Original Articles

Iron intake during pregnancy reduces low birth weight: A propensity score analysis

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Abstract
Background: Low birth weight (LBW) remains a significant public health problem. As nutritional problems, including anaemia, can cause LBW, iron supplementation is needed during pregnancy.

Objectives: To assess the impact of iron supplementation during pregnancy on birth weight in Indonesia using data from the 2017 Indonesia Demographic Health Survey (IDHS).

Method: Birth weight was categorized into two groups, LBW (<2500g) and normal birth weight (2500g or more). Iron supplementation was constructed into two groups, mothers who did not take or whose intake was less than 90 tablets during pregnancy and mothers who took ≥90 tablets during pregnancy. A sample of 10,518 children born within five years was matched using propensity scores. We used binary logistic regression and adjusted for 12 possible confounders after matching the data. Then, we performed logistic regression to assess the relationship between iron intake during pregnancy and birth weight. We built multistage multivariate logistic regression models using the backward elimination technique. We adjusted the model with some confounding factors, including socioeconomic and community-level factors, maternal and child characteristics, and maternal and child health services.

Results: After adjusting for potential confounders, this study found that iron supplementation during pregnancy significantly reduced LBW (AOR: 0.75; 95% CI: 0.64 to 0.88).

Conclusions: This study found that iron supplementation during pregnancy significantly reduced LBW.

(Key words: Low birth weight, Anaemia, Iron supplementation, Propensity score match, Indonesia)

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Background
Low birth weight (LBW) remains a significant public health problem. LBW, defined as a birth weight of less than 2,500g regardless of gestational age, is associated with both short-term and long-term negative impacts. In 2015, one in seven babies was born with LBW[1]. LBW was associated with an increased risk of infant mortality. There was a higher risk of infection, a higher vulnerability to childhood illness and a decreased chance of child survival. LBW contributes to 40–60% of neonatal mortality[2]. In the long-term, LBW is associated with mental deficiency, learning and behaviour disturbances and psychosocial impairment. Several illnesses, including cardiovascular disease, diabetes, hypertension, behavioural problems, cognitive impairment and psychological disorders can influence the negative consequences of LBW on the body[3].

Causes of LBW can be classified as genetic, constitutional, maternal morbidities and nutritional during antenatal period, including anaemia[3]. Anaemia during pregnancy affects 38% of pregnant women[4]. Almost half of pregnant women in Indonesia suffer from anaemia during pregnancy[5]. Pregnant women are more susceptible to anaemia, particularly iron deficiency anaemia, due to physiological changes that occur during pregnancy. Pregnant women are more likely to get anaemia because they need more iron and folic acid while they are pregnant. Anaemia during pregnancy has been linked to adverse outcomes for mothers and neonates. Consequently, much effort is required to develop, re-evaluate, and implement strategies to prevent and control anaemia during pregnancy[6,7].

Pregnant women require additional iron and adequate iron stores to avoid iron deficiency. Hence direct iron supplementation for pregnant women is one of the most prevalent public health measures[8].

The World Health Organization (WHO) recommends taking 30–60 mg of iron orally daily[9]. Pregnant women should consume a minimum of 90 iron tablets during their pregnancy[10]. The Indonesian government has provided free anaemia prevention and iron supplementation as a national programme.

Objectives

This study examined the effect of iron supplementation on birth weight in Indonesia using a nationally representative survey.

Method

We used data from the 2017 Indonesia Demographic Health Survey (IDHS). The survey included 49,627 women of reproductive age, 34,199 of whom reported giving birth, and 15,984 who reported having delivered their babies within five years of the survey.

The samples were selected using multistage stratified sampling. The IDHS recorded the women's antenatal, delivery, and postnatal care services five years prior to the survey based on the respondent's recall[11]. This study was limited to 15,357 mother-child dyads that completed all variables used. The primary exposure variable of this study was the mother's report of iron supplementation during pregnancy.

The IDHS asked about iron supplementation during pregnancy: 'Did you get or buy iron/folic acid tablets or iron syrup during this pregnancy?' 'How many days did you take the tablets during your pregnancy?' We constructed a variable iron supplementation into two groups; (1) Mothers who did not take iron supplementation or whose intake was less than 90 tablets during pregnancy, and (2) Mothers who took ≥90 tablets during pregnancy.

The outcome variable in this study was birth weight. The mothers were also asked, "Was child weighed at birth?". If the mother answered yes, she was asked another question, "What was the weight of the child when born?" For children who were weighed at birth, mothers were asked to show the health record, where birth weight was recorded. For mothers who lacked the card, birth weight was determined using mother's recall. We categorized birth weight into two groups, LBW if birth weight was less than 2500g, and normal birth weight if birth weight was 2500g or more.

