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RESEARCH ARTICLE

Examining the Birth Weights of Children in India: Impact of Iron-Folic Acid Supplements during Pregnancy

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Abstract

Objective: To evaluate the association between Iron Folic Acid (IFA) supplementation during pregnancy and children's birth weights in India. **Methods:** We have used India Human Development Survey-2, 2011-12 data to verify this relation. This is a nationally representative survey of 42,152 households in 1503 villages and 971 urban localities across India. The association between the child's birth weight and IFA intake during pregnancy along with other potential factors are analysed using logistic regression. **Findings:** Approximately 24 percent of women were found to be never consuming IFA during pregnancy and 31 percent of pregnant women took IFA for less than three months which is below the prescribed limit in 2011-12. This study finds that IFA supplementation has significantly associated with 23 percent (and 31 percent in Model 2) reduction in odds of low-birth-weight outcome when it is consumed for more than 3 months during pregnancy. However, this association is not significant for less than 3 months supplementation. Our study has also shown that factors like maternal nutrition (BMI taken as a proxy), maternal education, mother's age and wealth quintile are likely to impact birth weight after adjustment for other covariates. **Novelty:** To our knowledge, there are just handful of studies which attempted to find out the association between IFA supplementation during pregnancy and birth weight outcome using population level data in India. We need sufficient evidence to establish the relationship for this developing country where almost 58 percent of pregnant women were anaemic. Our study tries to find out the magnitude of association between Iron and Folic Acid (IFA) supplementation during pregnancy and children's birth weights in India using nationally representative IHDS data. This study also examines the socio-economic and demographic factors associated with birth outcome. From this analysis, we can emphasis on some potential policy interventions to reduce prevalence of low birth weight. The useful policies to ensure nutritious food to pregnant women and also to women who are likely to conceive will be highly effective.

Keywords: Low birth weight; Antenatal care; Iron supplementation; Determinants of low birth-weight; IHDS data

1 Introduction

Globally more than 20 million infants are born with low birth weight and India alone produces almost forty percent of all Lower Birth Weight (LBW) children born in developing countries[1]. Low birth weight has adverse health consequences including neonatal mortality, morbidity, many chronic diseases in later life as well[2–9].

Public health intervention like micronutrient supplementation during pregnancy in many countries have shown positive impact on infant birth weight and early development in childhood[2–7].

The Iron-Folic acid (IFA) intervention during pregnancy has been reported to be vital determinant of birth weight[2,3,8,9]. As per the national guidelines, pregnant women should take IFA tablets daily for at least 100 days[10]. According to NFHS4 2015–2016 survey[11], over 50 percent of pregnant women were diagnosed with Iron-deficiency anaemia. Also, an average of only 30.3% of mothers consumed IFA for 100 days or more when they were pregnant. Studies have found that women's education, household's income level and number of antenatal visits improve IFA intake[12].

Recent studies[5,6,13,14], using NFHS data, established that IFA intake during pregnancy has been found to have significantly positive impact on birth-weight in India.

Also, there are systematic review and meta-analysis which explored the association between IFA and infant birth weight in global perspectives[8,9]. However, present empirical evidence of the beneficial effect of IFA during pregnancy on infant birth weight is very limited in India's context.

To our knowledge, there are just handful of studies[5,13,14] which attempted to investigate this association using population level data in India. We need sufficient evidence to establish the relationship for this developing country where almost 58 percent of pregnant women were anaemic (NFHS-4).

This study tries to explore the association between Iron and Folic Acid (IFA) supplementation during pregnancy and children's birth weights in India using nationally representative data set. This study also examines the socio-economic and demographic factors associated with birth outcome.

2 Data and Methodology

We have used India Human Development Survey-2, 2011-12 data[15]. This is a nationally representative survey of 42,152 households in 1503 villages and 971 urban localities across India. This survey is the most recent national survey and covers array of topics on health, education, employment, gender relation, medical facilities, village infrastructure etc.

