coverage and content of ANC services		
Good (frequency of visits $\geq 4$ times and 7 complete components)	1.00 (reference)	
Less (frequency of visits $< 4$ times and 7 complete components)	1.28 (0.97, 1.69)	0.079
Less (frequency of visits $\geq 4$ times and 7 components were incomplete)	0.94 (0.85, 1.05)	0.250
Poor (frequency of visits $< 4$ times and 7 components were incomplete)	1.30 (1.11, 1.52)	0.001
ASEAN country		
Indonesia	1.00 (reference)	
Cambodia	0.88 (0.75, 1.02)	0.086
Myanmar	1.02 (0.83, 1.26)	0.826
The Philippines	2.25 (2.01, 2.51)	$< 0.001$

Values are presented as adjusted odds ratio (95% confidence interval). ANC, antenatal care; LBW, low birth weight; ASEAN, Association of South-east Asian Nations.

<sup>1</sup>Adjusted odds ratio controlled for maternal age during pregnancy, parity, antenatal care provider, smoking status, baby's sex, birth spacing, mother's education level, wealth index, area of residence, and socio-familial empowerment variables.

<sup>2</sup>Analysis with multivariable logistic regression.

**Table 5.** Multivariable logistic regression analysis<sup>1</sup> of factors affecting the incidence of LBW in 4 ASEAN countries

Variables	Indonesia	Cambodia	Myanmar <sup>2</sup>	The Philippines
Timing of the first ANC visit				
First trimester	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Second/third trimester	1.01 (0.80, 1.28)	0.97 (0.64, 1.47)	0.98 (0.60, 1.59)	1.03 (0.81, 1.29)
None	0.78 (0.53, 1.15)	0.32 (0.05, 1.89)	1.14 (0.30, 4.33)	1.01 (0.57, 1.81)
Completeness of coverage and content of ANC services				
Good (frequency of visits $\geq 4$ times and 7 complete components)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Less (frequency of visits $< 4$ times and 7 complete components)	1.56 (0.48, 5.09)	1.87 (0.96, 3.65)	0.82 (0.36, 1.87)	1.11 (0.63, 1.96)
Less (frequency of visits $\geq 4$ times and 7 components were incomplete)	0.94 (0.76, 1.18)	0.99 (0.71, 1.38)	1.17 (0.70, 1.96)	1.08 (0.84, 1.39)
Poor (frequency of visits $< 4$ times and 7 components were incomplete)	1.57 (1.08, 2.27)*	1.83 (1.13, 2.99)*	2.59 (1.49, 4.49)*	1.18 (0.80, 1.75)

Values are presented as adjusted odds ratio (95% confidence interval).

LBW, low birth weight; ASEAN, Association of Southeast Asian Nations; ANC, antenatal care.

<sup>1</sup>Adjusted odds ratio controlled for maternal age during pregnancy, parity, antenatal care provider, smoking status, baby's sex, birth spacing, mother's education level, wealth index, area of residence, and socio-familial empowerment variables; Analysis with multivariable logistic regression.

<sup>2</sup>Myanmar was the only country for which data were available on 6 components of the complete coverage and content of ANC services.

\* $p < 0.05$ .

LBW associated with poor complete coverage and content of ANC services, as the odds for the incidence of LBW in mothers with poor complete coverage and content of ANC services was 1.18 times higher than those with good ANC services (aOR, 1.18; 95% CI, 0.80 to 1.75).

## DISCUSSION

This study aimed to determine the effects of complete coverage and content of ANC services on the incidence of LBW in 4 ASEAN countries. The results showed that mothers who received poor ANC services were 1.30 times more likely to give birth to LBW babies after controlling for maternal age, the baby's sex, ANC provider, smoking status, maternal education, parity, wealth index, area of residence, and socio-familial empowerment variables. Indonesia, Cambodia, and Myanmar showed statistically significant LBW risks, of which Myanmar had the highest (aOR, 2.59; 95% CI, 1.49 to 4.49). However, it should be noted that Myanmar has a high missing data rate, which may have affected the results of this study. The results of this study align with the research of Servan-Mori et al. [21], which stated that both the timeliness of ANC visits and the quality of basic services are key to reducing the incidence of LBW. Although the results of the Philippines were not statistically significant, it had a risk of LBW associated with poor complete coverage and content of ANC services, as the odds for the incidence of LBW in mothers with poor complete coverage and content of ANC services was 1.18 times higher than those with good ANC services (aOR, 1.18; 95% CI, 0.80 to 1.75). These

findings are consistent with previous results reported in the literature [11,22,23].

These results also showed that an ANC visit in the first trimester did not affect the incidence of LBW across the 4 countries. However, different results were reported by Bhaskar et al. [24] in Eastern Nepal and Paul et al. [11] in India, who found that mothers who made their first ANC visit in the second or third trimester were at a higher risk of giving birth to babies with LBW than mothers who underwent first ANC visits in the first trimester. We assume that the fixed effect of the composite variable of the complete coverage and content of ANC services in this study substantially influenced the significance of the first ANC visit. Consequently, first-trimester ANC alone is not enough to reduce the incidence of LBW—instead, the quality of ANC, combined with a minimum quantity, is essential. During ANC visits, pregnant female should receive a complete range of services. According to the literature, to reduce LBW incidence, full ANC services are the most effective strategy [11]. The results of this study, however, showed that good complete coverage and content of ANC services infrequently occur, in about 14.7% of female in Indonesia, 28.2% in Cambodia, 44.2% in the Philippines, and 45.5% in Myanmar.