In the final analysis, we included some confounding factors classified into three main groups: community-level and socioeconomic factors, maternal and child characteristics and maternal and child healthcare services factors.

IDHS wealth index is a composite measure of a household's total standard of living, constructed utilizing simple data on a household's ownership of certain assets, material used in housing construction, types of water access and sanitary services household utilises. Principal Component Analysis (PCA) method was used to create the wealth index, divided into quintiles for the study (poorest, poorer, middle, richer, and richest). Birth rank and birth interval variables were combined to form a five-category composite variable consisting of first birth rank children, children of the second or third birth rank with a previous birth interval of more than two years, children of the second or third birth rank with a previous birth interval of 2 years or less, children of fourth or higher birth rank with a previous birth interval of more than two years, and children of fourth or higher birth rank with a previous birth interval of 2 years or less.

We included women's participation in the potential confounders. We measured women's participation using the Women's Participation Index (WPI). WPI is a composite variable derived from three household decision-making items: (1) use of maternal healthcare, (2) large household expenditures and (3) visiting family or relatives. We assigned one score to each decision involving women, whether made alone or by collaborating with others. Each decision made without women's contribution received a score of 0. We added the scores and assigned them a value between 0 and 3. None (index value 0), low (index value 1), moderate (index value 2), and high (index value 3) were the final response categories[10].

We used logistic regression to find a set of variables that could be used to predict prenatal iron intake and then we did a propensity score-matched analysis. Based on previous studies, we chose the variables to be evaluated[11,12].

The propensity score was derived using seven variables. It used a propensity score matching method to match a group of children whose mothers took iron supplements during pregnancy with a group of children whose mothers did not take iron supplements during pregnancy (Figure 1).

We matched the likelihood score of mothers who took iron supplements during pregnancy to that of mothers who did not take iron supplements during pregnancy. This nearest neighbour propensity score matching was implemented without any additional modifications. The caliper distance was the difference between the mothers who were matched and those who were not. This difference had to be less than 0.2 of the sample's propensity score's standard deviation[13].

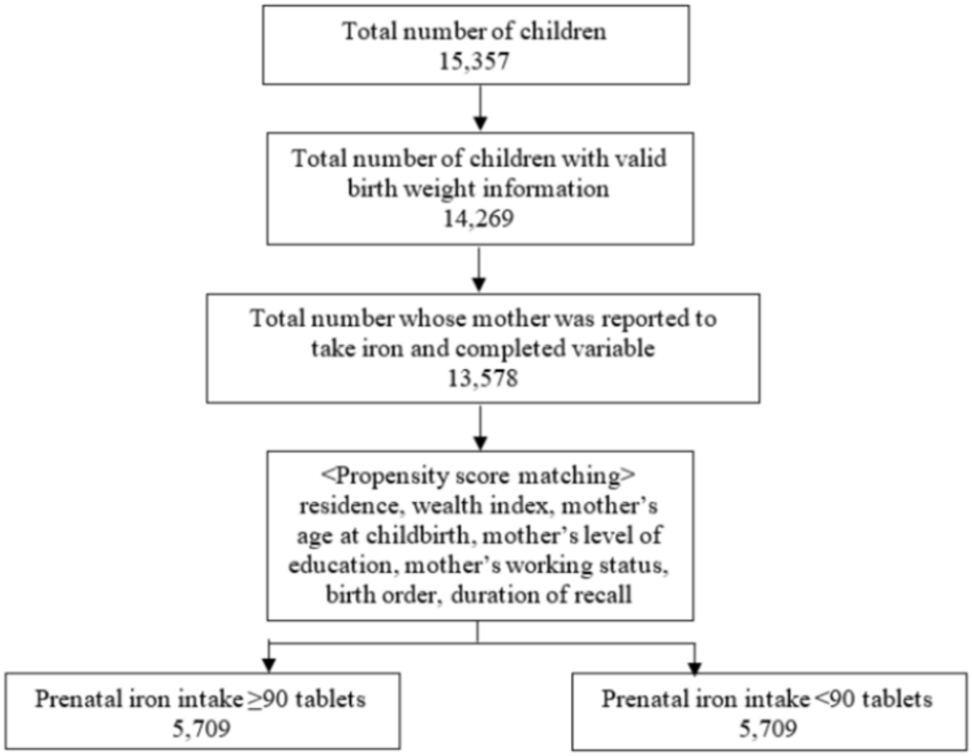

Figure 1: ***Process of selection of most recent live births in the five years prior to interview in 2017 Indonesia Demographic and Health Survey based on propensity score matching***

Ethical issues: The 2017 IDHS got ethical approval from the Inner-City Fund (ICF) International and ORC Macro Institutional Review Boards (ICF IRB FWA00000845). It followed the guidelines established by the US Department of Health and Human Services to protect human subjects, and all information provided by participants was kept anonymous. All the respondents had been informed about the survey and signed consent obtained before the interview.