We have done the analysis using two groups of mothers from the same the master data file (IHDS-2). The analysis which uses first sample is referred to as Model 1 and the analysis using other sample is referred to Model 2.

In Model 1, we have used records of birth weight and all the independent variables pertaining to all last births recorded since 2005 in IHDS-2. In Model 1, the maximum upper age of the children is around 6-7 years at the time of survey. As we have solely depended on mother's reporting of birth size which is the most crucial variable for this study, we have selected more recent born children in Model 2. **In Model 2,** we only considered children who were born between 2008 and 2012 to reduce recall bias. We assume, mothers can remember the birth size of the child more accurately if they were born maximum 3-4 years prior to the survey compared to the longer stretch of 2005-12 (in Model 1). Model 2 is a subset of Model 1 as Model 1 has all the mothers whose child is born after 2005 and Model 2 has mothers whose child is born after 2008. Therefore, the sample size is more in Model 1 and less in Model 2. Needless to say, as Model 2

captures shorter time frame, it gives more accurate maternal and household characteristics which are similar to birth time characteristics.

Women file contains 13,885 ids for last births (since 2005 till survey date) who were alive and information about birth weight is available for 13,434 children. The information about IFA supplementation, new-born's birth weight is available only for last pregnancy since 2005. When controlled for various covariates, regression includes **12, 637 observations in Model 1**. For Model 2, number of observations is 8,469 who were born since 2008. Again, the sample size is reduced to **7,897** after controlling for all covariates in **Model 2** regression.

Our analysis is based on the conceptual framework adapted from WHO's [16] list of factors that can be potential determinants of sub-optimal foetal development. It is conceptualised that birth weight is directly related to some factors which are referred to as 'proximate' determinants, like mother's nutrition, antenatal care, life style factors of mothers. Some 'underlying' factors influence birth size indirectly through influencing proximate factors, like mother's education, her status, poverty, etc

In this analysis, we evaluate the impact of iron folic acid (IFA) supplementation during pregnancy on child's birth weight. Along with IFA, the main variable of interest, this study aims to identify other factors which are also correlated with low birth weight. The dependent variable birth weight is categorical. Therefore, the association between this categorical variable and other factors are analysed using logistic regression. All the factors which we included as controls in the logistic regression are based on previous studies.

2.1 *Dependent variable*

Birth weights are recorded only from mothers' recall. If birth weight is less than 2500 gms then it is called a low birth weight and any weight above this limit is considered to be normal. In this IHDS data birth weights recalled by mothers are recorded. Birth weight of only last birth is asked to mother to reduce recall bias. The survey records four types of response for birth weight- very small, small, average and large. We constructed outcome variable as binary– 'very small' and 'small' as LBW and other responses as Normal. We coded Normal weight as '0' and LBW as '1'.

As there is no authentic information about child's exact birth weight in the data, we have to completely rely on mothers' report which is a proxy for birth weight.

2.2 *Independent variables*

The main variable of interest is self-reported iron-folic acid supplements consumed during last pregnancy. Mothers were asked if they received any iron folic tablets or syrup during last pregnancy. If the reply was "Yes", they were further asked if they received enough IFA to last three months or more. Iron folic acid consumption was taken as categorical variable: as

(i) not consumed (ii) consumed for less than 3 months and (iii) consumed for more than 3 months.

The covariates included in the analysis can be categorised as maternal characteristics (IFA supplementation, Age, BMI, education, Ante-Natal Care (ANC) visits, birth order of the last-born child), socio economic characteristics (income, caste, religion, place of residence), household characteristics (source of drinking water).

We calculated BMI using mother's height (in meter) and weight (in Kg). The formula of BMI calculation is mother's weight over her height squared. BMI was classified into three categories: (i) underweight (<18.5 kg/m2) (ii) normal (18.5- 23.00 kg/m2) and (iii) overweight (>23.00 kg/m2)

We adopted logistic regression to study the association between iron-folic acid supplementation with the occurrence of LBW.