The reason for the incompleteness of the 7 ANC service components was due to the low frequency of laboratory tests (urine and blood) in all 4 countries (ranging from 34.0 to 68.6% for urine sample tests and 44.4 to 70.7% for blood sample tests). Based on a mapping of routine ANC components in Asian countries, Benova et al. [25] found that taking urine and blood samples had the lowest coverage of ANC components and stated this area needed the most improvement. Concentrating exclusively on the number of ANC visits may have reduced coverage effectiveness. Even with a higher overall median number of ANC visits, countries with a larger range of ANC visits (e.g., Egypt, Jordan, and Indonesia) were less likely to reach high coverage levels for all 6 routinely measured components of care, including blood pressure measurements, urine samples, blood samples, tetanus protection, iron supplementation, and the receipt of information on potential complications. According to the WHO, the 2016 ANC guideline emphasizes the quality of care provided during each contact, highlighting the components of high-quality care.

ANC services are key to maternal health monitoring and the early detection of danger signs. Prioritizing the measurement of body weight and fetal development every month can be an effective strategy for reducing the incidence of LBW. Weighing

the mother at each visit is intended to detect fetal growth disorders. A weight gain of less than 9 kg throughout the pregnancy, or less than 1 kg per month, indicates a fetal growth disorder [16]. The measurement of blood pressure is intended to determine the potential risk of hypertension, as uncontrolled hypertension during pregnancy can lead to pre-eclampsia, and mothers with both mild and severe pre-eclampsia often give birth to LBW babies. Similarly, iron tablets function as a nutritional supplement for both the mother and the fetus. The WHO recommends providing iron supplements of 20-60 mg and folic acid supplements of 0.4 mg in addition to context-specific interventions for pregnant female who experience anemia [13]. One of the purposes of the urine sample test is to determine the presence of protein in the urine (proteinuria), which is another indicator of pre-eclampsia, and one of the purposes of examining a blood sample is to determine hemoglobin levels, as low hemoglobin levels can indicate anemia [16]. Limited or incomplete monitoring of maternal health and the absence of basic laboratory testing is a concern in all 4 countries included in this study.

The results of this study strengthen those from previous studies that used DHS data in Colombia (2015), in which the risk of LBW after non-standardized ANC services was 1.8 times higher than after standardized ANC services [26]. In another study by Zhou et al. [10] in 42 poor counties in Western China, the results showed that children whose mothers did not receive ANC components, such as measurements of weight and blood pressure and blood and urine tests, had a higher risk of LBW compared to those whose mothers received them.

The findings show that a first-trimester ANC visit alone is not enough to reduce the incidence of LBW. We obtained consistent results across 4 ASEAN countries (Indonesia, Myanmar, Cambodia, and the Philippines), indicating that high-quality ANC services are as important as quantity. Pregnant females are advised to have at least 4 ANC visits that include a complete set of 7 ANC component services. Special efforts need to be focused on pregnant female with low education levels and low economic status. It is recommended that first of all, healthcare workers who provide ANC services should seek to improve the completeness of coverage and content of ANC services to all pregnant female. Secondly, increasing maternal health literacy is very important for the well-being of mothers and babies (for example, emphasizing the importance of full ANC services). Thirdly, urine samples and blood samples are among the components of ANC that require the greatest improvement across

4 ASEAN countries. Fourthly, a focus on quality in addition to the minimum quantity of ANC services is a necessity. Lastly, as evidenced by the results of most of the participants in rural areas having a higher risk of LBW in this study, efforts need to be made to improve the accessibility and cost burdens of ANC.

### Strengths and Limitations of This Study

One advantage of this research was its use of survey data with a high national-level sample size, meaning that the results of the analysis can be defined both nationally and with high levels of precision. Measurements of the complete coverage and content of ANC services were based on maternal recall up to 5 years, which may have introduced reporting and recall bias. We have no way of knowing from the DHS data whether the ANC components were completed at the right time, with the correct frequency, or with an appropriate response. A more accurate measure of quality, to which females with complications or infections known to increase the risk of LBW responded appropriately, could perhaps have shown much stronger effects. Secondly, mothers' recall of LBW may not have been precise. Measurements of the outcome of LBW are subject to misclassification, particularly if relying on maternal recall rather than a health card (which can also be subject to mismeasurement and misreporting). In addition, a significant proportion of the children did not have their birth weight recorded (Table 1). The present results may be impacted by these missing values (selection bias), especially for Myanmar, which had high missing rates (up to 48%). Lastly, the study did not control for additional variables related to the incidence of LBW, such as maternal nutritional status, changes in maternal weight during pregnancy, and occupation; therefore, confounder bias was possible.

### SUPPLEMENTAL MATERIALS

Supplemental material is available at <https://doi.org/10.3961/jpmph.22.316>.

### CONFLICT OF INTEREST

The authors have no conflicts of interest associated with the material presented in this paper.

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