Statistical analysis: We analysed data using Stata 15.1. A comparison was made between women who reported taking iron supplements during pregnancy and those who did not, using frequency tabulations for variables used for calculating propensity score and any potential confounding factors. We used binary logistic regression to assess association between iron supplementation intake during pregnancy and birth weight. We built multistage multivariate logistic regression models using the backward elimination technique. First stage of study focused on socioeconomic and community level factors. Non-significant factors ($p>0.05$) were eliminated in the first stage. Second step was to look at the characteristics of both mother and child in the model that were considered important at community-level and socioeconomic status factors. In the third stage, maternal and child health service factors were examined in the model that considered important community-level and socioeconomic status factors and maternal and child characteristics. The exposure variable (mother's reported use of iron supplements during pregnancy) was evaluated and adjusted for significant community-level and socioeconomic status factors, maternal and child characteristics, and maternal and child health service factors in the final stage.

Results

Table 1 shows the frequency of covariates used to make the propensity score of the most recent live births five years before each interview in Indonesia in 2017. In the five years preceding the survey, there were 11,418 live births, matching propensity score analysis. As expected, children whose mothers took iron supplements during pregnancy and those whose mothers did not take iron supplements had the same number of covariates used to make propensity score after they were matched.

Table 2 shows the effect of prenatal iron supplementation on LBW in the final model. This study found that children whose mothers take adequate prenatal iron supplementation had an adjusted odds of LBW significantly reduced by 25% [Adjusted Odds Ratio (AOR): 0.75; 95% confidence interval (CI) 0.64-0.88].

Table 1: ***Before and after matching for prenatal iron supplementation intake regarding covariates***

Covariate	Before matching		After matching	
	Prenatal iron supplementation		Prenatal iron supplementation	
	<90 tablets	≥90 tablets	<90 tablets	≥90 tablets
Residence – n (%)				
Rural	4185 (63.9)	2363 (36.1)	2453 (50.9)	2363 (49.3)
Urban	3684 (52.4)	3346 (47.6)	3256 (49.1)	3346 (50.7)
Maternal age at birth – n (%)				
<35 years	6357 (58.0)	4596 (41.0)	4619 (50.1)	4596 (49.9)
± 35 years	1512 (57.6)	1113 (42.4)	1090 (49.5)	1113 (50.5)
Maternal education – n (%)				
Primary or less	2066 (63.8)	1170 (36.2)	1230 (51.3)	1170 (48.7)
Secondary	4459 (57.0)	3366 (43.0)	3344 (49.8)	3366 (50.2)
Higher	1344 (53.4)	1173 (46.6)	1135 (49.2)	1173 (50.8)
Maternal working status – n (%)				
Did not work	4277 (59.2)	2952 (40.8)	2988 (50.3)	2952 (49.7)
Worked	3592 (56.6)	2757 (43.4)	2721 (49.7)	2757 (50.3)
Wealth index – n (%)				
Poorest	2054 (68.0)	968 (32.0)	1004 (50.9)	968 (49.1)
Poorer	1720 (62.8)	1019 (37.2)	1015 (49.9)	1019 (50.1)
Middle	1539 (57.2)	1152 (42.8)	1204 (51.1)	1152 (48.9)
Richer	1390 (53.0)	1231 (47.0)	1321 (51.8)	1231 (48.2)
Richest	1166 (46.5)	1339 (53.5)	1165 (46.5)	1339 (53.5)
Birth order – n (%)				
1	2414 (56.8)	1834 (43.2)	1864 (50.4)	1834 (49.6)
2-3	4118 (57.1)	3099 (42.9)	3024 (49.4)	3099 (50.6)
4 +	1337 (63.3)	776 (36.7)	821 (51.4)	776 (48.6)
Duration call - Mean	27.5	26.9	27.2	26.9

Table 2: ***Logistic regression for iron supplementation and LBW after adjusting for confounding factors***