Our dependent variable is the birth weight which categorised as low birth weight and normal birth weight. Independent variables taken in this model are based on previous studies using similar datasets.

Ethnicity was classified as 1) General caste: they are considered socially, economically and educationally privileged 2) other backward class (OBC): they are socially and educationally disadvantaged 3) Scheduled caste (SC) and 4) Scheduled tribe (ST). Among all caste groups, SC s and STs are historically more deprived and marginalised in India. These terms are used by Indian Constitution to classify the caste system.

ANC visit has 3 categories- 1) No ANC visit at all 2) 1-3 ANC visits and 3) more than 3 visits. Birth order is categorised into three groups – 1) first child 2) 2-3rd child 3) fourth or higher.

3 Result and Discussion

Model 1 has sample of 12,637 and Model 2 has sample of 7,903 ever-married women who have given birth to their last child since January, 2005 and 2008 respectively till the survey date.

Descriptive statistics of the sample, taken from IHDS-2, 2011-12 survey, are shown in Table 1. This survey documents birth related details pertaining to only latest birth (like birth weight, immunisation, prenatal care, postnatal care, birth related complication, etc.). The eligible women were asked about their last birth delivered since January, 2005. Table 1 shows descriptive statistics of all women who have given last birth since 2005 till the survey. As per the mothers' recalls, the prevalence of low birth weight was 16.16 percent in our sample. Almost 24 percent of women did not have iron folic acid supplementation during their last pregnancy while 31.5 percent had for less than three months and 45 percent have for more than three months. As per this population, around 28 percent women had anaemia related complication during last pregnancy. 26.6 percent of women in our sample was underweight during the survey. In the sample, almost all women have utilised antenatal check-up services at least for ones. Almost 41 percent has 1-3 ANC visits and around 59 percent has more than 3 visits.

Table 1. Descriptive statistics of some major characteristics, IHDS-2 (2011-12)

	Percent
Birth weight	
Low Birth Weight (LBW)	16.16
Iron-Folic acid (IFA) supplementation	
none	23.78
less than 3 months	31.48
more than 3 months	44.74
Anaemia during last pregnancy	27.8
Mother's BMI	
Underweight	26.57
Normal	45.36
Overweight	28.07
Ante natal Checkup	
No visit	0.14
1-3 visits	40.95
more than 3 visits	58.91
Mother's age	
15-19	2.16
20-24	23.53
25-29	36.32
30-50	37.99
Birth order	
1st child	28.22
2-3rd child	51.01
4th or more	20.77
Mother's education	
Illiterate	32.21
Below primary	5.95
Primary completed	17.33
8th class completed	28.7
Higher secondary or above	15.82

LBW was more prevalent among children whose mothers were underweight and very young at age (Table 2). Children from the poorest quintile has higher prevalence (19.89 percent) compared to their richest counterpart (11.29 percent). LBW was predominant among those children whose mothers did not take iron-folic acid supplementation (18.96 percent for no IFA supplementation vis-a-vis 12.87 percent for more than 3 months IFA supplementation).

We have adopted logistic regression model to test the association of IFA with prevalence of low-birth-weight children. We have controlled for various maternal, socioeconomic and household characteristics in this model. The result of regression, after adjusting for all maternal, demographic and socioeconomic characteristics, is given in Table 3 **. Model 1** and **Model 2** both are result of logistic regressions using same set of covariates and dependent variable. The only difference is in sample size. Model

Table 2. Rates of LBW across various maternal, socioeconomic variables, IHDS-2 (2011-12)

Variable	LBW (%)
Place of residence	
Rural	17.3
Urban	13.74
Sex of the child	
Boy Child	15.59
Girl child	17.18
Mother's BMI	
Underweight	18.92
Normal	15.42
Overweight	15.13
Mother's age	
15-19	22.96
20-24	18.47
25-29	15.92
30-50	14.97
IFA supplements	
No supplements	18.96
consumed for < 3 months	18.69
consumed for > 3 months	12.87
Caste of household	
General caste	15.64
OBC	15.03
SC	18.2
ST & others	18.77
Religion of household	
Hindu	16.45
Muslim	15.87
Christian	14.73
Sikh & others	14.01
Income quintile	
Poorest	19.89
Poor	18.03
Middle	16.41
Richer	14.85
Richest	11.29

1 considers all last birth since 2005 till the date of interview, whereas Model 2 only considers last births since 2008. Model 2 is built only keeping in mind that mother's memory about IFA doses during pregnancy, birth weight of the child may not be very authentic if she has delivered her last child almost 8 years back (for example: if last child was born in January, 2005 and she was interviewed in December,2012). In Model 2, a mother has delivered her last child maximum 5 years prior to interview (for example: if woman has delivered in January, 2008 and was interviewed in December, 2012).

The result in Table 3 reveals that Model 1 and 2 exhibit similar result. In both the models, same determinants are coming as significant for birth weight (with the exception of wealth quintile). Magnitudes of odds ratios are also closer in both the models.

IFA supplementation is significantly correlated with low birth weight when it is consumed for more than 3 months during pregnancy with 26 percent and 31 percent reduction in odds of low-birth-weight child respectively in Model 1 and Model 2. However, this association is not significant for less than 3 months supplementation. This result is consistent with limited studies in the Indian context [5,13,14] and also the studies with global context [4,7–9].

Table 3. Logistic Regression, IHDS-2 (2011-12)

Factors	Model 1 Odds ratio	Model 2 Odds ratio
IFA supplementation: No supplementation [Ref]		
Supplementation for less than 3 months	1.023 (0.069)	0.94 (0.081)
Supplementation for more than 3 months	0.744*** (0.049)	0.686 *** (0.050)
Antenatal check-up: No ANC visit [Ref]		
1-3 visit	0.957 (0.618)	1.69 (1.813)
More than 3 visits	0.966 (0.623)	1.672 (1.80)
BMI group: Underweight [Ref]		
Normal	0.879** (0.053)	0.813*** (0.060)
Overweight	0.886* (0.063)	0.82*** (0.072)
Mother's age: 15-19 years [Ref]		
20-24 years	0.786 (0.137)	0.758 (0.140)
25-29 years	0.648** (0.115)	0.650** (0.123)
30-50 years	0.569*** (0.104)	0.672** (0.134)
Mother's education: Illiterate [Ref]		
Below primary	0.902 (0.100)	0.928 (0.138)
Primary	0.969 (0.073)	1.027 (0.0965)
8th class completed	0.799*** (0.058)	0.823** (0.073)
Higher secondary or more	0.806** (0.078)	0.756** (0.0878)
Birth order: 1st child [Ref]		
2nd-3rd child	0.989 (0.065)	0.975 (0.073)
4th or more	1.061 (0.099)	0.998 (0.120)
Sex of the child: Boy [Ref]		
Girl	1.099* (0.055)	1.072 (0.066)
Income quintile: Poorest [Ref]		
Poor	1.011 (0.077)	1.029 (0.099)
Middle	0.989 (0.076)	0.936 (0.092)
Richer	1.007 (0.082)	1.107 (0.110)
Richest	0.822** (0.074)	0.874 (0.096)
Religion: Hindu [Ref]		
Muslim	1.075 (0.0789)	0.851* (0.082)
Christian	1.014 (0.197)	1.05 (0.251)
Sikh and others	0.806 (0.122)	0.886 (0.160)
Caste: General caste [Ref]		
OBC	0.734*** (0.047)	0.745*** (0.060)
SC	0.823 (0.062)	0.784 (0.073)
ST & others	0.957 (0.089)	0.918 (0.107)
Place of living: Rural [Ref]		
Urban	0.918 (0.057)	0.952 (0.072)
Indoor piped drinking water: No piped connection [ref]		
Piped drinking water inside home	0.938 (0.059)	0.956 (0.073)
N	**12637**	**7897**

Standard errors in parentheses; * p<0.10, ** p<0.05, *** p<0.01;
variables with superscript 'Ref' are baseline/ reference categories in the logistic regression.