Confounding factor	No. of children	No. of LBW	AOR (95% CI)	p-value
Prenatal iron supplementation				
<90 tablets	5,709	428	Reference	
≥90 tablets	5,709	334	0.75 (0.64-0.88)	0.000
Region				
Sumatra	2,947	165	0.79 (0.64-0.97)	0.027
Java-Bali	4,254	266	Reference	
Kalimantan	1,125	83	1.15 (0.88-1.50)	0.293
Sulawesi	1,486	112	1.05 (0.82-1.34)	0.690
East-Indonesia	1,606	136	1.21 (0.95-1.53)	0.124
Paternal education				
Primary or less	2,605	218	Reference	
Secondary	6,831	452	0.86 (0.71-1.04)	0.110
Higher	1,982	92	0.62 (0.46-0.84)	0.002
Wealth index				
Poorest	1,972	188	Reference	
Poorer	2,034	146	0.81 (0.64-1.03)	0.093
Middle	2,356	146	0.69 (0.53-0.89)	0.004
Richer	2,552	155	0.69 (0.53-0.89)	0.005
Richest	2,504	127	0.59 (0.44-0.80)	0.001
Birth order and interval				
Birth order 1	3,698	285	1.49 (1.26-1.76)	0.000
Birth order 2-3, interval ≤2 years	543	37	1.24 (0.87-1.79)	0.240
Birth order 2-3, interval >2 years	5,580	315	Reference	
Birth order 4+, interval ≤2 years	200	16	0.94 (0.53-1.68)	0.835
Birth order 4+, interval >2 years	1,397	109	1.06 (0.83-1.36)	0.622
Pregnancy complication				
No	9,347	531	Reference	
Yes	2,071	231	2.03 (1.72-2.4)	0.000
Type of pregnancy				
Single	11,350	721	Reference	
Multiple	68	41	25.06 (14.48-43.37)	0.000
Antenatal care				
Non-standardized	2,315	219	Reference	
Standardized	9,103	543	0.67 (0.60-0.87)	0.000
Birth attendance				
Non-health professional	459	48	Reference	
Health professional	10,959	723	0.11 (0.48-0.93)	0.017
Mode of delivery				
Vaginal	9,124	561	Reference	
Caesarean section	2,294	201	1.52 (1.27-1.83)	0.000

AOR: Adjusted Odds Ratio, CI: Confidence Interval

Discussion

Compared with mothers who did not intake iron supplementation as recommended, iron supplementation ≥90 tablets significantly reduced LBW. Our finding was consistent with some previous studies. A large cross-sectional study in China showed that iron supplementation was positively associated with birth weight after controlling some potential confounders[14]. National representative data from India also found that iron supplementation during pregnancy was inversely associated with LBW after adjusting for socioeconomic status. Significantly, the likelihood of LBW was 23% reduced by iron supplementation during pregnancy[15]. According to Imdad A, *et al*[16] routine daily iron supplementation reduced the incidence of LBW by 20% and increased the mean birth weight by 42.18g. Based on the available evidence, iron supplementation raises the haematologic indicators of iron status levels and lowers the prevalence of iron deficiency anaemia in LBW children[17], although, a study in Cleveland, United States, found that iron supplementation during pregnancy was not significantly affected by birth weight[18]. This controversial finding is dependent on the health status of the population studied. While the participants in this study were nearly healthy, their average total iron intake was higher than recommended[19].

Anaemia remained a major public health problem. Almost half of pregnant women suffer from anaemia in Indonesia[5]. Indonesia's government made a policy to solve this problem. Despite comprehensive policies addressing anaemia among women of reproductive age, Indonesia faces implementation challenges. Every pregnant mother should take a minimum of 90 iron tablets during pregnancy. Only 38% of mothers reported taking iron supplementation of a minimum of 90 tablets during pregnancy in 2018. Furthermore, the most educated mothers living in urban areas are more likely to take iron supplementation as a recommendation than less educated mothers who live in rural areas[5]. More effort is thus required to reach the most disadvantaged women, who have greater needs for iron supplementation.

There are several limitations to this study. Self-reported iron supplementation may differ from actual consumption, and we could not determine iron supplementation compliance. All variables were self-reported except birth weight, obtained from the health card and reported by mothers. As a result, recall bias may exist, though it is unlikely that it differed between mothers who received iron supplementation as a recommendation and mothers who did not receive iron supplementation as a recommendation. Another limitation of this study was that we did not mention iron status among respondents due to the non-availability of data.

Conclusions

This study found that iron supplementation during pregnancy significantly reduced LBW.

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