This study finds mother's health is a significant determinant for the prevalence of LBW child. Mothers with normal BMI has lower likelihood of delivering a LBW child compared to underweight mothers.

We observe, from this analysis, a strong relationship between maternal education and LBW. Mother's education is found to be an important determinant of child's birth weight. Mothers who have completed 8^{th} class or even more have 20 percent lower odds (in Model 1) of having LBW children compared to illiterate mothers. Mothers who are more than 25 years old have lesser likelihood of having LBW children compared to younger mothers. Model 1 shows that richest quintile has 18 percent lower chance of LBW child compared to their poorest counterpart while Model 2 finds no significant impact.

Interestingly, in both the models, children who belong to OBC (other backward caste) category are found to be less likely to be LBW children compared to children who belongs to General caste.

This study has not found any significant relationship between antenatal visits and prevalence of LBW.

4 Conclusion

Our analysis aimed to understand the association between IFA supplementation in pregnant mothers and child birth outcome. Mothers who consumed iron and folic acid supplements for more than 3 months during pregnancy were less likely to have LBW children (odds ratio: 0.744 with p-value 0.049 in Model 1 and odds ratio: 0.686 with p-value 0.05 in Model 2). In this paper, no association is found for women who took IFA tablet for less than 3 months.

This finding is consistent with the analysis of[2,3,13,14] which also used nationally representative NFHS (National Family Health Survey) data. Having shown this relationship, this looks really challenging for public health while IHDS data is clearly indicating that almost 55 percent of pregnant women either do not take IFA at all or consume IFA for less than prescribed 100 days (Table 1).

Our study has shown that factors like maternal nutrition (BMI), maternal education, mother's age and wealth quintile are significant determinants of birth weight after adjustment for other covariates.

The significant association between mother's education and child's birth weight can be explained by many ways. An educated pregnant mother may have more knowledge about antenatal care and best practices during pregnancy. She is more likely to take care of her own health and nutrition. Also, education is related with more say on age of marriage. Education reduces the incidences of marriage at very young age and therefore also reduces chance of early pregnancy.

We found our result is robust even when we dropped the older children and only considered children who are born in or after 2008.

Iron deficiency during pregnancy is already established to have intergenerational consequences. As there is high prevalence of maternal anaemia during pregnancy in this country, prevention and routine supplementation of iron and folic acid should be high priority to address maternal and neonatal health. Maternal anaemia should be detected early by regular health screening.

This study, however, recognizes certain limitations that should be considered while interpreting the findings. The unobservable factors, like probable health complications during pregnancy, which can affect growth of foetus was not captured in IHDS data. Another important limitation is the birth weight is self-reported by mothers and health card is not referred here. Therefore, the data may suffer from mother's recall bias.

However, all the results obtained from this analysis are quite consistent with studies done by other scholars, but this maternal recall data should be used with appropriate caution.

This study used cross-section data to evaluate the association between IFA supplementation during pregnancy and the birth weight. Therefore, no causal relationship can not be established from this analysis.

In spite of these limitations, this paper contributes hugely to the limited literature available to establish the association in Indian perspective. There is dearth of evidence-based information in this arena of public health.

From this analysis, we can emphasis on some potential policy interventions to reduce prevalence of low birth weight. The useful policies to ensure nutritious food to pregnant women and also to women who are likely to conceive will be highly effective. Antenatal check-up should be promoted and encouraged to diagnose any deficiency or complication. As ANC is the prime source of IFA intervention and also awareness about the nutrition during pregnancy, a comprehensive ANC is crucial. This is also important to analyse the demand side blockades to IFA consumption during pregnancy for better coverage of supplementation. A better intervention strategy will definitely improve the maternal nutrition as well as infant birth weight in India.

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